

ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges:

<i>IAA</i> (A-10000 Series)	A80-32627 -- A80-43838
<i>STAR</i> (N-10000 Series)	N80-22255 -- N80-28294

Previous publications announced in this series/subject category include:

<i>DOCUMENT</i>	<i>DATE</i>	<i>COVERAGE</i>
NASA SP-7042	April 1974	January 1968 -- December 1973
NASA SP-7043(01)	May 1974	January 1, 1974 -- March 31, 1974
NASA SP-7043(02)	November 1974	April 1, 1974 -- June 30, 1974
NASA SP-7043(03)	February 1975	July 1, 1974 -- September 30, 1974
NASA SP-7043(04)	May 1975	October 1, 1974 -- December 31, 1974
NASA SP-7043(05)	August 1975	January 1, 1975 -- March 31, 1975
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NASA SP-7043(25)	April 1980	January 1, 1980 - March 31, 1980
NASA SP-7043(26)	July 1980	April 1, 1980 - June 30, 1980

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ENERGY

A Continuing Bibliography

With Indexes

Issue 27

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from July 1 through September 30, 1980 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(27)) lists 1920 reports, journal articles, and other documents announced between July 1, 1980 and September 30, 1980 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Five indexes -- subject, personal author, corporate source, contract number, and report number -- are included.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at \$6.00 per document up to a maximum of 20 pages. The charge for each additional page is \$0.25. Microfiche⁽¹⁾ of documents announced in *IAA* are available at the rate of \$2.50 per microfiche on demand, and at the rate of \$1.10 per microfiche for standing orders for all *IAA* microfiche. The price for the *IAA* microfiche by category is available at the rate of \$1.25 per microfiche plus a \$1.00 service charge per category per issue. Microfiche of all the current AIAA Meeting Papers are available on a standing order basis at the rate of \$1.35 per microfiche.

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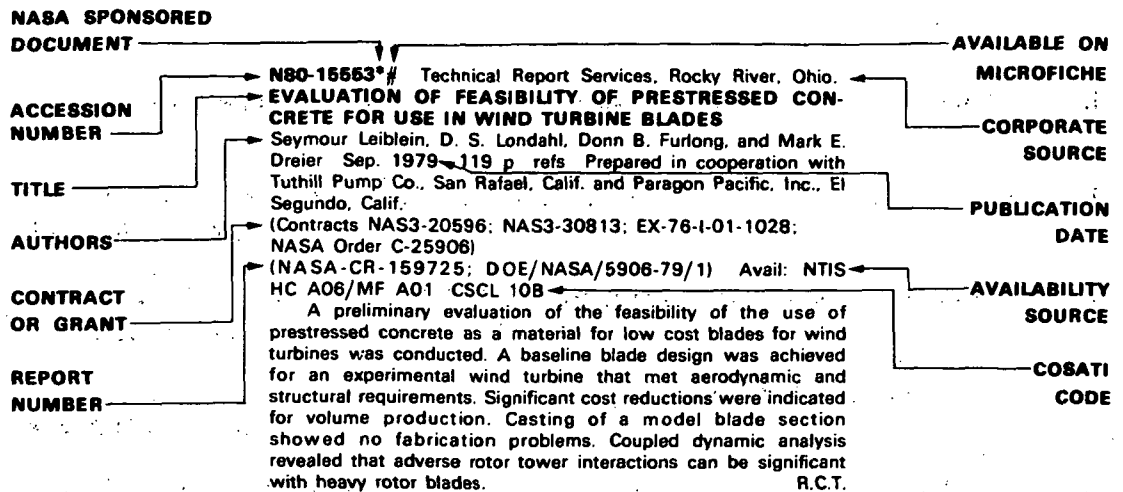
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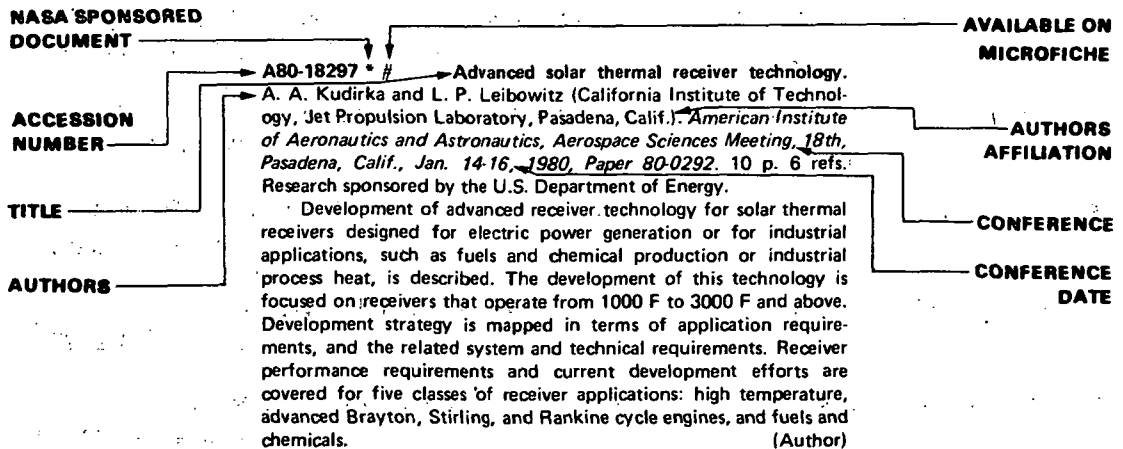
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OCTOBER 1980

01

ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

Includes energy requirements, energy conservation, and environmental impacts of energy systems.

A80-33433 Energy self-sufficiency in monsoonal Australia. T. R. Lee (Environment Council (N.J.), Inc., Darwin, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 173-177.

The paper presents the development concept of the Darwin Solar Village project, an energy self-sufficient residential development now in construction on the north coast of Australia. The project will employ windmill water pumping, commercial solar hot water systems, solar electrical systems, aerogeneration, and solar air conditioning. The use of methane produced from household wastes and wastes from agricultural and animal husbandry activities will have an important role in reducing the electrical power demand, primarily for cooking. The social requirements for the achievement of energy self-sufficiency are also discussed. V.L.

A80-33436 Canada's federal solar energy program. R. M. Aldwinckle (National Research Council, Ottawa, Canada). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 187-191.

A80-33437 Solar energy R & D projects in Denmark. V. Korsgaard and T. V. Esbensen (Danmarks Tekniske Højskole, Lyngby, Denmark). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 192-194.

A80-33441 National solar heating and cooling programme in the Netherlands. K. Joon, P. F. Sens (Netherlands Energy Research Foundation, Petten, Netherlands), and C. W. J. van Koppen (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 215-218.

A80-33442 National solar heating and cooling programme - New Zealand. R. F. Benseman and M. A. Collins. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 219-223. 10 refs.

A80-33443 Solar Heating '85 - Sweden's national solar heating program. L. O. Matsson (Solar Energy Association of Scandinavia, Stockholm, Sweden). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 224-228.

A80-33444 Solar energy research in Sweden. L. Kristoferson (Kungl. Svenska Vetenskapsakademien, Beijer Institutet; Swedish Energy R&D Commission, Stockholm, Sweden). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 229-232. 10 refs.

A80-33445 The United Kingdom solar heating programme. D. W. Jefferson-Loveday (Department of Energy, Energy Technology Support Unit, Harwell, Oxon, England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 233-237. 7 refs.

A80-33446 Status of the United States' Solar Heating and Cooling Program. F. H. Morse (U.S. Department of Energy, Office of Solar Applications, Washington, D.C.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 238-242. 5 refs.

A80-33672 International development assistance for renewable technologies - Current programs and institutional requirements. J. H. Ashworth and R. E. Meunier (Solar Energy Research Institute, Golden, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1460-1464.

Within the last several years, foreign assistance donor agencies have begun to provide significant aid for the search for renewable energy sources in developing nations. This paper reports preliminary results from a survey of development assistance projects in renewable energy sources, indicating which areas are extensions of traditional assistance areas and which are new areas of involvement. The last two portions of the paper indicate certain shortcomings in the current effort, and linkages which must be emphasized in order to increase the effectiveness of the range of donor activities. (Author)

A80-33675 A renewable energy system for developing countries. H. J. Allison (Oklahoma State University, Stillwater, Okla.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1475-1479. Research sponsored by the United Nations Environment Program.

Decentralized power systems which operate from renewable energy resources can supply reliable energy to remote areas of the developing nations of the world. Such systems can do much to improve the quality of life for millions of people throughout the world. This paper describes an energy system which integrates solar, wind, and biomass resources in a manner which produces a more flexible and reliable power source than could be made available from separate uses of these renewable resources. Prototype systems based on the concepts described in this paper are planned for Sri Lanka, Senegal, and Mexico. (Author)

A80-33677 Energy systems based on local renewable energy resources for a rural community in a developing country. D. Cavard and P. Cricqui (CNRS, Institut Economique et Juridique de l'Energie, Grenoble, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1485-1489.

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

The application of energy balance to a particular case, an isolated, rural developing community, shows the following relevant facts: (1) a relatively great actual importance and a large potentiality of the renewable energy sources, which could solve certain problems of development, (2) in general, present energy needs remain largely unsatisfied, and (3) the increase of the consumption of imported energy resources (mainly oil products) might cause some socio-economic disequilibria in this area. It is shown that it will be advantageous for such a country to develop all the biomass energy resources and the wind and photovoltaic solar sources in order to provide for the local needs of electricity and water-pumping.

(Author)

A80-33690 Integrating energy approaches in a large office building. M. Villocco. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1561-1564.

The TVA office complex for Chattanooga will be a demonstration of energy conscious design, pushing the state of the art in combining urban density with a solar envelope and in using daylight as a primary energy strategy. The paper describes the quantitative and qualitative design objectives of the project, the interdisciplinary team approach, and the technical conclusions of the design team. The paper also discusses the impact of the project on Chattanooga in terms of solar zoning and efforts to use cogeneration with renewable resources to provide off-the-grid power.

(Author)

A80-33706 Design and performance of low heat loss window systems. A. L. Berlad, Y. J. Yeh, N. Tutu, and R. Jaung (New York, State University, Stony Brook, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1652-1655.

A80-34018 # Two new energy information bases - ERDI/West, an energy research and development inventory for the West; and ESIDD, energy saving and investment data and documents. A. H. Rosenfeld and F. C. Winkelmann (California, University, Berkeley, Calif.). *CODATA Bulletin*, no. 23, May 1977, p. 1-3; Discussion, p. 3, 4. ERDA-supported research.

Two new energy information bases, ERDI/West and ESIDD are described. ERDI/West is a computer-based inventory destined to cover all energy-related activity in the Western Region of the U.S. It now contains information on projects and investigators in California, but ultimately will also have document and data files. ERDI/West is expected to be a useful tool for administrators, legislators, and researchers in planning, funding, or conducting energy research and development in the West. The second data base, ESIDD, Energy Savings and Investment Data and Documents, contains up-to-date information on existing documents and data on annual energy savings and required investment for different energy conservation measures in homes, commercial buildings, industry, and in home appliance selection. To illustrate the importance of cost-to-saving data for setting energy priorities, two energy strategies are compared: producing more energy by building a \$1.6 billion synthetic gas plant, versus conserving energy by adding extra insulation to existing homes and appliances.

(Author)

A80-34056 # Siemens/Düwag H-Bahn - Technology and comparative assessment. F. Frederich (Waggonfabrik Uerdingen AG, Krefeld-Uerdingen, West Germany). In: Advanced transit and urban revitalization - An international dialogue; Proceedings of the International Conference, Indianapolis, Ind., April 25-28, 1978. Volume 1. Washington, D.C., Advanced Transit Association, 1978. 19 p. 16 refs. Research supported by the Bundesministerium für Forschung und Technologie.

The paper deals with the technology of the H-Bahn. A brief description is given of the system components, comprising the track beams, track support columns, points, cabins and cars of various sizes

and running gear units with linear and rotating motor drives, as well as the automatic control system. A comparison with existing rapid transit systems proves the suitability of the H-Bahn as a rapid transit system. The criteria applied are capacity, riding comfort, noise propagation, width of traffic corridor, pollution emission, energy consumption, capital investment and operating costs.

(Author)

A80-34067 # The bus systems, passenger transit system of the future. M. Krüger (Maschinenfabrik Augsburg-Nürnberg AG, Munich, West Germany). In: Advanced transit and urban revitalization - An international dialogue; Proceedings of the International Conference, Indianapolis, Ind., April 25-28, 1978. Volume 1. Washington, D.C., Advanced Transit Association, 1978. 21 p. 14 refs.

The paper examines future bus systems which will integrate passenger requirements, vehicle design, and operation for improved reliability, frequency, speed, and comfort of bus riding. Traffic density, areas required for traffic, energy consumption, and safety are discussed, presenting an improved system which integrates the infrastructure such as the bus route, the bus stop, and traffic signals; the organization of passenger handling in regard to travel routes, ticket information and ticket purchase; and bus designs incorporating low energy consumption, low emissions, and independence from the use of oil.

A.T.

A80-34122 Investigation of further economics development of regional electricity supply concerns (Untersuchung zur weiteren wirtschaftlichen Entwicklung regionaler EVU). K. Hubig and G. Sickmüller (Überlandwerk Oberfranken AG, Bamberg, West Germany). *Energiewirtschaftliche Tagesfragen*, vol. 30, Apr. 1980, p. 225-229. In German.

The article examines the year-end results of the power plant operating costs during 1977 and 1978 in the Federal Republic of Germany. A complete economic analysis is made considering such factors as productivity and stagnation of capital budgets.

M.E.P.

A80-34124 The energy supply of today and tomorrow (Die Energieversorgung von heute und morgen). W. Janssen (Überlandwerk Unterfranken AG, Würzburg, West Germany). *Energiewirtschaftliche Tagesfragen*, vol. 30, Apr. 1980, p. 280-286. In German.

The paper examines present worldwide energy demand and compares it with predictions of future demand. Topics discussed include the exhaustible energies, regenerative energies, nuclear energy, electrical power, power plant capacities, safety and the environment, and the necessity and possibilities for energy conservation.

M.E.P.

A80-34125 The influence of the federal council on the formulation of the 'Regulation on general conditions for the supply of electricity for tariff customers' and the 'Second regulation on altering of the federal electricity tariff structure' - Attempt at a critical assessment (Zum Einfluss des Bundesrates auf die Fassung der 'Verordnung über Allgemeine Bedingungen für die Elektrizitätsversorgung von Tarifkunden (AVBEltV)' und der 'Zweiten Verordnung zur Änderung der Bundestarifordnung Elektrizität' - Versuch einer kritischen Würdigung). B. D. Sanders (Hannover-Braunschweigische Stromversorgungs-AG, Hanover, West Germany). *Energiewirtschaftliche Tagesfragen*, vol. 30, Apr. 1980, p. 286-298. 16 refs. In German.

A80-34600 The trace element chemistry of coal during combustion and the emissions from coal-fired plants. R. D. Smith (Battelle Pacific Northwest Laboratories, Richland, Wash.). *Progress in Energy and Combustion Science*, vol. 6, no. 1, 1980, p. 53-119. 155 refs.

A80-35649 Trace element inputs from a coal burning power plant to adjacent terrestrial and aquatic environments. D. W. Evans, J. G. Wiener (Georgia, University, Aiken, S.C.), and J. H. Horton. *Air Pollution Control Association, Journal*, vol. 30, May

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1980, p. 567-573. 25 refs. U.S. Environmental Protection Agency Contract No. IAG-D5-B681; Contract No. EY-76-C-09-0819.

A80-35740 # Wind energy from a utility planning perspective. N. G. Butler (Bonneville Power Administration, Portland, Ore.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 305-310.

A method of potential wind generation assessment is presented which has the objective of extracting the maximum amount of energy per year at the lowest cost. The method consists in examining existing regional data; estimating the annual average wind power, estimating the annual energy production of different sizes of wind turbines by using the 'Harder curve', and the total number of turbines per site. The estimated output per wind turbine and the total number of turbines per site combine to produce an estimate of the wind field energy production potential, once the extent of the wind field has been determined. The cost of energy is estimated from the standard cost of energy equation. V.L.

A80-35878 Application of combustion technology for NO(x) emissions reduction on petroleum process heaters. S. C. Hunter and W. A. Carter (KVB, Inc., Tustin, Calif.). *AIChE Symposium Series*, vol. 75, no. 188, 1979, p. 14-26. 12 refs.

Seven petroleum refinery process heaters were tested to evaluate the feasibility of combustion system adjustments as a means of pollutant emissions reduction. Adjustments evaluated included fuel heat content variation, load variation, adjustment of excess air, burner air register adjustments, and removal of burners from service. Most refinery heaters use natural draft burners and the five units tested of that type showed less flexibility for combustion system adjustments compared with mechanical draft heaters and boilers. The largest NO(x) reduction obtained while firing refinery gas was about 20% and some heaters showed no response. There were significant effects of fuel heat content and load changes that used further investigation. Two mechanical draft single-burner heaters were tested. Reduction of excess air reduced NO(x) on gas fuel but had no effect on NO(x) when firing No. 6 oil. One mechanical draft unit that had air preheat produced significantly higher NO(x) emissions than did the other heaters. (Author)

A80-35879 Investigation of first- and second-stage variables on control of NOx emissions using staged combustion in a pulverized coal wall-fired furnace. R. A. Brown, H. B. Mason (Acurex Corp., Mountain View, Calif.), D. W. Pershing, and J. O. L. Wendt (Arizona, University, Tucson, Ariz.). *AIChE Symposium Series*, vol. 75, no. 188, 1979, p. 27-47. 33 refs.

A80-35880 Process alternatives for stack gas desulfurization with H₂S regeneration to produce sulfur. G. T. Rochelle (Texas, University, Austin, Tex.) and C. J. King (California, University, Berkeley, Calif.). *AIChE Symposium Series*, vol. 75, no. 188, 1979, p. 48-61. 39 refs.

New and existing process alternatives are reviewed for stack gas desulfurization by aqueous, buffered scrubbing with H₂S regeneration to produce elemental sulfur. The existing commercial processes include the citrate and phosphate processes; which use a single regeneration loop. Analysis of the reaction kinetics and stoichiometry indicates that the rate of H₂S regeneration is probably controlled by liquid-phase mass transfer resistance. Liquid circulation through the air flotation cells and main reactor could be greatly reduced by recycling scrubber solution after partial reaction with H₂S. Such a double-loop process could also provide a capability for intermediate storage of solution between scrubbing and regeneration. A number of alternative buffer systems are considered which could provide less expensive alternatives for purging sulfates and chlorides. (Author)

A80-35890 Particulate sulfur and trace metal emissions from oil fired power plants. R. L. Bennett and K. T. Knapp (U.S.

Environmental Protection Agency, Research Triangle Park, N.C.). *AIChE Symposium Series*, vol. 75, no. 188, 1979, p. 174-180.

Particulate emissions from five oil-fired electric utility power plants have been chemically characterized. One plant was studied on two separate field tests while consuming different fuels: Venezuelan and Middle East oil. Emission samples were collected for a variety of plant operating parameters including power load, levels of excess oxygen, sulfur content of fuel, trace metal (principally vanadium and nickel) concentrations of fuel, and use of fuel additives. Elemental emission concentrations were determined by wavelength dispersive X-ray fluorescence (XRF) measurement of particulate samples collected on a variety of filter substrates. The relative merits and limitations of each type of filter are discussed. Particle size distribution of the chemical elements in the emissions were determined by XRF analyses of samples collected by cascade impactors. (Author)

A80-35897 Planning air quality control systems for power generation. P. N. Chermisinoff (New Jersey Institute of Technology, Newark, N.J.) and R. A. Salib (Ebasco Services, Inc., New York, N.Y.). *AIChE Symposium Series*, vol. 75, no. 188, 1979, p. 274-283.

The paper covers the examination of the step-by-step procedures required for optimization of air quality control systems (AQCS) as applied to a 500-MW unit sample case scheduled to go on line in early 1980. A historical review of the power industry's thinking is presented whenever applicable. The steps of the AQCS optimization procedures are identified. An optimization technique based on large-scale fuel and ash analyses is presented, and its potential savings for industry is discussed. S.D.

A80-36053 Oil from shale - The potential, the problems, and a plan for development. A. E. Lewis (California, University, Livermore, Calif.). *Energy (UK)*, vol. 5, Apr. 1980, p. 373-387. 23 refs. Contract No. W-7405-eng-48.

A unitized management and development of the government-owned oil shale in Colorado is expected to make it technically and economically practical to obtain very large production rates of shale oil from this source. The paper discusses the resource potential, impediments to development of resource, technology for development of government land and government organization and policy required for development. Important differences exist in the nature of the oil-shale resource held by the government and that held by private companies. These differences are crucial both in estimating production costs and incentives necessary for production and for defining applicable technology. It is proposed that a single federal authority, Piceance Basin Authority, be given the responsibility and authority for developing this government resource under a legislative charter from the Congress. S.D.

A80-36419 Cloud-active nuclei from coal-fired electric power plants and their interactions with clouds. P. V. Hobbs, J. L. Stith, and L. F. Radke (Washington, University, Seattle, Wash.). *Journal of Applied Meteorology*, vol. 19, Apr. 1980, p. 439-451. 14 refs. NSF Grant No. ENV-75-19701.

A80-36476 Chemical characteristics of oil refinery plumes in Los Angeles. F. P. Parungo, R. F. Pueschel, and D. I. Wellman (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). *Atmospheric Environment*, vol. 14, no. 5, 1980, p. 509-522. 14 refs. Research supported by the U.S. Environmental Protection Agency.

Airborne in situ measurements of gases (NO, NO₂, SO₂, O₃) and aerosol size distributions have been made in the vicinity of oil refineries in southern Los Angeles. Filter and impactor samples have been collected for post-flight chemical particle analyses using the BaCl₂ and Nitron reaction spot techniques, and X-ray energy spectrometry. It was found that the refinery operations increase the number concentration of aerosols in the size range between 0.05 micron and 23.5 microns particle radius. Sulfate and nitrate particles have been identified as oxidation products of SO₂ and NO_x.

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respectively. Sulfate particles have been found with a mode of less than 0.1 micron diameter, whereas inorganic nitrates dominate the mode between 1 and 10 microns. The strong affinity for water of the nitrates strongly affects visibility, cloud formation and the cloud drop size spectrum. (Author)

A80-36477 Air quality measurements in the coal fired power plant environment of Colstrip, Montana. J. D. Ludwick, D. B. Weber, K. B. Olsen, and S. R. Garcia (Battelle Pacific Northwest Laboratories, Richland, Wash.). *Atmospheric Environment*, vol. 14, no. 5, 1980, p. 523-532. 18 refs. U.S. Environmental Protection Agency Contract No. IAG-D7-0473.

A80-36550 Energy prices (Les prix de l'énergie). L. Gouni (Electricité de France, Paris, France). *Revue de l'Énergie*, vol. 31, Apr. 1980, p. 185-195. In French.

Numerous studies exist concerning energy prices and more specially, concerning price perspectives for the end of the 20th Century. This article deals with oil price futurology as little as possible and concentrates on trying to draw conclusions from the history of the past three decades. It includes: several remarks about price and cost concepts which enable the author to emphasize ambiguities in this field, observations about prices as seen from the consumer's angle, observations about costs and prices as seen from the energy supplier's angle, and observations concerning the notion of energy reference prices. (Author)

A80-36976 Scientific Workshop on the Automobile: Energy Conservation and Atmospheric Pollution, Paris, France, December 6, 7, 1979, Complete Proceedings (Journées Scientifiques sur l'Automobile: Economies d'Énergie et Pollution Atmosphérique, Paris, France, December 6, 7, 1979, Compte Rendu Integral). Workshop sponsored by the Association pour la Prévention de la Pollution Atmosphérique, Ministère de l'Environnement et du Cadre de Vie, Ministère de la Santé, Ministère de l'Industrie, and Ministère des Transports. *Pollution Atmosphérique*, vol. 22, Jan.-Mar. 1980. 208 p. In French.

Papers are presented on the biological effects, physical chemistry, and characterization of automobile-produced air pollutants and the effects of energy conservation and traffic control measures on automobile pollution levels. Specific topics include the physical chemistry of automobile pollutants, the fine analysis of polynuclear aromatic hydrocarbons, the detection of toxic and carcinogenic effects of pollutant compounds and mixtures, and the effects of automobile pollution on vegetation. Attention is also given to the Bordeaux automatic traffic control system, diesel engine optimization with respect to pollution and noise, fuel conservation objectives in the transportation sector, electric vehicle development, a casinghead-gas-fueled urban bus, and the development of three-way catalytic converters. A.L.W.

A80-37331 # Impacts of fossil fuel use on environment and climate. W. Bach (Münster, Universität, Münster, West Germany). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 4.1-4.23. 53 refs.

This paper reviews the physical impacts of fossil fuel use on the environment and climate system. Such an analysis involves the assessment of the future world fossil fuel resources and their relative share in a future global energy mix. The specific environmental impacts are shown for conventional and unconventional coal, oil and gas production and combustion. The impact on climate is demonstrated for the release of heat, particles and CO₂. Results of temperature change due to CO₂-increase are shown for a low (30TW) and a high (50TW) energy supply scenario. It is noted that the perception of the general impacts of fossil fuel use on the environment is not very high, whereas the specific impact of increasing CO₂ on climate is presently perceived as the greatest risk. Uncertainties in the CO₂-impact assessment make it, however,

pollution monitoring and alert network currently being set up are indicated, and planned systematic studies are presented. A.L.W.

A80-37332 # Production of synthetic hydrocarbon fuel, environmental aspects and comparison to hydrogen production from water. W. Peschka (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für technische Physik, Stuttgart, West Germany). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 5.1-5.14. 8 refs.

The paper compares the environmental pollution of different fuels. This is significant due to increasing pollution with NO(x), CO, and hydrocarbons. The release of carbon dioxide may be a crucial problem, and the consumption of fossil fuels and carbon-free fuels such as hydrogen may provide a solution. It is expected that the air industry will use kerosene in the future and poor quality crude oil due to increased prices; the alternative sources such as oil shale and coal will require large amounts of hydrogen and energy, and fuels made from synthetic crude oils will have a higher nitrogen content contributing to pollution. Liquid hydrogen will produce none of the carbon-related pollutants, and will be the most environmentally acceptable fuel. It is concluded that whether hydrogen fuel will be utilized for clean energy will be determined by the air industry because of its energy consumption, and it represents an essential link in the production-consumption chain. A.T.

A80-37351 Consumer experience with electric vehicles. M. A. Kocis (New York State, Dept. of Transportation, Planning and Research Bureau, Albany, N.Y.). *Journal of Advanced Transportation*, vol. 14, Spring 1980, p. 13-22. 5 refs. Research sponsored by the New York State Department of Transportation.

The results of a study intended to show how present electric vehicle owners use their vehicles, what problems are encountered, and the prospects for repurchase, are presented. Aspects covered include vehicle descriptions, comparison with internal combustion engine vehicles, and an overall rating. It is concluded that user's experience shows that electric vehicles can replace internal combustion engine vehicles in many situations. Finally, owner acceptance of the electric vehicle concept has relied on energy, environmental and economic considerations, yet these owners feel that longer range, faster speeds, and reasonable costs are important factors for future purchases decisions and for further acceptability. M.E.P.

A80-37353 Transportation energy contingencies - A status report on public response and government roles. D. T. Hartgen (New York State, Dept. of Transportation, Albany, N.Y.). *Journal of Advanced Transportation*, vol. 14, Spring 1980, p. 47-72. 31 refs.

Recent work at NYSDOT to develop transportation energy contingency plans for dealing with energy crises such as experienced in 1973-74 and 1979, is summarized. On the basis of recent household data from New York, these two recent crises are described and compared with respect to shortfall, price rises and public response. In both cases shortfalls of 11-13% and price rises of 30-35% were found. In general, it is reported, public responses were similar, focusing on driving slower and cuts in discretionary shop travel, however the 1979 crisis also showed major savings in vacation related actions and purchases of fuel-efficient cars. It is concluded that clearer government roles and responsibilities for contingency actions, coupled with current contingency plan development by local government and recent establishment of state conservation targets, should mean greater effectiveness in dealing with these events and hence generally less impact than in the past. M.E.P.

A80-37618 Technical aspects of lime/limestone scrubbers for coal-fired power plants. I - Process chemistry and scrubber systems. H. T. Karlsson and H. S. Rosenberg (Battelle Columbus Laboratories, Columbus, Ohio). *Air Pollution Control Association Journal*, vol. 30, June 1980, p. 710-714. 9 refs.

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A80-37680 Silicon carbide-tungsten heat pipes for high-temperature service. L. B. Lundberg (California, University, Los Alamos, N. Mex.). (*American Chemical Society and Chemical Society of Japan, Chemical Congress, Honolulu, Hawaii, Apr. 1-6, 1979.*) I & EC - *Industrial and Engineering Chemistry, Product Research and Development*, vol. 19, June 1980, p. 241-244, 8 refs.

Silicon carbide is being considered for use as the structural material in liquid metal heat pipes to be used in high-temperature, waste-heat recovery from plants operating with fossil fuels. In order to protect the SiC from attack by the sodium or lithium metal working fluid, the SiC must be coated internally with tungsten. Experiments have been performed to determine the rate of reaction (layer growth) between SiC and tungsten in a vacuum over the temperature range 1875 to 2075 K. This reaction rate is similar to that observed for the tungsten-carbon reaction forming W2C. The reaction layer developed from the SiC-W reaction consists of two phases, W5Si3 and W2C. Based on the observed reaction rate, it is estimated that for heat pipe operating lifetimes of 20 years and tungsten coating thickness of 0.25 mm, the practical steady operating temperature limit is about 1575 K. (Author)

A80-37691 Fuel - A system problem of major proportions. W. T. Hardaker (Air Transport Association of America, Washington, D.C.). In: *Air Traffic Control Association, Annual Fall Conference, 24th, Atlantic City, N.J., October 15-19, 1979, Proceedings*. Washington, D.C., Air Traffic Control Association, Inc., 1979, p. 10-14.

In the present paper, some substantial achievements of the airlines in reducing fuel consumption by computer-aided flight planning, purchase of more efficient aircraft and engines, and better utilization of aircraft are reviewed, and means of addressing the challenge to use the available fuel more efficiently are examined. These include optimum utilization of airports, maximum use of established fuel-conservation descent procedures and existing gate-hold procedures, minimization of circuitous routings and of the adverse effects of airspace reservations, improved information on expected arrival delays to the pilot - enabling him to save fuel by reducing speed, and implementation of the Wake Vortex Advisory System, to mention only a few of the ATC actions that can be taken. V.P.

A80-37984 California State energy efficient State Office Building. B. S. Setty (Benham-Blair and Affiliates, Inc., Falls Church, Va.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 1029-1055.

Advanced energy technology, utilizing concentrated solar collectors and ice storage system was employed to achieve the lowest energy consumption and lowest life cycle cost. The paper will discuss the functions of the concentrating collectors and its integration with ice storage systems as follows: (1) utilization of concentrating solar collectors passive systems in order to save nonrenewable sources of energy; (2) modes and tracking mechanism of the concentrated solar collectors; (3) concentrating collector system interaction with high temperature storage system; (4) conversion of solar energy into ice, its implications, and its interaction with the ice storage system; and (5) system's flexibility to provide solar heat at maximum efficiency. (Author)

A80-37989 Use of renewable fuels in the rural development of India. G. C. Pandey (Jawaharlal Nehru University, New Delhi, India). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 1119-1131.

An analysis is made of the possible application of renewable energy sources for domestic use, especially in rural areas in tropical and semitropical countries, using available technology. Attention is given to the use of solar cookers and to biogas technology, by which a savings of firewood as well as oil and oil products, such as synthetic

fertilizers, can be realized. The actual implementation of such energy sources is discussed, and factors are taken into account. J.P.B.

A80-38017 French solar energy program and its application for international cooperation. M. J. Pheline (Délégation aux Energies Nouvelles, Paris, France). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 1937-1949.

A large-scale solar energy development program is now underway in France which includes: thermal conversion and its applications for space heating, thermodynamic conversion and power production, direct conversion by photocells, bioconversion, and various applications, such as cooking, desalination, and solar communications. Consideration is also given to various cooperative actions with other countries in solar energy research and applications. It is predicted that by 1985 solar and geothermal energy will contribute 1 to 2 percent of the total primary energy consumption in France. V.L.

A80-38018 An assessment of need for developing and implementing technical and skilled worker training for the solar energy industry. C. G. Orsak, R. Barnstone, Y. Jani, H. Gibson, and J. Morehouse (Navarro College, Corsicana, Tex.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 1976-2002.

A research project has been carried out by Navarro College for the Department of Energy with the objective of determining the national need for manpower trained in solar energy technology. The project had three basic tasks: to conduct a survey of solar heating and cooling systems, review existing consumer demand studies to forecast manpower requirements, and conduct a skills study to determine the types of curriculum required. The analysis shows that there will be at least 2.4 million solar units installed by 1985. Accordingly, by that year there must be a minimum of 25,000 skilled workers in the solar field; one fifth of these must be trained at the technician level. To meet the demands for solar workers, 80 schools, each graduating 50 solar technicians per year will be needed between 1978 and 1985. V.L.

A80-38210 Heat pumps for heating, cooling, and energy recovery 1976-1990 (Wärmepumpen für Heizung, Kühlung und Energierückgewinnung 1976-1990). R. Rudolph, G. Purper, R. Frische, F. Grüning, H. Jansen, I. Paul, and C. Rode (Battelle-Institut, Frankfurt am Main, West Germany). Cologne, Verlag TÜV Rheinland GmbH, 1979. 192 p. 46 refs. In German. \$14.66.

The present status and future possibilities of heat pumps are surveyed. Attention is given to technology, noting that electric compression heat pumps are the most developed. Systems discussed include monovalent and bivalent electro-heat pumps with heat sources such as water, ground, ambient air, and solar energy. It is shown that the emphasis of development is on the improvement of individual components such as the working medium, the condenser, and heat exchanger. Also examined are costs and economy, as well as the market potential for heat pumps. Further, an assessment is made of how heat pumps will affect the ecology, governmental policy, the economy, and society. M.E.P.

A80-38303 Energy and environmental politics in the 80's (Energie- und Umweltpolitik in den 80er Jahren). G. Weiser (Ministerium für Ernährung, Landwirtschaft und Umwelt, Stuttgart, West Germany). (*Arbeitsgemeinschaft Regionaler Energieversorgungs-Unternehmen, Jahrestagung, Stuttgart, West Germany, Apr. 29, 1980.*) *Energiewirtschaftliche Tagesfragen*, vol. 30, May 1980, p. 323-327. In German.

Factors involved in determining energy and environmental policy in the FRG are surveyed. Attention is given to the goals of the energy policy in Baden-Württemberg: (1) to assure the supply of energy for all consumers over the long term and under the most

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favorable conditions, (2) attaining an economical and rational use of energy; and (3) protecting the environment while meeting the demand for energy. A detailed description is given of the strategy of the program which includes the following measures: (a) reduction of dependence on oil, (b) increased energy conservation by consumers, (c) accelerated development of regenerative energy sources, (d) expansion of natural gas and long distance heating supply, (e) encouraging rational energy generation and usage, and (f) increased usage of coal and nuclear energy. M.E.P.

A80-38304 **Topical questions of energy economics (Aktuelle Fragen der Energiewirtschaft).** G. Hecker (Arbeitsgemeinschaft regionaler Energieversorgungs-Unternehmen; ELEKTROMARK kommunales Elektrizitätswerk Mark AG, Hagen, West Germany). (*Arbeitsgemeinschaft Regionaler Energieversorgungs-Unternehmen, Jahrestagung, Stuttgart, West Germany, Apr. 29, 1980.*) *Energiewirtschaftliche Tagesfragen*, vol. 30, May 1980, p. 333-336. In German.

A survey is made of the factors affecting the economics of energy in the FRG. Attention is given to the fact that the development of the power distribution in the FRG during 1978-79 was greater than the economic growth rate. Also examined is the need for rational and economic energy utilization, which involves a rational integration of electricity, gas, and utilization of long distance heating on the basis of power-heat-coupling and industrial waste heat. Consideration is also given to the problem that new techniques such as coal gasification and coal liquefaction will increase the demand beyond what can be met. In addition, the need for more nuclear power is stressed. M.E.P.

A80-38366 **Practical application of flue gas de-NO_x/system using honeycomb type catalyst.** M. Yamamoto, J. Miyake, T. Sengoku, T. Shiomi (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan), S. Minagawa (Mitsubishi Heavy Industries, Ltd., Hiroshima Shipyard and Engine Works, Hiroshima, Japan), N. Yokoyama (Mitsubishi Heavy Industries, Ltd., Hiroshima Technical Institute, Hiroshima, Japan), and T. Miyagawa (Mitsubishi Heavy Industries, Ltd., Nagasaki Shipyard and Engine Works, Nagasaki, Japan). *Mitsubishi Heavy Industries Technical Review*, vol. 17, Feb. 1980, p. 11-18.

A system based on a honeycomb type catalyst has been developed for removing NO_x from flue gases emitted from heavy-oil or coal-fired boilers. This paper reviews the design of the system and describes its performance during two years of operation at the Sodegaura Refinery. B.J.

A80-38905 * # **Potential benefits for propfan technology on derivatives of future short- to medium-range transport aircraft.** I. M. Goldsmith (Douglas Aircraft Co., Long Beach, Calif.) and J. V. Bowles (NASA, Ames Research Center, V/STOL Systems Technology Branch, Moffett Field, Calif.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1090*, 10 p.

It is noted that several NASA-sponsored studies have identified a substantial potential fuel savings for high subsonic speed aircraft utilizing the propfan concept compared to the equivalent technology turbofan aircraft. Attention is given to a feasibility study for propfan-powered short- to medium-haul commercial transport aircraft conducted to evaluate potential fuel savings and identify critical technology requirements using the latest propfan performance data. An analysis is made of the design and performance characteristics of a wing-mounted and two-aft-mounted derivative propfan aircraft configurations, based on a DC-9 Super 80 airframe, which are compared to the baseline turbofan design. Finally, recommendations for further research efforts are also made. M.E.P.

A80-38983 # **Lightweight diesel aircraft engines for general aviation.** A. P. Brouwers (Teledyne Continental Motors, Muskegon, Mich.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1238*, 12 p.

This project reintroduces the diesel engine as an aircraft

powerplant. A concept design study of two engines was conducted to define configurations and applicable advanced technologies. The information generated in the course of this study was then used to evaluate the performance of two aircraft: a six-place twin and a four-place single. The computer generated aircraft performance data show a vast improvement over current gasoline-powered aircraft. Next the 186-cruise kW engine was also designed utilizing the experience gained from the concept design study. The development program of this engine is in process. (Author)

A80-39554 **Paving the way for energy-saving innovations.** D. G. Jansson and G. C. Newton, Jr. (MIT, Cambridge, Mass.). *Technology Review*, vol. 83, June-July 1980, p. 42-53.

The paper examines the Energy Related Inventions Program of DOE which aims at stimulating the innovative process to assure that energy saving products reach the marketplace and are assimilated into economy. Specifically, the program will enable the inventors to compete effectively for public or private contract support, and to form new enterprises for production of their inventions; it will also help to negotiate the commercialization of their inventions. Five inventions, including equipment for waste heat utilization for commercial cooking equipment and a wastewater aeration power control device were evaluated for viability and energy impact; the evaluation consisted of estimates of the possible energy impact, assessments of invention's business potential, barriers to commercialization, and the role of DOE support in stimulating technology. A.T.

A80-40313 **New Technology Transport for fuel critical economy.** P. A. Hudak (Boeing Co., Seattle, Wash.) and K. A. B. Macdonald (Boeing Commercial Airplane Co., Seattle, Wash.). In: *Annual Reliability and Maintainability Symposium, San Francisco, Calif., January 22-24, 1980, Proceedings*. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 101-105.

The design objective of the New Technology Transport (NTT) which will have fly-by-wire, power-by-wire, digital data bus communication honeycomb primary structure, electric engine start, and will require no auxiliary unit is described. The impact of OPEC on the wholesale price index and airline economic parameters are discussed, and NTT studies to reduce operating costs by fuel efficiency improvement including the use of a high bypass turbofan, active boundary layer control, and high turbine inlet temperature are examined. Reducing crew and maintenance costs are considered, noting that structural corrosion and fatigue maintenance costs will be diminished by the use of a honeycomb primary structure in the fuselage, wing, and empennage. Finally, the elimination of the auxiliary power unit maintenance and fuel cost, and the reduced electronic/electric maintenance costs are noted. A.T.

A80-40344 **Common Cause Failures - A dilemma in perspective.** A. M. Smith (General Electric Co., Sunnyvale, Calif.) and I. A. Watson (U.K. Atomic Energy Authority, Lancs., England). In: *Annual Reliability and Maintainability Symposium, San Francisco, Calif., January 22-24, 1980, Proceedings*. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 332-339, 31 refs.

This paper identifies the broad spectrum of Common Cause Failure (CCF) definitions used by various authors. These definitions, as applied to real aircraft and nuclear reactor failure events, lead to a divergence of interpretation and a resultant confusion that obscures meaningful progression in CCF analysis. A new definition is proposed, explained, and tested against the examples. Technical as well as Administrative Practices are cited as ways to control or eliminate the product defects that lead to CCF. (Author)

A80-40349 **A Boolean approach to common cause analysis.** R. B. Worrell and D. W. Stack (Sandia Laboratories, Albuquerque, N. Mex.). In: *Annual Reliability and Maintainability Symposium, San Francisco, Calif., January 22-24, 1980, Proceedings*.

New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 363-366. 14 refs.

It is shown that a transformation of variables can be used to achieve qualitative common cause analysis. Transformation equations that relate cause events to the primary events of a fault tree are described, and the substitutions that change the minimal cut set equation for the top event of the fault tree from a function of primary events to a function of cause events are explained. Examples are presented which show that different kinds of common cause analysis are accomplished by simple modifications of the transformation equations. (Author)

A80-40751 Liquid fuel supplies. H. Perry. *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 103-107. 6 refs.

This paper presents an overview of United States and world petroleum, natural gas, and natural gas liquids presumed recoverable but as yet undiscovered resources and suggests that the depletion of these fuels may not occur as quickly as frequently predicted. The paper points out that the construction of a synthetic fuels industry will be very costly and will provide only a small amount of increased energy independence. The fear is expressed that haste in accepting a specific synfuels process on the basis of present technology may serve to forestall the development of a better technology. The paper suggests that we construct relatively few plants now each using a different technology in order to gain better understanding of the various technologies, more information on costs and the essential but as yet unknown information on environmental and socioeconomic effects of large scale plants. (Author)

A80-40759 Environmental concerns for coal synfuel commercialization. F. E. Witmer (U.S. Department of Energy, Environmental Control Technology Div., Washington, D.C.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 185-195. 8 refs.

The control of multimedia environmental impacts (air, land, water) for commercial U.S. coal synfuel facilities is briefly discussed, based on process design data and environmental standards. While environmental control technology appears to be adequate, there is a critical need for confirmatory data from large-scale operating plants. Worker exposure to fugitive emissions and the disposal of solid waste are of special concern. The major environmental impediments to the commercialization of existing coal synfuel technology are time delays, facility size limitations, and 'non-acceptance' by the impacted community. (Author)

A80-40825 Synthetic fuels from coal: Overview and assessment. L. L. Anderson (Utah, University, Salt Lake City, Utah) and D. A. Tillman (Washington, University, Seattle, Wash.). New York, Wiley-Interscience, 1979. 170 p. 154 refs. \$16.95.

The book contains a critical analysis of today's synthetic fuels option from the point of view of both user and producer. The principles of coal conversion and the history of synthetic fuel production are reviewed. Specific fuel types (low, medium, and high Btu gases, heavy and light liquids) and such synthetic fuels as petrochemical feedstocks are considered. Economic and environmental costs associated with synthetic fuel production are examined. V.T.

A80-40935 A global and long-range picture of energy developments. W. Häfele (International Institute for Applied Systems Analysis, Laxenburg, Austria). *Science*, vol. 209, July 4, 1980, p. 174-182. 22 refs.

An analysis of the balance between energy supply and demand for the next 50 years has been made for seven major world regions for two scenarios: one in which world energy consumption increases from today's 8.2 terawatt/yr to 22 TW/yr and the other where the increase is to 35 TW/yr. Factors considered with regard to energy demand include population growth, economic growth and technological progress, and energy sources such as oil, coal, nuclear and

solar power are discussed. It is shown that time will be the limiting constraint in adapting the energy supply infrastructure to changing resource availability, and that resources will be available but a strong shift to low-grade fossil fuels such as shale oil and tar sands will be required. J.P.B.

A80-40944 # The energy problem - Its effect on aircraft design. IV - The unforecastable future. W. Tye. *Aircraft Engineering*, vol. 52, June 1980, p. 2-4.

Future supplies of energy for aviation and their affect on aircraft design are considered. Attention is given to proven and ultimately recoverable reserves of oil and gas and to the use of coal for fuel oil. Also discussed are advanced aircraft concepts, including laminar flow and the associated requirements of the porous surfaced wing and the suction system. In addition, the use of liquid hydrogen and of multibladed turbo-propellers with large blade chords, small thickness and high tip speeds, efficient up to a Mach number of 0.8, is considered. J.P.B.

A80-40945 # Fuel economy in the airlines. T. Ford. *Aircraft Engineering*, vol. 52, June 1980, p. 5-8.

Fuel savings during flight procedures are examined with regard to takeoff, climb optimization and automatic flight management using autopilot and autothrottle systems. The importance of the leading edge to the flow characteristics is also considered, along with engine design, development and maintenance. Research into terminal area capacity and efficiency, the improvement of approach and landing capability in adverse weather and the reduction of noise impact through operating procedures is discussed. In addition, the improvement of aircraft fuel efficiency by recovering deterioration losses and by incorporating drag reduction/engine fuel saving modifications is considered. J.P.B.

A80-40965 Equitable performance comparison and economic evaluation of active and passive solar energy systems. M. S. Drew and R. B. G. Selvaie (S-Matrix Enterprises, Ltd., Richmond, British Columbia, Canada). *Energy* (U.K.), no. 5, May 1980, p. 407-415. 5 refs. Research supported by the British Columbia Ministry of Education, Science and Technology.

An evaluation of active and passive solar energy systems is made which assigns to both systems an equal energy demand. Active systems with baseline energy requirements equivalent to those of passive systems are identified by making a careful accounting of what passive solar energy properly belongs in the building load. This analysis allows an equitable economic comparison between the two alternative design solutions to the problem of maximizing life cycle savings for a system which supplies heat to a structure with specified floor area and heating load per unit floor area. (Author)

A80-41469 # High temperature heat pipes for waste heat recovery. M. A. Merrigan and E. S. Keddy (California, University, Los Alamos, N. Mex.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1505*. 8 p. 5 refs. Research sponsored by the U.S. Department of Energy.

Operation of heat pipes in air at temperatures above 1200 K has been accomplished using SiC as a shell material and a chemical vapor deposit (CVD) tungsten inner liner for protection of the ceramic from the sodium working fluid. The CVD tungsten has been used as a distribution wick for the gravity-assisted heat pipe through structure, achieved by control of the metal vapor deposition rate. Wick performance has been demonstrated in tests at approximately 2 kW through-put with a 19-mm-i.d. SiC heat pipe. Operation of ceramic heat pipes in repeated start cycle tests has demonstrated their ability to withstand temperature rise rates of greater than 1.2 K/s. (Author)

A80-41472 * # A high performance cocurrent-flow heat pipe for heat recovery applications. E. W. Saaski and J. C. Hartl (Sigma Research, Inc., Richland, Wash.). *American Institute of Aeronautics*

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and *Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1508*. 9 p. 24 refs. NASA-supported research.

By the introduction of a plate-and-tube separator assembly into a heat pipe vapor core, it has been demonstrated that axial transport capacity in reflux mode can be improved by up to a factor of 10. This improvement is largely the result of eliminating the counter-current shear that commonly limits reflux heat pipe axial capacity. With benzene, axial heat fluxes up to 1800 W/sq cm were obtained in the temperature range 40 to 80 C, while heat flux densities up to 3000 W/sq cm were obtained with R-11 over the temperature range 40 to 80 C. These very high axial capacities compare favorably with liquid metal limits; the sonic limit for liquid sodium, for example, is 3000 W/sq cm at 657 C. Computational models developed for these concurrent flow heat pipes agreed with experimental data within + or - 25%. (Author)

A80-41488 # Determination of the extinction coefficient of glass fiber insulation. T. J. Love and A. Saboonchi (Oklahoma, University, Norman, Okla.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1528*. 4 p.

In case of radiative equilibrium the transport of thermal radiation depends only on the extinction coefficient for both scattering and homogeneous media. A method of determination of the extinction coefficient for light density glass fiber insulation is presented with values of the measurement for a typical domestic glass fiber insulation. (Author)

A80-41506 * # Fuel conservation through active control of rotor clearances. R. S. Beitler, A. A. Saunders, and R. P. Wanger (General Electric Co., Aircraft Engine Group, Evendale, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1087*. 8 p. Contract No. NAS3-20643.

Under the NASA-sponsored Energy Efficient Engine (EEE) Project, technology is being developed which will significantly reduce the fuel consumption of turbofan engines for subsonic transport aircraft. One technology concept being pursued is active control of rotor tip clearances. Attention is given to rotor tip clearance considerations and an overview of preliminary study results as well as the General Electric EEE clearance control approach is presented. Finally, potential fuel savings with active control of rotor clearances for a typical EEE mission are predicted. M.E.P.

A80-41558 Respirable aerosols from fluidized bed coal combustion. I - Sampling methodology for an 18-inch experimental fluidized bed coal combustor. G. J. Newton, R. L. Carpenter, H.-C. Yeh, and E. R. Peele (Lovace Biomedical and Environmental Research Institute, Albuquerque, N. Mex.). *Environmental Science and Technology*, vol. 14, July 1980, p. 849-853. 11 refs. Contract No. EY-76-C-04-1013.

Methods and equipment used to characterize respirable aerosol samples from the exhaust system of an experimental 18-inch ID atmospheric pressure fluidized bed coal combustor are presented. Sampling is performed by the extraction of a small sample of the effluent aerosols at four separate locations within the exhaust system by a probe moving at a velocity 1.2 times greater than the average velocity of the highly turbulent duct flow, followed by the dilution of the sample and its piping to a chamber from which samples could be obtained under milder conditions. Equipment includes 3-ft long, 0.5-in. OD stainless steel sampling probes, a radically injected diluter designed to reduce thermophoretic losses, a Tenax gas chromatography sampling system, and a sampling chamber serving to screen out particles with aerodynamic diameters greater than 10 microns and containing various sampling instruments. The apparatus has been found to be effective in sampling aerosols resulting from the fluidized bed combustion of Montana Rosebud subbituminous coal, Texas lignite, Western Kentucky high-sulfur bituminous coal and Paraho oil shale. A.L.W.

A80-41559 Respirable aerosols from fluidized bed coal combustion. II - Physical characteristics of fly ash. R. L. Carpenter, G. J. Newton, S. J. Rothenberg, and P. B. DeNee (Lovace Biomedical and Environmental Research Institute, Albuquerque, N. Mex.). *Environmental Science and Technology*, vol. 14, July 1980; p. 854-859. 26 refs. Contract No. EY-76-C-04-1013.

The respirable fraction of the exhaust aerosol produced by an experimental 18-in. atmospheric pressure fluidized bed coal combustor was sampled to assess the potential inhalation hazard associated with this technology. Aerosol sampling instrumentation and the basis for its choice are described. Respirable fly ash aerosol parameters at four locations in the exhaust cleanup system are reported, as is the penetration of system cleanup devices by the respirable aerosol. Particle morphology was examined by transmission and scanning electron microscopy. The specific surface area of the fly ash was determined as was the adsorption and desorption half-time of water vapor. These data were determined for fly ash particles obtained when the combustor was operated using a western low-sulfur subbituminous coal, an eastern high-sulfur bituminous coal, lignite, lignite refuse, and Paraho oil shale. The data show that the fly ash escaping the fluidized bed exhaust cleanup system has a mass median aerodynamic diameter on the order of 2 microns and consists of unfused particles having high specific surface areas. (Author)

A80-41571 # Thermochemistry of seed and slag vaporization and condensation in coal-fired MHD. P. E. Blackburn and C. E. Johnson (Argonne National Laboratory, Argonne, Ill.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1344*. 6 p. Research sponsored by the U.S. Department of Energy.

A computer code has been developed that calculates equilibrium compositions of the gas and condensed phases in the coal-fired MHD system. The code, MHD80, is based on the laws of mass action, conservation of mass, and, for the condensate, an assumed ideal solution of stable compounds in two immiscible phases. Potassium activities predicted with the code agree with measurements at NBS on synthetic slags and at Argonne on UTSI slag. The code has been used to determine condensation temperatures, loss of potassium to slag, conditions for removal of sulfur as potassium sulfate, and the chemical form of trace impurities. (Author)

A80-41664 Photometric analysis of aerial photographs to detect and map sulfur dioxide effects of soybeans near two large, coal-fired power plants. C. D. Sapp (Tennessee Valley Authority, Air Quality Branch, Muscle Shoals, Ala.). In: Remote sensing of earth resources. Volume 8 - Annual Remote Sensing of Earth Resources Conference, 7th, Tullahoma, Tenn., March 27-29, 1979, Technical Papers. Tullahoma, Tenn., University of Tennessee, 1980, p. 9-27. 7 refs. U.S. Environmental Protection Agency Contract No. IAG-D6-E721.

A80-41826 Energy economic demands of the Federal Republic of Germany and the resulting consequences for the energy policy of the 1980's (Energiewirtschaftliche Anforderungen der Bundesrepublik Deutschland und daraus folgende Konsequenzen für die Energiepolitik der 80er Jahre). F. J. Spalthoff (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). (*Rheinisch-Westfälisches Elektrizitätswerk, Workshop Energie, St. Engelmar, West Germany, Nov. 7, 1979.*) *Energiewirtschaftliche Tagesfragen*, vol. 30, June 1980, p. 386, 388, 390, 392, 394. In German.

A80-41842 Alabama Electric Cooperative flue gas desulfurization operating and maintenance experience. C. A. Johnson (Peabody Process Systems, Inc., Stamford, Conn.) and R. Hutcherson (Alabama Electric Cooperative, Inc., Leroy, Ala.). *Air Pollution Control Association, Journal*, vol. 30, July 1980, p. 744-748.

The design factors contributing to the exceptionally good operating and maintenance performance of limestone flue gas

desulfurization systems for two 225-MW coal-fired generators are discussed, and the experience obtained is examined in detail. Attention is given to the spray-tower absorber, mist eliminator chemistry control by use of hydroclones, simplicity of design, absorber liner material selection and installation, and the adaptability of the design to actual operating conditions. The actual performance of the systems with respect to start-up (push-button), SO₂ removal and limestone utilization (high efficiency and utilization), power and manpower requirements (both low) and availability (up to 97%) is reviewed, and problems with the ball mill system, the dampers, instrumentation and the slurry transfer line are indicated. A.L.W.

A80-41849 Technical aspects of lime/limestone scrubbers for coal-fired power plants. II - Instrumentation and technology. H. T. Karlsson and H. S. Rosenberg (Battelle Columbus Laboratories, Columbus, Ohio). *Air Pollution Control Association, Journal*, vol. 30, July 1980, p. 822-826. 8 refs.

Instrumentation and particulate removal and sludge disposal technology for lime/limestone scrubbers for coal-fired power plants is discussed. Consideration is given to means for gas flow determination, SO₂ sampling, slurry concentration, mist concentration/distribution and pH monitoring and SO₂ monitoring for process control purposes. Particulate removal by electrostatic precipitators and/or wet scrubbing and means of removing the mist formed when the flue gas passes through SO₂ absorber units are considered, and methods for flue gas reheating following scrubbing and operational aspects of dampers and fans are indicated. Finally, the treatment and disposal of the sludge collected are discussed, and it is concluded that although safe and trouble-free equipment for vital component systems is not available, great progress towards this end has been made. A.L.W.

A80-42158 # Continuously variable ratio transmissions for single-shaft gas turbines. H. J. Förster (Daimler-Benz AG, Stuttgart, West Germany). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-21*. 7 p. Members, \$1.50; nonmembers, \$3.00.

The single-shaft gas turbine was combined with various CVR transmissions. Of the three variants studied in detail - purely hydrostatic transmission, hydrostatic transmission with internal power splitting, and hydrodynamic transmission with variable pitch converter - the latter gives the best transmission efficiency. However, comparison with the two-shaft gas turbine shows quite clearly that in practically all cases a large part of the gain in efficiency achieved by increasing the process temperature to 1623 K is absorbed by the losses from the CVR transmissions. Because of the great significance attached today to fuel consumption, the combination of single-shaft gas turbine with CVR transmission - on the basis of these investigations - cannot be recommended. This statement would even apply if it was to be proved that the simple design of the single-shaft gas turbine alone permitted the use of ceramic material and thus the higher process temperatures. This is because the conditions along the traction resistance line for level ground have a much greater effect on everyday fuel consumption than the efficiency ratings at full load. The latter only has an effect during acceleration or when steep gradients are being negotiated. (Author)

A80-42159 # The Perbury transmission. F. G. Perry (Perbury Engineering, Ltd., Whitehead, Northern Ireland). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-22*. 6 p. Members, \$1.50; nonmembers, \$3.00.

The paper presents an overview of the Perbury transmission system principles, background, development status and applications. Future development areas covering traction fluids, rolling component fatigue life, regime gearing arrangements and production packaging are discussed noting that whatever the form of prime mover, large improvements in vehicle fuel economy are possible with correct engine management. S.D.

A80-42190 * # An analytical study of nitrogen oxides and carbon monoxide emissions in hydrocarbon combustion with added nitrogen - Preliminary results. D. A. Bittker (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-60*. 11 p. 19 refs. Members, \$1.50; nonmembers, \$3.00.

The influence of ground-based gas turbine combustor operating conditions and fuel-bound nitrogen (FBN) found in coal-derived liquid fuels on the formation of nitrogen oxides and carbon monoxide is investigated. Analytical predictions of NO_x and CO concentrations are obtained for a two-stage, adiabatic, perfectly-stirred reactor operating on a propane-air mixture, with primary equivalence ratios from 0.5 to 1.7, secondary equivalence ratios of 0.5 or 0.7, primary stage residence times from 12 to 20 msec, secondary stage residence times of 1, 2 and 3 msec and fuel nitrogen contents of 0.5, 1.0 and 2.0 wt %. Minimum nitrogen oxide but maximum carbon monoxide formation is obtained at primary zone equivalence ratios between 1.4 and 1.5, with percentage conversion of FBN to NO_x decreasing with increased fuel nitrogen content. Additional secondary dilution is observed to reduce final pollutant concentrations, with NO_x concentration independent of secondary residence time and CO decreasing with secondary residence time; primary zone residence time is not observed to affect final NO_x and CO concentrations significantly. Finally, comparison of computed results with experimental values shows a good semiquantitative agreement. A.L.W.

A80-42225 # Fuel-flexible combined cycles for utility power and cogeneration. P. B. Roberts, T. E. Duffy (Solar Turbines International, San Diego, Calif.), and H. Schreiber (Electric Power Research Institute, Palo Alto, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-101*. 14 p. Members, \$1.50; nonmembers, \$3.00. Research supported by the Electric Power Research Institute.

Two combustion turbine combined cycle power plants have been studied for performance and operating economics. Both power plants are in the sizing range that will be suitable for small utility application and use less than 106 GJ/hr (100 million Btu/hr). The first power plant is based on the Solar Turbines International (STI) Mars industrial gas turbine. The combined gas turbine/steam cycle is direct fired with No. 2 diesel fuel. A total installed cost for the system is estimated to be within the band 545 to 660 \$/kW. The second power plant is based on STI's Centaur industrial gas turbine. The combined gas turbine/steam cycle is indirectly fired with solid fuel although it is intended that the installation can be initially fired with a liquid fuel. (Author)

A80-42227 # Utility system planning effects on the economic merit of advanced combined cycle power systems. W. Fraize, F. Davis (Mitre Corp., Bedford, Mass.), and G. Manning (U.S. Department of Energy, Washington, D.C.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-105*. 6 p. 6 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. ET-78-C-01-3179.

A80-42254 Design study for a fuel efficient turbofan engine. R. C. Kingcombe and S. W. Dunning (National Gas Turbine Establishment, Farnborough, Hants., England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-141*. 9 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

An engine design study is presented in which the target is a 15 percent reduction in installed specific fuel consumption over the large engines currently in service while still meeting anticipated noise and emissions regulations. The fuel saving is achieved with a low specific thrust (bypass ratio 10) and a high overall cycle pressure ratio (42 at cruise). A three-shaft design is proposed, employing highly loaded components in order to reduce the number of

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turbomachinery stages and hence keep down cost and weight. It is argued that this approach is the one most compatible with projected technological advances. The engine configuration is given and the key features explained, highlighting areas where further research would be of particular advantage. Finally, the predicted engine performance is given, together with an estimate of the savings in direct operating cost. (Author)

A80-42255 * # The Energy Efficient Engine /E3/ - Advancing the state of the art. W. B. Gardner and D. E. Gray (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-142.* 11 p. 7 refs. Members, \$1.50; nonmembers, \$3.00. NASA-sponsored research.

The NASA-sponsored Energy Efficient Engine (E3) Program, intended to develop and demonstrate the technology for reducing fuel consumption in future environmentally acceptable turbofan engines, is presented. The development of the flight propulsion system design is outlined and the resulting preliminary design is presented. Component design and subcomponent supporting technology verification work in progress is discussed, with attention given to fabrication development, the transition duct, mixer design, the fan, the high-pressure compressor, the combustor, and the high-pressure turbine. It is noted that the detailed design of the core components is essentially complete and fabrication of the hardware has begun, with the program on schedule toward testing in 1982. A.L.W.

A80-42258 * # Results from tests on a high work transonic turbine for an energy efficient engine. D. E. Crow, H. Welna, I. D. Singer (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.), and M. R. Vanco (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-146.* 9 p. Members, \$1.50; nonmembers, \$3.00. Contract No. NAS3-20646.

The experimental results of the evaluation of two high work, transonic, single-stage turbines investigated under the Energy Efficient Engine (E3) Program are presented. The objective of the E3 program is to provide an advanced technology base for a new generation of fuel-conservative turbofan engines. A single-stage turbine required fewer cooled airfoils, a reduced number of leakage paths and no interstage seals. These advanced energy efficient engines require high engine pressure ratios resulting in high expansion ratio, transonic, turbine designs which must have high aerodynamic efficiency. The goal of the turbine program is to develop a high pressure turbine that is compatible with the overall engine design and has an uncooled efficiency of 90.8 percent. (Author)

A80-42273 # Industrial AFB-fired gas turbine systems with topping combustors. C. L. Marksberry and B. C. Lindahl (Fluidyne Engineering Corp., Minneapolis, Minn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-163.* 12 p. 5 refs. Members, \$1.50; nonmembers, \$3.00.

An Atmospheric Fluidized Bed (AFB) combustor providing thermal input to gas turbines is a promising near-term means of decreasing national premium fuel consumption. In an AFB many solid fuels, including marginal fuels such as anthracite culm, bituminous gob, high sulfur coals, lignite, and petroleum coke, can be used effectively providing both very low emission levels and acceptable return-on-investment. This paper discusses the state of AFB/gas turbine cogeneration technology with reference to typical industrial plant applications. Design considerations and design limits for both the AFB heat exchangers and the topping combustor are discussed and compared. An example based on plant process data and commercially available components is also presented. Both the heat exchangers and the combustors are viewed with reference to state-of-the-art technology. (Author)

A80-42282 # Evaluation method for closed cycle gas turbines in cogeneration applications. H. C. Daudet and S. W. Trimble (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-176.* 14 p. 11 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. EF-77-C-01-2611.

The utilization of coal-fired closed cycle gas turbine/atmospheric fluidized bed (CCGT/AFB) electrical power generating plants for cogeneration was investigated. Both industrial process and district heating and cooling applications in the 10- to 50-MWe range were considered. An evaluation procedure was developed in which cogeneration plant capital, operating, maintenance, and financing costs are compared with the cost of providing equivalent services by traditional methods. Computer optimized conceptual designs of the CCGT/AFB plants were prepared, and performance and capital costs were estimated. A broad spectrum of applications including towns, military bases, universities, and industrial processes was surveyed. This paper presents the general evaluation procedure, typical plant designs, and the evaluation of two applications. (Author)

A80-42450 Prospects for energy responsive urban planning and design. A. Bowen (Miami, University, Coral Gables, Fla.). In: *Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures.* Toronto and New York, Pergamon Press, 1979, p. 555-585. 8 refs.

Effective energy utilization through appropriate urban planning and design is discussed. Climate-derived urban patterns are considered in terms of the effects on building volume for dry as well as humid conditions in hot, temperate and cold regions. Emphasis is placed on the use of appropriate energies, including ambient and conventional, in a cold climate where a hemispherical building constructed from concrete is recommended; a temperate climate requiring 'A' frame construction with north/south elevation sloped to latitudinal response, and a hot-dry climate with a building shaped like a hollow doughnut cambered outward to prevent year-round heat gain through the walls. Also considered are solar geometry, wind patterns and computer programs available as aids in urban design and planning. J.P.B.

A80-42451 Regional planning strategies for hybrid energy optimization. A. Bowen (Miami, University, Coral Gables, Fla.). In: *Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures.* Toronto and New York, Pergamon Press, 1979, p. 587-628.

A review is presented of available fuels and energy sources with regional planning strategies for hybrid energy optimization. The fuels include coal, crops, nuclear sources, geothermal, hydraulic power, and solar; energy sources are classified as genotypes which are easily applied at scaled levels within a defined region, and phenotypes which are modifications of regional sources to suit any site within a district. Regional energy genotypes include renewable ambient energies such as solar, wind, and geothermal, and nonrenewable energies exemplified by coal, natural gas, oil, and waste heat; phenotypes use the appropriate genotype energy for its most suitable use in its available or modified version as determined by site constraints, wind barriers, and precipitation. The regional ambient energy patterns in the US are summarized in terms of solar radiation, humidity, and comfort indicators, noting the effects of climate manipulation through landscape treatments. A.T.

A80-42925 # A utility company's view of energy from waste. T. E. Gieruszczak (Consumers' Gas Co., Toronto, Canada). *CanInfo Communications, Energy from Waste Seminar: A Decade of Development, Toronto, Canada, Nov. 21, 22, 1979, Paper.* 25 p.

Energy supplies and conservation are discussed, particularly with regard to the situation in Canada, and attention is given to the natural gas surplus and the need to import oil. Emphasis is placed on alternative energy sources including peat, lignite, tidal power from

the Bay of Fundy, the thermochemical gasification of biomass, gasohol and a combination wind turbine-diesel-generator. Near-term solutions to the energy crisis are considered such as conservation, systems cogenerating power and heat, and energy from solid waste: examples of incineration systems with major heat recovery operations are presented. J.P.B.

A80-42926 # Role of the public utility in developing energy from waste. R. E. Waters and R. J. Walters (Ontario Hydro, Toronto, Canada). *CanInfo Communications, Energy from Waste Seminar: A Decade of Development, Toronto, Canada, Nov. 21, 22, 1979, Paper 11 p.*

Energy from waste products is discussed along with the efficient use of resources and in particular, the utilization of heat. Emphasis is placed on burning garbage produced in cities in steam-raising incinerators and district heating, as well as the high load densities required. Also considered are process steam applications, such as in forest products industries, waste heat, and the temperature of condenser cooling water discharges. Present projects with regard to refuse burning and the heat supply from thermal stations are also examined. J.P.B.

A80-42927 # Energy recovery in the sludge treatment process at Toronto's main treatment plant. N. J. Perkins (Gore and Storrie, Ltd., Toronto, Canada). *CanInfo Communications, Energy from Waste Seminar: A Decade of Development, Toronto, Canada, Nov. 21, 22, 1979, Paper 9 p.*

A80-43304 * # Aerodynamic design optimization of a fuel efficient high-performance, single-engine, business airplane. B. J. Holmes (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1846. 13 p.*

A design study has been conducted to optimize a single-engine airplane for a high-performance cruise mission. The mission analyzed included a cruise speed of about 300 knots, a cruise range of about 1300 nautical miles, and a six-passenger payload (5340 N (1200 lb)). The purpose of the study is to investigate the combinations of wing design, engine, and operating altitude required for the mission. The results show that these mission performance characteristics can be achieved with fuel efficiencies competitive with present-day high-performance, single- and twin-engine, business airplanes. It is noted that relaxation of the present Federal Aviation Regulation, Part 23, stall-speed requirement for single-engine airplanes facilitates the optimization of the airplane for fuel efficiency. (Author)

A80-43305 # Fuel efficiency of small aircraft. B. H. Carson (U.S. Naval Academy, Annapolis, Md.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1847. 9 p. 10 refs.*

There is a basic mismatch between the amount of power installed in small propeller-driven aircraft and that required for efficient cruising, which results from climb performance requirements. It is shown in this paper that there is a way of using excess power for most efficient cruise, the resulting airspeed coming closest to the Gabrielli-von Karman limit line of vehicular performance. A survey of 111 light aircraft was conducted, and it is found that many are operated at this optimum, while many more are not. A figure of merit is developed that measures cruise performance. Rationale is presented that is directly applicable to design for cruise efficiency. (Author)

A80-43341 # Solar and geothermal Rankine cycle engines can convert petroleum industry waste heat into electrical power. R. E. Barber (Barber-Nichols Engineering Co., Arvada, Colo.). *American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper 80-Pet-27. 6 p. 5 refs. Members, \$1.50; nonmembers, \$3.00.*

Development work presently being carried on for solar and geothermal applications is applicable to utilize the waste heat from petroleum processes in the less than 700 F range. Much waste heat is

presently being recovered by process modifications. This paper shows the efficiency expected and the estimated equipment cost of Rankine engines as a function of waste heat temperature and some examples of solar and geothermal Rankine engines that might be applicable to accomplish this energy savings. (Author)

A80-43741 Development of a NO(x)-free combustion system. M. Sadakata, T. Furusawa, D. Kunii (Tokyo University, Tokyo, Japan), M. Imagawa (Tanabe Kakoki Co., Ltd., Japan), and M. Nawada (Hitachi, Ltd., Tokyo, Japan). *Energy Developments in Japan*, vol. 2, Apr. 1980, p. 355-373.

The development of a NO(x)-free combustion-heating system realizing both pollution control and energy savings is described. An experiment was carried out by using a small model plant. The system consists of a combustion furnace and a new-type multifunctional heat exchanger. The heat exchanger is a rotary continuous type designed for soot collection and for catalytic combustion of CO and H₂ as well as for preheating combustion air. V.T.

A80-43828 Energy analysis of wave and tidal power. R. Harrison (Sunderland Polytechnic, Sunderland, England), K. G. Smith (South Australia Institute of Technology, Whyalla, Australia), and J. S. Varley (IPC Science and Technology Press, Ltd., Guildford, Surrey, England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 5, June 1980, p. 274-278. 12 refs.

Energy requirements for building wave- and tidal-power systems are estimated and the relationship between energy requirements and extraction efficiency is examined for wavepower systems. It is found that a point of maximum net output is reached, beyond which further increases in extraction efficiency result in decreased net energy. In this manner, the energy analysis identifies a limit on the energy which could, in principle, be extracted by a wave-energy system. Finally, it is noted that although similar limits could be identified for other types of energy sources, the tidal power analysis is confined to a brief comparison of energy inputs and outputs. M.E.P.

A80-43829 Economic and operational implications of a complex of wind-driven generators on a power system. E. D. Farmer (Central Electricity Generating Board, Central Electricity Research Laboratory, Leatherhead, Surrey, England), V. G. Newman, and P. H. Ashmore (Central Electricity Generating Board, Planning Dept., London, England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 5, June 1980, p. 289-295. 8 refs.

An assessment is presented of the technical and economic implications of integrating a sizeable complex of aerogenerators into a power system. An important economic and operational factor is the variable and uncertain nature of the wind. However, it is shown that the effects of the more rapid fluctuations are mitigated by the incoherency of different machine outputs; a diversity factor is defined in terms of the spacing of an array of machines and the turbulence length scale. In contrast, the slower variations require a significant enhancement of the operational reserve capacity without addition of dedicated storage in order to accommodate wind-power penetration up to 20% of maximum demand. The increased uncertainty of the residual generation affects the economics of utilization of pumped-storage and gas-turbines as standby plant. The results of an analysis of a year's data, pertaining to demand and wind speed at 4 well separated sites, are presented. (Author)

A80-43833 Heat-pump applications to single-family dwellings - An analysis by computer model. J. Sundell and J. A. Bubenko, Sr. (Kungl. Tekniska Hogskolan, Stockholm, Sweden). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 5, June 1980, p. 320-325.

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N80-22326*# Teledyne Continental Motors, Muskegon, Mich.
DESIGN STUDY: A 186 kW LIGHTWEIGHT DIESEL AIRCRAFT ENGINE Final Report
Alex P. Brouwers Apr. 1980 24 p
(Contract NAS3-20830)

(NASA-CR-3261) Avail: NTIS HC A02/MF A01 CSCL 21E
The design of an aircraft engine capable of developing 186 kW shaft power at a 7620 m altitude is described. The 186 kW design takes into account expected new developments in aircraft designs resulting in a reassessment of the power requirements at the cruise mode operation. Based on the results of this analysis a three phase technology development program is projected resulting in production dates of 1985, 1992, and 2000. R.E.S.

N80-22520# Institute of Gas Technology, Chicago, Ill.
DEVELOPMENT OF COMBUSTION DATA TO UTILIZE LOW-Btu GASES AS INDUSTRIAL PROCESS FUELS: PROJECT 61004 SPECIAL REPORT NO. 8: BOILER BURNER

R. T. Waibel and E. S. Fleming May 1979 40 p refs
(Contract EX-76-C-01-2489)
(FE-2489-45) Avail: NTIS HC A03/MF A01

Data were gathered to determine the performance of a boiler burner with a gun-type fuel injector when retrofit with three low-Btu gases, the performance of natural gas was used as a base line for comparison. The burner was fired on the IGT pilot-scale test furnace, simulating one burner in a multiburner array of an industrial boiler. In order to fire the low-Btu gases at the 3.0 million Btu/hr rate and upstream pressure of 30 psia used for natural gas, the fuel injector was modified by increasing the sizes of the fuel orifices to permit delivery of the required fuel volume at sonic velocity. With the appropriate fuel injector, all the low-Btu fuels exhibited stable flames at fuel enthalpy inputs of 3.0 million Btu/hr. All the low-Btu fuel gases had longer flame lengths than natural gas, although not long enough to create flame impingement problems. The thermal efficiencies of the low-Btu gases ranged from 29.5 percent for Koppers-Totzek oxygen to 26 percent for Winkler air compared with 32 percent for natural gas. DOE

N80-22523# Katzen (Raphael) Associates, Cincinnati, Ohio.
GRAIN MOTOR FUEL ALCOHOL TECHNICAL AND ECONOMIC ASSESSMENT STUDY

Jun. 1979 368 p refs
(Contract EJ-78-C-01-6639)
(HCP/J6639-01) Avail: NTIS HC A16/MF A01

The technical and economical feasibility for production of motor fuel alcohol from a plant with a capacity of 50 million US gallons per year is evaluated. Included are a detailed process design using proven technology, a complete budget estimate of the plant investment including working capital, a detailed analysis of the annual operating cost using corn as the primary feedstock, and a complete financial analysis which establishes the alcohol selling price required to net to the investor a 15 percent discounted cash flow (interest rate or return). Other considerations for production of motor fuel alcohol are evaluated and discussed, namely: excursions on plant capacities; excursions on feedstock material; sensitivity analyses on financial parameters; and substitution of corn stover for coal as the fuel source. An assessment and commentary on the agricultural, technological, and economic impact of a major gasohol program in the US are also given. DOE

N80-22527# Pullman Kellogg, Houston, Tex.
COAL CONVERSION CONTROL TECHNOLOGY. VOLUME 1: ENVIRONMENTAL REGULATIONS; LIQUID EFFLUENTS Final Report, Apr. 1977 - Nov. 1978

L. E. Bostwick, M. R. Smith, D. O. Moore, and D. K. Webber Oct. 1979 540 p
(Contract EPA-68-02-2198)
(PB80-126469; EPA-600/7-79-228A-Vol-1) Avail: NTIS HC A23/MF A01 CSCL 13B

Environmental regulations for gaseous, liquid, and solid wastes, and the control technology for liquid effluents are addressed. Available and developing control technology was

evaluated in view of federal, state, regional, and international environmental standards. GRA

N80-22528# Pullman Kellogg, Houston, Tex.
COAL CONVERSION CONTROL TECHNOLOGY. VOLUME 2: GASEOUS EMISSIONS; SOLID WASTES Final Report, Apr. 1977 - Nov. 1978

L. E. Bostwick, M. R. Smith, and D. K. Webber Oct. 1979 384 p
(Contract EPA-68-02-2198)
(PB80-126477; EPA-600/7-79-228B-Vol-2) Avail: NTIS HC A17/MF A01 CSCL 13B

The control technology of gaseous emissions and solid wastes is discussed. Available and developing control technology was evaluated in view of the requirements of federal, state, regional, and international environmental standards. GRA

N80-22649# Kentucky Univ., Lexington. Dept. of Mechanical Engineering.

BASIC RESEARCH ENGINEERING: FLUID DYNAMICS AND THERMAL PROCESSES

L. D. Conta and R. F. Hill Aug. 1979 28 p Workshop held at Lexington, Ky., 1-2 Feb. 1979 Prepared in cooperation with Engineering Societies Commission on Energy, Inc., Washington, D.C.

(Contract EF-77-C-01-2468)
(FE-2468-53) Avail: NTIS HC A03/MF A01

Specific research needs in fluid dynamics and thermal processes were identified during a workshop held to emphasize the importance of basic research in developing new technologies for meeting national energy problems. Specific research projects related to fluid dynamics, separation phenomena, energy processing, and energy reactions as well as programs for assessing the status of technology advancement in these fields and for making the results of these assessments accessible and useful to practicing engineers are recommended. DOE

N80-22764# Oak Ridge National Lab., Tenn. Energy Div.
WATER AVAILABILITY FOR ENERGY IN 1985 AND 1990

Jerome E. Dobson and Alf D. Shepherd Oct. 1979 108 p refs
(Contract W-7405-eng-26)
(ORNL/TN-6777) Avail: NTIS HC A06/MF A01

The effects of the National Energy Plan (NEP) on water for energy demands in 1985 and 1990 are examined. Estimates of total consumption are compared with estimates of critical monthly surface-water supply, derived from streamflow and reservoir use data, in each WRC Aggregated Subarea in the conterminous United States. It is concluded that water availability will not inhibit implementation of the NEP because its conservation goals actually retard the growth of water for energy demands in most basins compared with what might be expected without the NEP. However, the results of this assessment and previous corroborative water for energy analyses show that, with or without the NEP, energy development will cause additional water availability problems on already stressed streams and reservoirs throughout much of the western United States, southern Florida, the Ohio River Basin, and the highly urbanized areas of the Eastern Seaboard. DOE

N80-22782*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

DISPERSED STORAGE AND GENERATION CASE STUDIES

Khosrow Bahrami, John A. Stalkamp, and Amy Walton 15 Mar. 1980 187 p refs
(Contracts NAS7-100; DE-AI01-79ET-29026)
(NASA-CR-162996; JPL-Pub-79-98) Avail: NTIS

HC A09/MF A01 CSCL 10A

Three installations utilizing separate dispersed storage and generation (DSG) technologies were investigated. Each of the systems is described in costs and control. Selected institutional and environmental issues are discussed, including life cycle costs. No unresolved technical, environmental, or institutional problems were encountered in the installations. The wind and solar

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photovoltaic DSG were installed for test purposes, and appear to be presently uneconomical. However, a number of factors are decreasing the cost of DSG relative to conventional alternatives, and an increased DSG penetration level may be expected in the future. R.E.S.

N80-22837# General Atomic Co., San Diego, Calif.
CLOSED-CYCLE GAS TURBINE: A PROVEN COGENERATION PLANT ADAPTABLE TO FOSSIL, NUCLEAR, AND SOLAR HEAT SOURCES

C. F. McDonald Jun. 1979 71 p refs Presented at Conf. on Energy Conversion and Solar Energy, Milan, Italy, 26 Sep. 1979
(Contract EY-76-C-03-0167)
(GA-A-15322; CONF-790383-1) Avail: NTIS HC A04/MF A01

Existing operational closed-cycle gas turbine (CCGT) plants and projects nuclear, fossil, and solar plants of the future are reviewed. The benefits of the CCGT are discussed. DOE

N80-22847# Iowa State Univ. of Science and Technology, Ames, Dept. of Mechanical Engineering.

ENERGY CONSERVATION VIA HEAT TRANSFER ENHANCEMENT Quarterly Progress Report, 1 Jan. - 31 Mar. 1979

A. E. Bergles, G. H. Junkhan, and R. L. Webb Jun. 1979 48 p refs
(Contract ET-78-S-02-4649)
(COO-4649-5) Avail: NTIS HC A03/MF A01

The theory and practice of heat transfer enhancement are discussed. A technical literature file and manufacturers' file are reported and the initial patent technology information file is evaluated. Application studies on enhancement of waste heat recuperators and laminar internal flow heat transfer are described and data for the heat transfer and friction characteristics of internally finned tubes is discussed. Natural convection from rough surfaces is assessed. Major effort was directed toward planning of the Research Workshop on Energy Conservation Through Enhanced Heat Transfer. The Workshop, scheduled for May 24 and May 25, 1979 in Chicago, will be co-sponsored by NSF. DOE

N80-22848# Midwest Research Inst., Golden, Colo.

END-USE MATCHING OF SOLAR ENERGY SYSTEMS

F. Kreith, D. Kearney, and A. Bejan (Colo. Univ., Boulder) 1979 25 p refs Presented at the 2d Law of Thermodyn. Workshop, Washington, D.C., 14-16 Aug. 1979
(Contract EG-77-C-01-4042)
(SERI/TP-34-325) Avail: NTIS HC A02/MF A01

The choice among available energy sources for a given task requires technical and economic tradeoffs on the part of the individual investor. From the national perspective, however, the effectiveness with which available energy sources are utilized may well become an overriding consideration. End-use matching is a procedure for introducing solar energy into the national energy infrastructure. The result of end-use matching is an identification of the most cost-effective combination of process energy needs, solar collector technology, geographic location, and economics by matching currently available solar system hardware with particular industrial processes and their locations. End-use matching methodology is discussed and first and second law thermodynamics analyses applied to a solar system producing process steam are illustrated. DOE

N80-22849# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

COMMUNICATION STRATEGY TO COMMERCIALIZE PASSIVE SOLAR ENERGY

D. R. Wolcott (Intern. Business Serv., Inc., Washington, D.C.) and F. F. Shoemaker 1979 6 p refs Presented at the Natl. Passive Solar Energy Conf., Kansas City, Mo., 3-5 Oct. 1979
(Contract EG-77-C-01-4042)
(SERI/TP-69-412; CONF-791022-10) Avail: NTIS HC A02/MF A01

Although certain technical and economic issues remain to

be clarified, passive solar market development is increasingly dependent upon communications such as information dissemination, education, training and promotional activities. Target audiences are identified as both recipients, and disseminators of passive solar communications. Form and quality of information are discussed in terms of the stages of an innovation adoption decision-making process. Several communication-related barriers which impede the commercialization of passive solar are discussed and general information and education response are suggested. A statement of precepts which should guide passive solar communication programs is also included. DOE

N80-22850# ICF, Inc., Washington, D. C.
ENERGY EXTENSION SERVICE PILOT PROGRAM EVALUATION REPORT: THE FIRST YEAR. VOLUME 2: PILOT STATE REPORTS

Sep. 1979 638 p Prepared in cooperation with Westat Res. Inc., Rockville, Md.
(Contract EY-77-C-01-2671)
(DOE/CS-2671-3) Avail: NTIS HC A99/MF A01

A discussion of the operations of the ten EES pilot-state programs during the period from October 1, 1977 through September 30, 1978 is presented. Each of the ten pilot states, Alabama, Connecticut, Michigan, New Mexico, Pennsylvania, Tennessee, Texas, Washington, Wisconsin, and Wyoming, received a grant to develop and implement a 19 month program. A case study description of the operations of the pilot program in each state is presented with special attention given to the two programs selected in each state for more detailed study and survey research. DOE

N80-22876# Department of Energy, Washington, D. C.
ENVIRONMENTAL DEVELOPMENT PLAN: MAGNETOHYDRODYNAMICS

May 1979 199 p refs
(DOE/EDP-0045) Avail: NTIS HC A09/MF A01

The updated environmental development plan (EDP) for DOE's magnetohydrodynamics (MHD) program is presented. A brief summary of the environmental concerns identified in the original MHD EDP is given. MHD technology and DOE's MHD program are described and environmental concerns are identified. The environmental concerns associated with MHD are addressed and resolved are tabulated. An environmental concerns is developed. DOE

N80-22878# Exxon Nuclear-Idaho Co., Inc., Idaho Falls.
LOW-LEVEL AIRBORNE MONITORING TECHNIQUES UTILIZED IN A FIELD MEASUREMENT PROGRAM AT OPERATING PRESSURIZED WATER REACTORS

D. W. Akers, N. K. Bihl, S. W. Duce, J. W. Tkachyk, and B. G. Motes 1979 14 p Presented at the 23rd Conf. on Anal. Chem. in Energy Technol., Gatlinburg, Tenn., 9 Oct. 1979
(Contract EY-76-C-07-1570)
(CONF-791049-8) Avail: NTIS HC A02/MF A01

An in-plant measurement program underway at commercial nuclear power stations is described. Measurements were made of low level airborne radioactivity concentrations and release rates. A discussion of the measurement methods is given. The monitoring methods discussed include several types of radiiodine species samplers in addition to an atmospheric C-14 and tritium sampler. Each method is individually evaluated with emphasis upon: system description, observed detection limits, sample preparation, analysis, problems encountered in field use, and appropriate usage in a nuclear power plant ventilation system. DOE

N80-22882# Los Alamos Scientific Lab., N. Mex.
NATIONAL IMPACTS ON VISUAL AIR QUALITY FROM A FUTURE ENERGY SCENARIO

D. Nochumson, M. Wecksung, and G. Gurule 1979 11 p refs Presented at ACPA Conf. on Visibility, Denver, 26 Nov. 1979
(Contract W-7405-eng-36)
(LA-UR-79-3214; CONF-791139-1) Avail: NTIS HC A02/MF A01

A methodology was developed to evaluate impacts on atmospheric visual air quality for nonurban areas caused by

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regional haze. Estimated values of median visual range for 39 nonurban ambient air quality monitoring sites were shown to have a high correlation with observed values. A decline in median visual range is projected in regions of the west and the Gulf Coast where there is a substantial growth in the combustion of sulfur containing fossil fuels--coal, in particular. The projected decline in median visual range in mandatory Class One Federal areas, particularly in the Western US, may conflict with Congress's goal of protecting these areas against visibility impairment. Regulations for defining visibility impairment remain to be defined. The meeting of the emission limitations of the state implementation plans is projected to significantly improve the low visibilities experienced in the Eastern US, particularly in the Ohio Valley and the surrounding region. DOE

N80-22883# Battelle Pacific Northwest Labs., Richland, Wash. **USE OF RECONNAISSANCE LEVEL INFORMATION FOR ENVIRONMENTAL ASSESSMENT**

R. F. Foster, W. H. Rickard, J. A. Strand, and M. L. Warner Nov. 1979 46 p

(Contract EY-76-C-06-1830)

(NUREG-CR-0990; PNL-3080) Avail: NTIS HC A03/MF A01

Reconnaissance level information (RLI) sufficient for comparing the environmental and socio-economic features of candidate sites for nuclear power stations and for guiding plant design, baseline surveys, and operational practices is discussed. Environmental concerns of special importance for site evaluation include: aquatic ecology, terrestrial ecology, land and water use, socioeconomics, and institutional constraints. A scheme is suggested for using RLI to assign classifications to candidate sites based on the potential level of concern associated with the different environmental features. DOE

N80-22888# Research Triangle Inst., Research Triangle Park, N. C.

PROCEEDINGS: SYMPOSIUM ON FLUE GAS DESULFURIZATION, VOLUME 1

Franklin A. Ayer, comp. Mar. 1979 638 p refs Proc. held at Las Vegas, Nev. 5-8 Mar. 1979

(Contract EPA-68-02-2612)

(PB80-133168; EPA-600/7-79-167A) Avail: NTIS HC A99/MF A01 CSCL 13B

Contents: overview of control technology-the bridge between energy utilization and environmental goals; health effects of SO₂ and sulfates; energy, environmental, and economic impacts of flue gas desulfurization under alternative new source performance standards; status of development, energy and economic aspects of alternative technologies; economic and energy requirements of sulfur oxides control processes; combined coal cleaning and FGD; the interagency flue gas desulfurization evaluation study; status of flue gas desulfurization in the United States; recent results from EPA's lime/limestone scrubbing programs; compliance programs for SO₂ emission; and SO₂ and NO_x removal technology in Japan. GRA

N80-22889# Research Triangle Inst., Research Triangle Park, N. C.

PROCEEDINGS: SYMPOSIUM ON FLUE GAS DESULFURIZATION, VOLUME 2

Franklin A. Ayer Mar. 1979 631 p refs Symp. held at Las Vegas, Nev., 5-8 Mar. 1979

(Contract EPA-68-02-2612)

(PB80-133176; EPA-600/7-79-167B) Avail: NTIS HC A99/MF A01 CSCL 13B

Contents: utility conventional combustion comparative environmental assessment - coal and oil; design and commercial operation of lime/limestone FGD sludge stabilization systems; power plant flue gas desulfurization using alkaline fly ash from western coals; environmental effects of FGD disposal - a laboratory/field landfill demonstration; summary of utility dual alkali system; the FGD reagent dilemma - lime, limestone, or thiosorbic lime; The status of industrial boiler FGD applications in the United States; status of the project to develop standards of performance for industrial fossil-fuel-fired boilers; and, flue gas desulfurization applications to industrial boilers. GRA

N80-22895# Battelle Columbus Labs., Ohio. **CRITERIA FOR ASSESSMENT OF ENVIRONMENTAL POLLUTANTS FROM COAL CLEANING PROCESSES Final Report, Sep. 1976 - Apr. 1979**

R. A. Ewing, B. W. Cornaby, P. VanVorhis, J. C. Zuck, and G. E. Raines 1979 202 p refs

(Contract EPA-68-02-2163)

(PB80-102791; EPA-600/7-79-140) Avail: NTIS HC A10/MF A01 CSCL 06F

The development of criteria for assessing environmental pollutants associated with coal cleaning processes is described. The major criterion for ranking the importance of any pollutant is the relationship between its expected environmental concentration and the maximum concentration which presents no long-term hazard to humans or biota. Environmental concentrations depend on emission rates and the effects of physical transport and dispersion. GRA

N80-23131# Battelle Pacific Northwest Labs., Richland, Wash. **HIGH-LEVEL WASTE IMMOBILIZATION PROGRAM: AN OVERVIEW**

W. R. Bonner Sep. 1979 46 p refs

(Contract EY-76-C-06-1830)

(PNL-3094) Avail: NTIS HC A03/MF A01

Technology to allow safe, affordable immobilization and disposal of nuclear waste is reviewed. Waste forms and processes are being developed on a schedule consistent with national needs for immobilization of high-level wastes stored at Savannah River, Hanford, Idaho National Engineering Laboratory, and West Valley, New York. This technology is directly applicable to high-level wastes from potential reprocessing of spent nuclear fuel. Topics covered include: (1) waste form development and characterization; (2) process development; and (3) radioactive process demonstration. DOE

N80-23214*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

TRACTION STUDIES OF NORTHEAST CORRIDOR RAIL PASSENGER SERVICE: EXECUTIVE SUMMARY

T. W. Macie and J. A. Stallkamp 15 Mar. 1980 64 p refs Sponsored in part by DOE

(Contract NAS7-100)

(NASA-CR-162997; JPL-Pub-80-3) Avail: NTIS HC A04/MF A01 CSCL 13F

The enabling legislation of 1976 for improvement of service in the Northeast corridor (NEC) requires a schedule of 2 h. 40 min between Washington and New York City by 1981 and 3 h 40 min between NYC and Boston, when the electrification is completed. Various options of the NEC operation that may satisfy the legislation, were investigated, particularly in terms of travel time and energy consumption. NEC operations were compared with overseas systems and practices. The emerging new technology of AC traction was also evaluated. A.R.H.

N80-23215*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ASSESSMENT OF THE POTENTIAL OF HYBRID VEHICLES: SUMMARY

F. T. Surber et al 15 Mar. 1980 70 p refs

(Contracts NAS7-100; EM-78-I-01-4290; JPL Proj. 5030-345)

(NASA-CR-163059; JPL-Pub-80-13) Avail: NTIS HC A04/MF A01 CSCL 13F

The potential of hybrid vehicles as a replacement of the conventional gasoline or diesel fueled internal combustion engine vehicle within the next 20 to 30 years, was assessed. Hybrid vehicle designs and applications which are technically and economically viable were studied to determine if reductions in petroleum usage were large enough to warrant major expenditures of research and development funds. Critical technical areas where research and development can be most usefully concentrated were identified. E.D.K.

N80-23477# Argonne National Lab., Ill. **ENVIRONMENTAL ASSESSMENT OF THE UTILIZATION OF ALCOHOL FUELS IN HIGHWAY VEHICLE APPLICATIONS** Oreste M. Bevilacqua and Martin J. Bernard, III 1979 11 p

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refs Presented at 2d Intern. Conf. on Energy Use Management. Los Angeles, 22-26 Oct. 1979

(Contract W-31-109-eng-38)

(CONF-791009-19) Avail: NTIS HC A02/MF A01

Four alternative alcohol fuel utilization scenarios are described. The development of the utilization scenarios was based on an evaluation of a broad range of implementation constraints and considerations. The final set of utilization scenarios will be used in the environmental assessment to bracket the probable environmental impacts and implications during the foreseeable future. DOE

N80-23485# Badger Plants, Inc., Cambridge, Mass. **CONCEPTUAL DESIGN OF A COAL-TO-METHANOL-TO-GASOLINE COMMERCIAL PLANT. VOLUME 3: ENVIRONMENTAL Interim Final Report, 31 Aug. 1977 - 1 Mar. 1979**

Mar. 1979 216 p

(Contract EX-76-C-01-2416)

(FE-2416-43-Vol-3: IFR-2) Avail: NTIS HC A10/MF A01

The environmental considerations associated with an industrial manufacturing complex are addressed with specific reference to a coal-to-gasoline manufacturing facility. The environmental laws and regulations affecting the design of the coal-to-gasoline facility are summarized. Environmental control methods and equipment are outlined that will yield a zero plant discharge of all process waste water streams. Gaseous emissions are tabulated and methods of treatment and control are also described. Waste disposal by landfill methods are also considered. DOE

N80-23629# California Univ., Livermore. Lawrence Livermore Lab.

BATTERY-POWERED, DIFFERENTIAL INFRARED ABSORPTION SENSOR FOR METHANE, ETHANE, AND OTHER HYDROCARBONS

G. E. Bingham, C. H. Gillespie, and J. H. McQuaid 8 Oct. 1979 21 p refs Presented at the Gas Res. Inst. Symp. on Methane Detection and Measurement, Chicago, 27 Aug. 1979 (Contract W-7405-eng-48; Grant NSF DEB-77-16327)

(UCRL-83317; CONF-790887-1) Avail: NTIS HC A02/MF A01

The performance goals, design considerations and physical details of the miniature infrared absorption sensor developed for the liquefied natural gas spill safety program are presented. The sensor is lightweight, battery-powered, portable, self-contained, and able to interface readily to large array data systems. Essentially a precision infrared differential spectrometer capable of operating over the full range of gas concentrations expected in the spill diffusion tests, the sensor is expected to cost less than \$7000 per unit. The present design of this open-cell fast response sensor allows it to measure two components, but it can be modified to measure additional components at a reduced sampling frequency. To minimize temperature effects and power consumption, the sensor has a single source, single detectors design which includes a rotating chopper-filter wheel. A CMOS microprocessor interfaced with an arithmetic chip is used to linearize sensor output and correct for component interference. DOE

N80-23662# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

DEVELOPMENT OF HIGH-TEMPERATURE TURBINE SUBSYSTEM TECHNOLOGY TO A TECHNOLOGY READINESS STATUS, PHASE 2 Quarterly Report, Apr. - Jun. 1978

A. Caruvana, E. D. Alderson, N. R. Antrim, H. V. Doering, R. P. Dubois, M. Dreedman, and R. Frishmuth Jul. 1978 185 p refs

(Contract EX-76-C-01-1806)

(FE-1806-48) Avail: NTIS HC A09/MF A01

Progress is reported in a program design to bring to technology readiness, over a six- to ten year duration, a coal-derived fuel at a firing temperature of 2600 F with growth capability 3000 F. The objectives of phase 2 are to: perform component design and trade-off analyses in sufficient depth to support the component design and test tasks; and update the phase 1 combined cycle

studies to evaluate the commercial viability of a GE-TRV turbine system. Information is included on hot gas path development test facilities, low BTU gas cleanup system, motorized rig test air turbine tests, liquid- and gas-fueled combined cycle power plants, turbine subsystem design, update of verification tests system definition and technology readiness vehicle design. DOE

N80-23779*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE EFFECT OF CATALYST LENGTH AND DOWNSTREAM REACTOR DISTANCE ON CATALYTIC COMBUSTOR PERFORMANCE

David Anderson 1980 24 p refs Presented at the 4th Workshop on Catalytic Combust., Cincinnati, 14-15 May 1980; sponsored by EPA

(Contract EC-77-A-31-1040)

(NASA-TM-81475; DOE/NASA/1040-80/14; E-409) Avail: NTIS HC A02/MF A01 CSCL 10B

A study was made to determine the effects on catalytic combustor performance which resulted from independently varying the length of a catalytic reactor and the length available for gas-phase reactions downstream of the catalyst. Monolithic combustion catalysts from three manufacturers were tested in a combustion test rig with no. 2 diesel fuel. Catalytic reactor lengths of 2.5 and 5.4 cm, and downstream gas-phase reaction distances of 7.3, 12.4, 17.5, and 22.5 cm were evaluated. Measurements of carbon monoxide, unburned hydrocarbons, nitrogen oxides, and pressure drop were made. The catalytic-reactor pressure drop was less than 1 percent of the upstream total pressure for all test configurations and test conditions. Nitrogen oxides and unburned hydrocarbons emissions were less than 0.25 g NO₂/kg fuel and 0.6 g HC/kg fuel, respectively. The minimum operating temperature (defined as the adiabatic combustion temperature required to obtain carbon monoxide emissions below a reference level of 13.6 g CO/kg fuel) ranged from 1230 K to 1500 K for the various conditions and configurations tested. The minimum operating temperature decreased with increasing total (catalytic-reactor-plus-downstream-gas-phase-reactor-zone) residence time but was independent of the relative times spent in each region when the catalytic-reactor residence time was greater than or equal to 1.4 ms. R.E.S.

N80-23780*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SUMMARY AND EVALUATION OF THE PARAMETRIC STUDY OF POTENTIAL EARLY COMMERCIAL MHD POWER PLANTS (PSPEC)

Peter J. Staigner and John M. Abbott 1980 11 p refs Presented at the 7th Intern. Conf. on Magnetohydrodyn. Elec. Generation, Cambridge, Mass., 16-20 Jun. 1980; sponsored by the Symp. on the Eng. Aspects of Magnetohydrodynam., Inc.

(Contract EF-77-A-31-2674)

(NASA-TM-81497; DOE/NASA/2674-80/9; E-434) Avail: NTIS HC A02/MF A01 CSCL 10B

Two parallel contracted studies were conducted. Each contractor investigated three base cases and parametric variations about these base cases. Each contractor concluded that two of the base cases (a plant using separate firing of an advanced high temperature regenerative air heater with fuel from an advanced coal gasifier and a plant using an intermediate temperature metallic recuperative heat exchanger to heat oxygen enriched combustion air) were comparable in both performance and cost of electricity. The contractors differed in the level of their cost estimates with the capital cost estimates for the MHD topping cycle and the magnet subsystem in particular accounting for a significant part of the difference. The impact of the study on the decision to pursue a course which leads to an oxygen enriched plant as the first commercial MHD plant is described. R.E.S.

N80-23782# Delta Electronic Control Corp., Irvine, Calif. **DESIGN, CONSTRUCTION AND TESTING OF A 60 kW SOLAR ARRAY AND POWER CONVERSION SYSTEM Final Report, Jan. 1978 - Aug. 1979**

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

J. S. Suelzle Aug. 1979 138 p
(Contract DAAK70-78-C-0018)
(AD-A080877; DECC-61211-003) Avail: NTIS
HC A07/MF A01 CSCL 10/1

A 60 kW photovoltaic array and power conversion system was designed, constructed, tested and installed by Delta Electronic Control Corporation. The system is currently operative, augmenting a remote diesel power generating station at Mt. Laguna Air Force Station. The system, which operates without on-site energy storage, operates unattended, extracting the maximum available power from the solar array. GRA

N80-23786# Woodard-Clyde Consultants, San Francisco, Calif. Fossil Fuel and Advanced Systems Div.

ENVIRONMENTAL ASSESSMENT METHODOLOGY: SOLAR POWER PLANT APPLICATIONS. VOLUME 2: INDUSTRIAL IMPLICATIONS AND SECONDARY-IMPACT METHODOLOGY

K. Nair and A. Sichertman Apr. 1979 123 p refs Sponsored by the Elec. Power Res. Inst. (EPRI Proj. 551)

(EPRI-ER-1070-Vol-2) Avail: NTIS HC A06/MF A01

A methodology for assessing industrial implication and secondary impacts of central solar electric stations was developed using an input output formulation, and a computer model was developed to help estimate these impacts. An independent assessment of the market penetration of solar energy to the year 2000 was made using Bayesian statistical techniques to evaluate different future scenarios. Techniques for assessing the likelihood of these scenarios were also developed. DOE

N80-23794# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

BASIC RESEARCH NEEDS IN ENERGY CONSERVATION

Jack M. Hollander Oct. 1979 28 p refs
(Contract W-7405-eng-48)

(LBL-9939) Avail: NTIS HC A03/MF A01

The role of research in energy conservation, the role of government in conservation research and the role of basic research in conservation are discussed with information on the need for research on the physical, environmental, social, and economic aspects of energy conservation in the residential, industrial, and transportation sectors, and the outlook for U.S. energy supply and demand. DOE

N80-23799# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

CONVERSION SYSTEM OVERVIEW ASSESSMENT. VOLUME 2: SOLAR-WIND HYBRID SYSTEMS

T. S. Jayadev, J. Henderson, and C. Bingham Aug. 1979 34 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-35-078-Vol-2) Avail: NTIS HC A03/MF A01

Solar-wind hybrid systems are discussed. It is shown that there are large areas in the United States where solar and wind resources are comparable in magnitude and there are diurnal and seasonal complementarities which offer the potential for cost-effective hybrid systems. There are also distinct engineering features of the two conversion technologies. Electric power generation from wind is straightforward and cost-effective, whereas solar thermal conversion to generate heat is more cost-effective than to generate electricity. Examples of hybrid systems utilizing these features on total energy application are presented. DOE

N80-23802# Los Alamos Scientific Lab., N. Mex.

ENERGY FROM HOT DRY ROCK

Robert H. Hendron 1979 22 p refs Presented at the Conf. on Long-Term Energy Resources, 3 Dec. 1979; sponsored by UNITAR

(Contract W-7405-eng-36)

(LA-UR-79-3256; CONF-791216-1)

Avail: NTIS HC A02/MF A01

The Hot Dry Rock Geothermal Energy Program is described. The system, operation, results, development program,

environmental implications, resource, economics, and future plans are discussed. DOE

N80-23803# New Zealand Energy Research and Development Committee, Auckland.

ELECTRICITY FROM REFUSE

M. White 1979 51 p refs

(NZERDC-44; ISSN-0110-1692)

Avail: NTIS HC A04/MF A01

The conversion of refuse to electricity for Auckland involves the combustion of refuse directly or as a refuse-derived fuel to release heat energy, which in turn is converted to high-pressure steam for driving steam turbogenerators. Domestic/commercial collected refuse, privately deposited domestic refuse and industrial/commercial refuse are used. Only those technologies are considered that have been basically proven by commercial operation and systems designed to make use, whenever possible, of existing plant and equipment. The following options are examined for close technical and economic assessment: mass burning in sloping grate boiler plant, semi-suspension combustion boiler plant, supplementary firing of a refuse-derived fuel and refuse-fueled power station using semi-suspension combustion boiler plant. Extensive data are compiled on: refuse from the Auckland urban area; design of systems; environmental and technical aspects. DOE

N80-23805# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

PROPOSITION ON ENERGY ANALYSIS AND ECONOMIC EFFICIENCY

Donald I. Hertzmark Oct. 1979 22 p refs

(Contract EG-77-C-01-4042)

(SERI/RR-51-332) Avail: NTIS HC A02/MF A01

Analytical results of an attempt to simultaneously optimize economic and thermodynamic efficiency are presented and discussed. The attempt to impose complete mathematical rationality and consistency on the pricing of energy commodities failed since it was not possible to consistently weigh purely physical efficiency measures, much less social factors. Nevertheless, the use of both material balance and entropy analysis is valuable for evaluating nonmarket decisions, as well as identifying opportunities for process improvements. DOE

N80-23807# Los Alamos Scientific Lab., N. Mex.

RESIDENTIAL PASSIVE SOLAR SYSTEMS: REGIONAL SENSITIVITY TO SYSTEM PERFORMANCE COSTS, AND ALTERNATIVE PRICES

C. Kirschner, S. Ben-David, and F. Roach 1979 32 p Presented at the 2nd Miami Intern. Conf. on Alternatives Energy Sources, Miami Beach, Fla., 10-13 Dec. 1979

(Contract W-7405-eng-36)

(LA-UR-79-3390; CONF-791204-12)

Avail: NTIS HC A03/MF A01

The economic potential of two passive space heating configurations were analyzed. These were a masonry thermal storage wall (trombe) and a direct gain system - both with night insulation. A standard tract home design for each of the two passive systems was used throughout the analysis to allow interregional comparisons. The economic performance of these two systems was evaluated on a regional basis (223 locations) throughout the United States. A sensitive analysis was conducted on two conventional energy types (electricity and natural gas) to determine the impact of alternative fuel price escalation rates and solar costs upon feasibility of the two solar systems. Cost goals for solar system prices were established under one set of future fuel prices and stated economic conditions. DOE

N80-23820# Los Alamos Scientific Lab., N. Mex.

PRELIMINARY DEFINITION AND CHARACTERIZATIONS OF SOLAR INDUSTRIAL PROCESS HEAT TECHNOLOGY AND MANUFACTURING PLANT FOR THE YEAR 2000

Richard T. Meyer and Ted Prythéro 1979 7 p Presented at the Solar Ind. Process Heat Conf., Oakland, Calif., 31 Oct.-2 Nov. 1979

(Contract W-7405-eng-36)

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(LA-UR-79-2812; CONF-791024-4) Avail: NTIS
HC A02/MF A01

The findings and projections of this preliminary definition and characterization of a solar industrial process heat technology and manufacturing plant for the year 2000 indicate that the technology and the manufacturing would be significantly more sophisticated and expanded than exists in the solar industry today. The solar process heat technology is defined to be a parabolic trough collector system and to utilize a combustion of the more advanced materials and components under current development. The manufacturing operations are projected to include glass-making, silvering, electroplating and plastic-forming, which, while standard industrial procedures, will be additions to or expansions of existing solar manufacturing plants. These integrated operations for the year 2000 solar facility will introduce important environmental residuals which will need to be managed and controlled to satisfy local, state, and federal environmental standards. DOE

N80-23830# Systems Consultants, Inc., Washington, D. C. **REGIONAL APPLICATION OF FOSSIL ENERGY TECHNOLOGIES: AN ANALYTICAL APPROACH Final Report**
W. Rebello, D. Canete, H. Phipps, and R. Smith Sep. 1979
312 p refs
(Contract EX-76-C-01-2442)
(DOE/ET-2442-1) Avail: NTIS HC A14/MF A01

Energy supply/demand profiles are presented for the 50 states and the nine US census regions using 1974 statistics. These profiles include quality and type of energy reserves, annual primary resource production, and consumption by end-use sector. A method for use by energy planners in assessing the effects of policy decision on energy profiles was developed. A series of energy indices was derived for each census region. The indices are defined to include the effect of consumption of relatively scarce fuels (oil and gas) versus plentiful fuels (coal). A number of fossil energy technologies under development are described. The potential impact of the maturation of these technologies on each census region's energy posture is discussed in conjunction with any regional constraints that may exist. Finally, a number of sample what if scenarios are discussed and the impact of fossil fuel replacements on national, regional, and sector energy consumption quantitatively is assessed. DOE

N80-23833# IBM Federal Systems Div., Huntsville, Ala. **ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK**
May 1979 266 p
(Contract EG-77-C-01-4049)
(Solar/0010-79/05) Avail: NTIS HC A12/MF A01

A major goal of the National Solar Heating and Cooling Demonstration Program is to collect and analyze data which will be used to determine the thermal performance of selected solar energy systems. To meet the goals and objectives of the Demonstration Program, the National Solar Data Network was developed. The network consists of sensors which measure key performance parameters at a selected site, a site data acquisition system, telephone transmission circuits and a central data processing system which collects data and performs the computations required for system performance analysis. The output of the National Solar Data Network is a monthly performance report which defines the energy contribution of the solar energy system and resultant fossil fuel savings. The performance data for homes throughout the US is included. DOE

N80-23841# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis. **FEDERAL REPUBLIC OF GERMANY: ESTIMATES OF FUTURE ENERGY/GDP RELATIONSHIPS**
R. Bruce Williamson and Edward L. Allen Dec. 1979 64 p refs
(Contracts EY-76-C-05-0033; DE-AC05-76OR-00033)
(ORAU/IEA(M)-79-22) Avail: NTIS HC A04/MF A01

Postwar trends in the West German economy, demography, and energy use were analyzed. The base year is 1976, and projections are made up to the year 2000 for gross domestic product (GDP) and sectoral energy demand. West Germany's 2.8 percent average annual GDP growth rate for the 1970s

contrasts sharply with the 5.4 percent rate achieved in the 1960s. Future GDP growth is projected to level off at 2.9 percent a year, on the average, between now and 2000. This projection places German economic growth below that of Japan, Canada, and France but ahead of that projected for Italy and the United Kingdom. The relationship between West Germany energy demand and economic growth was stable in the postwar period. In 1976, total energy consumption stood at 9.8 quads and is projected to increase to 12.7 quads in 2000, an average annual 1.1 percent increase. The E/GDP ratio is expected to improve substantially by the year 2000, with the residential sector leading the way in energy efficiency. DOE

N80-23847# Urban Systems Research and Engineering, Inc., Cambridge, Mass.

DIRECT REGIONAL ENERGY/ECONOMIC MODELING (DREEM) DESIGN Final Report

P. D. Hall and C. J. Pleatsikas Oct. 1979 146 p refs
(Contract EI-78-C-01-6345)

(DOE/EIA/6345-1) Avail: NTIS HC A07/MF A01

The use of regional and multiregional economic models for estimating the indirect and induced impacts of Federally-mandated energy policies was investigated. Alternative types of energy policies that can impact regional economics and the available analytical frameworks for measuring the magnitudes and spatial extents of these impacts were examined. The models capabilities for addressing various energy policy issues are summarized. Then the applicability of the model in specified contexts is demonstrated by developing appropriate input data for three scenarios. These scenarios concern the multi-state impacts of alternative coal mining development decisions, multi-regional impacts of macroeconomic change, and the comprehensive effects of an alternative national energy supply trajectory. DOE

N80-23848# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.

UNITED KINGDOM: ESTIMATES OF FUTURE ENERGY/GDP RELATIONSHIP

J. C. Gehman and Edward L. Allen Dec. 1979 106 p refs
(Contracts EY-76-C-05-0033; DE-AC05-76OR-00033)
(ORAU/IEA(M)-79-25) Avail: NTIS HC A06/MF A01

The UK economy is expected to grow in real terms due, for the most part, to advances in productivity. With productivity increasing, but at a declining rate, real GDP is projected at 50 percent above the 1976 level. The historical shift from goods production to services is expected to continue, but at a slower pace; by the year 2000 service output is expected to reach 55 percent of GDP. In the transport sector, the historical shift toward the passenger car is expected to saturate at about 70 percent of total ton-miles, while the shift toward truck freight is expected to continue and reach 76 percent of total ton-miles. Goods production is expected to stagnate and could fall to 33 percent of GDP by 2000. Historically, E/GDP has fallen steadily in the United Kingdom due almost exclusively to industrial conservation (investment in new and more efficient plant and equipment). Conservation should spread to all other sectors of the economy as a result of government policy. The E/GDP ratio is expected to fall by another 28 percent by the year 2000. This implies total energy consumption of 8.7 quads. DOE

N80-23849# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.

CANADA: ESTIMATES OF FUTURE ENERGY/GNP RELATIONSHIPS

E. L. Allen, James A. Edmonds, and R. Bruce Williamson Dec. 1979 61 p refs

(Contracts EY-76-C-05-0033; DE-AC05-76OR-00033)

(ORAU/IEA(M)-79-24) Avail: NTIS HC A04/MF A01

The Canadian economy expanded at an annual rate of 4.6 percent in the 1970s (GNP growth), second only to the remarkable record of Japan. In the future, Canadian economic development is expected to fall below past rates of achievement, primarily because of declining numbers of new entrants in the labor force. However, other factors affecting growth remain favorable. Canada, in particular, is virtually self-sufficient in energy. Government policy is to carry out a vigorous program of

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conservation, and to parallel this effort with domestic energy price increases which will move up to world levels over the next few years. As to economic growth, GNP expansion is expected to remain well above 3 percent a year for the balance of this century. Energy consumption is expected to grow from 7.51 Btu x 10 to the 15th power (quads) in 1976 to 13.3 quads by 2000. This means that energy growth, as a consequence of determined conservation, is expected to be about half as rapid as economic growth to 1990. DOE

N80-23854# Massachusetts Inst. of Tech., Cambridge.
PROCESS APPLICATIONS FOR GEOTHERMAL ENERGY RESOURCES Progress Report

1 Oct. 1979 9 p
(Contract ET-78-S-02-4896)
(COO-4896-T1) Avail: NTIS HC A02/MF A01
Energy use characteristics of the major energy using industries in the US were examined. Using the pulp and paper industry, two analyses were performed of the potential for substituting geothermal energy for fossil fuel in specific plants. The lack of industry interest is discussed. DOE

N80-23857# Brookhaven National Lab., Upton, N. Y.
SERIES SOLAR HEAT PUMP AND ENERGY CONSERVATION

Edward A. Kush 1979 24 p refs Presented at the 2nd Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10-13 Dec. 1979
(Contract EY-76-C-02-0016)
(BNL-27012; CONF-791204-13) Avail: NTIS HC A02/MF A01

An overview is given of the series solar heat pump concepts and the reasons why it can serve an important role in energy conservation in space heating. These are highlighted by elevated coefficients of performance (COP's) and the use of low temperature potentially inexpensive solar collectors. The characteristics required of the subsystems and integrated system are detailed. Particular emphasis is given to the performance of the heat pump itself at high temperature source conditions corresponding to those of solar input, and recent laboratory results which demonstrate very high COP's using practical components are shown. The reasons why the high COP's are a necessary but not sufficient condition for competitive overall system performance are detailed and methods for applying the high COP's to an effective solar assisted heat pump system are discussed. Ongoing development work in the field is summarized. DOE

N80-23866# Transportation Research Board, Washington, D.C.
Commission on Sociotechnical Systems.
ENERGY POLICY IMPACT EVALUATION

Susan Singer-bart, ed., Raisin K. Mufti (Princeton Univ.), Michael J. Munson (Princeton Univ.), Kenneth Chomitz (California Univ., Irvine), Richard A. Margiotta (Tennessee Univ., Knoxville), Lawrence J. Reilly (Harvard Univ., Cambridge Mass.), David T. Hartgen (New York State Dept. of Transportation, Albany), Leon Rudman (DOE, Cambridge, Mass.), Robin Dubin (Johns Hopkins Univ., Baltimore), David L. Greene (ORNL, Tenn.) et al 1979 44 p refs. Sponsored in part by DOE
(PB80-137953; TRB/TRR-726; ISBN-0-309-02979-1; LC-79-607912; ISSN-0361-1981) Avail: NTIS HC A03/MF A01; Paper copy also available from Transportation Res. Board, 2101 Constitution Ave., Washington, D. C. 20418 CSDL 10A

Five papers are presented which deal with the following areas: approach to assessing the impact of energy conservation policies on transportation demand; survey and analysis of energy intensity estimates for urban transportation modes; foreign oil dependence; state-level analysis; vehicle kilometers traveled; evaluation of existing data sources; and multivariate classification of automobiles by use of an automobile characteristics data base. GRA

N80-23873 Pennsylvania State Univ., University Park.
THE CHEMICAL TRANSFORMATION OF SULFUR DIOXIDE TO SULFATE IN THE PLUME OF THE COAL-BURNING

KEYSTONE POWER PLANT Ph.D. Thesis
Allen Conrad Dittenhoefer 1979 137 p
Avail: Univ. Microfilms Order No. 8010048

Measurements of the oxidation rate of sulfur dioxide to sulfate particles were made in the plume of the coal-fired Keystone power plant using instrumented aircraft. Aerosol number concentrations in nine distinct size intervals spanning the range 0.01-2.0 micrometer diameter were obtained using a condensation nucleus counter, an optical particle counter, and an electrical aerosol analyzer. These measurements were combined with cascade impactor sampling and quantitative sulfate analysis of individual plume and background particles using a transmission electron microscope to determine the mass concentration of sulfate at various positions in and out of the plume. From cross sectional plume mappings of the horizontal and vertical concentration profiles of SO₂ and sulfate mass it was possible to calculate the SO₂ conversion rate in the plume. It was found that although plume sulfate particle size distributions were highly dependent on both ambient relative humidity and solar radiative flux, relative humidity was the predominant parameter governing the SO₂ transformation rate within the initial one to two hours of plume transport. Dissert. Abstr.

N80-23876# Department of Energy, Washington, D. C.
ENVIRONMENTAL DEVELOPMENT PLAN FOR BIOMASS ENERGY SYSTEMS

Sep. 1979 56 p refs
(DOE/EDP-0032) Avail: NTIS HC A04/MF A01
Key elements of the Biomass Energy Systems Program are briefly described. Significant environmental concerns and requirements are identified. These include effects on soil erosion, soil quality, water quality, ecosystems, and air quality. J.M.S.

N80-23877# Department of Energy, Washington, D. C.
ENVIRONMENTAL DEVELOPMENT PLAN: GEOTHERMAL ENERGY SYSTEMS

Aug. 1979 77 p refs
(DOE/EDP-0036) Avail: NTIS HC A05/MF A01
All current and planned activities of the DOE Geothermal Energy Systems Program are covered. Major elements of this program include exploration of resources, confirmation of reservoirs, development of energy extraction systems, demonstration of utilization systems, identification and removal of institutional barriers, and a loan guaranty program. Environmental concerns and requirements for resolution of these concerns are discussed in detail. In terms of immediate need and importance in getting power online, the emission of H₂S is the most important concern and the demonstration of an effective abatement system is the most significant requirement. Other significant concerns are the management or disposal of spent geothermal fluids, the potential of land subsidence, questions of water availability for heat rejection systems, land use conflicts, and socio-economic and cultural problems. The requirements to appropriately research and mitigate these and other concerns in time to permit orderly and timely development of geothermal energy systems are presented. J.M.S.

N80-23878# California Univ., Livermore. Lawrence Livermore Lab.

POTENTIAL AIR QUALITY IMPACT OF GEOTHERMAL POWER PRODUCTION IN THE IMPERIAL VALLEY

P. H. Gudiksen, D. L. Ermak, K. C. Lamson, M. C. Axelrod, and R. A. Nyholm Oct. 1979 42 p refs
(Contract W-7405-eng-48)
(UCRL-52797) Avail: NTIS HC A03/MF A01

A regional assessment of the potential impact on air quality of developing the Imperial Valley's geothermal resources for power production is presented. A network of six stations was installed to characterize the air quality and atmospheric transport properties for the valley before development. These measured the ambient air concentrations of H₂S, SO₂, O₃, NO, NO_x, CO₂, Hg, Rn, and particulates. The geothermal fluids were analyzed chemically to estimate potential emission rates from future power plants. Using these data and advanced air quality modeling led to the prediction of the potential valley-wide impact of a 3000 MW development scenario. The impact analysis reveals that H₂S is

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the principal gaseous pollutant of concern. The ambient H₂S concentrations that would result from generating 3000 MW without emission controls exceed the California air quality standard (30 ppb) at least 1% of the time for an area in the northern part of the valley that is roughly 1500 sq km in size. DOE

N80-23881# Department of Energy, Washington, D. C. Div. of Technology Assessments.

ENVIRONMENTAL DEVELOPMENT PLANS FOR ENERGY TECHNOLOGY PROGRAMS, Summary Report

Oct. 1979 110 p

(DOE/EDP-0062) Avail: NTIS HC A06/MF A01

A review of 30 environmental development plans prepared in 1979 covering the Department of Energy's programs in the solar geothermal conservation, fossil, and nuclear energy technology areas is presented. For each area, the key environmental, health and safety concerns are identified, and the research required to resolve the concerns is discussed. Abbreviated milestones for technology and environmental activities are presented, and the completion dates for mandated environmental documents are summarized. DOE

N80-23904# Pullman Kellogg, Houston, Tex.
ENVIRONMENTAL STANDARDS FOR COAL CONVERSION PROCESSES. VOLUME 1: MOST STRINGENT, FEDERAL, AND SELECTED STATE REGULATIONS Final Report, Feb. 1977 - Jan. 1979

D. K. Webber and D. E. Whittaker Oct. 1979 268 p. refs

(Contract EPA-68-02-2198)

(PB80-126980; EPA-600/7-79-231-A)

Avail: NTIS

HC A12/MF A01 CSCL 13B

Existing and proposed environmental standards are synopsized as a guide for evaluating the efficiency of available and developing technology for controlling liquid, gaseous, and solid wastes from coal conversion processes. Within the U.S., the Federal (including EPA) standards and guidelines for air, water, and solid wastes were gathered together with standards for 22 states (selected for their potential in installing coal conversion facilities) and two regional commissions. Because environmental effects can cross national borders, standards and guidelines for Mexico, the Dominion of Canada, two Canadian provinces, and the international Joint Commission of U.S. and Canada were synopsized and added to the U.S. standards. All standards and guidelines are compared; from them the most stringent standards are summarized. GRA

N80-24146# Canadian Industries Ltd., Kingston (Ontario). Environmental Improvement Business Area.

SWARU: SOLID WASTE DISPOSAL RESOURCE SYSTEM [1979] 13 p

(NP-24196) Avail: NTIS HC A02/MF A01

The SWARU solid waste disposal resource recovery process a comprehensive system which can accept garbage and wastes of all kinds and converts the constituents to their highest and best economic use, is described. The incineration and materials handling technology, which facilitates resource recovery and ensures high thermal efficiency is evaluated and emissions from the plant are analyzed. DOE

N80-24217# Argonne National Lab., Ill.
ELECTRIC AND HYBRID VEHICLES IN THE URBAN FUTURE

Margaret K. Singh and Martin J. Bernard, III 1979 11 p refs
Presented at the 2nd Intern. Conf. on Energy Use Management, Los Angeles, 22-26 Oct. 1979

(Contract W-31-109-eng-38)

(CONF-791009-23) Avail: NTIS HC A02/MF A01

Basic electric and hybrid vehicle (EHV) information is outlined for transportation energy planners and engineers. Topics covered include: (1) the market potential for EHV's (trucks, buses, and automobiles) based on the work of several research groups and on expected technological characteristics of EHV's; (2) an assessment of the impact of EHV's on the urban structure and transport systems as well as urban environmental systems; and (3) current programs designed to accelerate the utilization of

EHV's. In the assessment, 61 types of vehicles are characterized and set in five distinct market scenarios. It is concluded that the potential for significant EHV markets by the year 2000 is high and an overall net benefit to urban areas will result. DOE

N80-24316*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ADVANCED COMPONENT TECHNOLOGIES FOR ENERGY-EFFICIENT TURBOFAN ENGINES

Neal T. Saunders 1980 19 p refs Presented at the 16th Joint Propulsion Conf., Hartford, 30 Jun. - 2 Jul. 1980; cosponsored by AIAA, ASME and SAE

(NASA-TM-81507; E-445) Avail: NTIS HC A02/MF A01 CSCL 21E

A cooperative government-industry effort, the Energy Efficient Engine Project, to develop the advanced technology base for future commercial development of a new generation of more fuel conservative turbofan engines for airline use is described. Engine configurations that are dependent upon technology advances in each major engine component are defined and current design and development of the advanced components are included. J.M.S.

N80-24393# Electrochemical Technology Corp., Seattle, Wash.
SURVEY OF ORGANIC ELECTROLYTIC PROCESSES Final Report

T. R. Beck, R. T. Ruggeri, R. C. Alkirk (Illinois Univ., Urbana), M. A. Stadherr (Illinois Univ., Urbana), and N. L. Weinberg Nov. 1979 272 p refs

(Contract W-31-109-eng-38)

(ANL/OEPM-79-5) Avail: NTIS HC A12/MF A01

The commercial status of electroorganic processes and whether there would be significant possible energy savings by introduction of electroorganic processes to replace conventional chemical processes for production of certain large-tonnage organic chemicals were determined. A list was compiled of the 220 organic chemicals that were produced at greater than 10,000 tons per year in 1975 in the United States. Search of the Swann and of the Fichter Bibliographies of electroorganic literature yielded references on 95 of these compounds. By application of selection rules to obtain promising candidates, nine chemicals with diverse electrochemical processes were chosen for detailed process energy calculations. Parallel calculations were made for presently-used commercial chemical routes to these products. Two of the nine electrochemical processes, adiponitrile and methyl ethyl ketone, had energy savings in comparison to the corresponding chemical processes. DOE

N80-24475# Battelle Columbus Labs., Ohio.

CARBOHYDRATE CROPS AS A RENEWABLE RESOURCE FOR FUELS PRODUCTION. VOLUME 2: IDENTIFICATION OF KEY POLICY ISSUES, ALTERNATIVES, AND IMPLICATIONS RELATING ENERGY FROM BIOMASS

D. A. Scantland, T. A. McClure, and E. S. Lipinsky 30 May 1979 75 p refs

(Contract W-7405-eng-92)

(BMI-2031-Vol-2) Avail: NTIS HC A04/MF A01

Significant quantities of ethanol from carbohydrate crops could be produced from the equivalent number of dollars currently diverted and expected to be spent under the Food and Agriculture Act of 1977; however the production of ethanol from sugar crops or corn would mean that significant changes in the prices of agricultural products could be expected (all other things being equal). In the initial development of ethanol fuels, ethanol from corn appears to be the least expensive as compared to sugarcane, sugar beets, and sweet sorghum. This is primarily because of high by-product credits. The crop with the greatest long term potential is sweet sorghum. Various policy incentive programs will continue to be directed towards stimulating biomass energy production. Four policy incentive programs are described. DOE

N80-24493# Midwest Research Inst., Golden, Colo.
ENVIRONMENTAL AND INSTITUTIONAL CONSIDERATIONS IN THE DEVELOPMENT AND IMPLEMENTATION OF BIOMASS ENERGY TECHNOLOGIES

Charlotte Schwab Sep. 1979 46 p refs

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

(Contract EG-77-C-01-4042)

(SERI/TR-62-264) Avail: NTIS HC A03/MF A01

The photosynthetic energy stored in plant and organic waste materials in the United States amounts to approximately 40% of the nation's total energy consumption. The conversion of the biomass energy source, in the form of biomass residues and wastes, can create problems. Environmental impacts may be significant, and legal responses to these impacts are a key determinant to the widespread adoption of biomass technologies. The major legal areas which will impact on biomass energy conversion include (1) the effect of existing state and federal legislation; (2) the role of regulatory agencies in the development of biomass energy; (3) governmental incentives to biomass development; and (4) legal issues surrounding the functioning of the technologies themselves. Emphasis is placed on the near-term technologies whose environmental impacts and institutional limitations are more readily identified. If biomass energy is to begin to achieve its apparently great potential, these questions must receive immediate attention. DOE

N80-24503# National Transportation Policy Study Commission, Washington, D. C.

UTILIZATION CONCERNS OF POTENTIAL TRANSPORTATION FUELS

Gretchen Coar Apr. 1979 43 p refs
(PB80-138498; NTPSC/WP-79-37)

Avail: NTIS

HC A03/MF A01 CSCL 10A

The known utilization problems for fuels which were identified as likely near and midterm alternatives to petroleum (synthetics from oil shale and coal, and alcohols from various sources) are identified and discussed. The focus is on distribution and handling, material compatibility, vehicle performance, fuel economy, environmental effects, safety and toxicity, and potential utilization in alternative engines. GRA

N80-24893*# Los Alamos Scientific Lab., N. Mex.

POTENTIAL PREDICTION NEEDS IN SUPPORT OF ENERGY SYSTEMS

Richard L. Blake /n NASA, Marshall Space Flight Center Solar-Terrest. Predictions Proc., Vol. 2 Dec. 1979 p 198-202 ref Sponsored in part by DOE

Avail: NTIS HC A99/MF A01 CSCL 10B

The relationship between emerging energy systems and the natural environment is discussed, including selected examples to show that energy systems are tied to global solar terrestrial processes. The interdependence of resources, technology, and environmental impact is considered in terms of needed geophysical, atmospheric, and solar terrestrial data inputs. The need for long term basic research on the solar terrestrial system is emphasized. J.M.S.

N80-24736# Department of Energy, Washington, D. C. Office of Leasing Policy Development.

ANALYSIS OF EXPLORATION, DEVELOPMENT AND PRODUCTION ACTIVITY ON FEDERAL OUTER CONTINENTAL SHELF LEASES

J. A. Gribbin, G. M. Kaitz, S. W. Edwards, and K. W. Erickson Dec. 1979 152 p refs

(DOE/RA-0044) Avail: NTIS HC A08/MF A01

Because the Outer Continental Shelf Lands Act Amendments of 1978 reconfirmed Congress' desire to ensure that persons holding Federal Outer Continental Shelf (OCS) leases act in a diligent manner to explore and develop the resources on these leases. The actual history of operations on all Federal OCS leases was examined. The primary objective of the analysis was to determine and to describe the actual record of exploration, development, and production activity on Federal OCS leases. The analysis was designed also to identify factors that influence the rate of this activity. DOE

N80-24754*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

FEDERAL POLICIES TO PROMOTE THE WIDESPREAD UTILIZATION OF PHOTOVOLTAIC SYSTEMS. SUPPLEMENT: REVIEW AND CRITIQUE

J. L. Smith 15 Apr. 1980 115 p

(Contracts NAS7-100; EX-76-A-29-1012)

(NASA-CR-163148; DOE/JPL-1012-45; JPL-80-32) Avail: NTIS HC A08/MF A01 CSCL 10A

Review comments of the Congressional report entitled 'Federal Policies to Promote the Widespread Utilization of Photovoltaic Systems' are presented. Responses to the review comments by the Jet Propulsion Laboratory, preparer of the Congressional report, are also presented. The Congressional report discussed various issues related to promoting the deployment of photovoltaic systems through the Federal Photovoltaic Program. Various program strategies and funding levels were examined. R.E.S.

N80-24797*# General Electric Co., Schenectady, N. Y. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 1: SUMMARY REPORT Final Report

H. E. Gerlaugh, E. W. Hall, D. H. Brown, R. R. Priestley, and W. F. Knightly Jan. 1980 154 p

(Contract DEN3-31)

(NASA-CR-159765; GE79ET0102; DOE/NASA/0031-80/1) Avail: NTIS HC A08/MF A01 CSCL 10B

Large savings can be made in industry by cogenerating electric power and process heat in single energy conversion systems rather than separately in utility plants and in process boilers. About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidates which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed-cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum-based residual and distillate liquid fuels, and low Btu gas obtained through the on-site gasification of coal. An attempt was made to use consistent assumptions and a consistent set of ground rules for determining performance and cost in individual plants and on a national level. It was found that: (1) atmospheric and pressurized fluidized bed steam turbine systems were the most attractive of the direct coal-fired systems; and (2) open-cycle gas turbines with heat recovery steam generators and combined-cycles with NO(x) emission reduction and moderately increased firing temperatures were the most attractive of the coal-derived liquid-fired systems. R.E.S.

N80-24802# Logistics Management Inst., Washington, D. C.

THE PROJECT INDEPENDENCE EVALUATION SYSTEM (PIES). VOLUME 1: DESCRIPTION OF THE SYSTEM, EXECUTIVE SUMMARY

Oct. 1978 51 p

(Contract EA-78-X-01-1321)

(HCP/I-1321-01/1) Avail: NTIS HC A04/MF A01

The project independence evaluation system (PIES) a national energy forecasting system used to provide baseline forecasts of energy prices, supplies, demand, and conversion activities is described. It is an analytical tool that can be used to examine the potential impact of changes in Federal policies by the specification of alternate scenarios. An overview which described the main features of the PIES: a discussion of the regional representation within the system; descriptions of the major supply and conversion submodels; a description of available documentation; and appendices that describe the modeling of refineries and utilities are provided. DOE

N80-24804# Argonne National Lab., Ill.

INSTITUTIONAL TOTAL ENERGY CASE STUDIES

D. Wulfinghoff Jul. 1979 51 p

(Contract W-31-109-eng-38)

(ANL/CNSV-TM-15) Avail: NTIS HC A04/MF A01

Profiles of three total energy systems in institutional settings are presented. The plants are those of Franciscan Hospital, a 384 bed facility in Rock Island, Illinois; Franklin Foundation Hospital, a 100 bed hospital in Franklin, Louisiana; and the North American Air Defense Command Cheyenne Mountain

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Complex, a military installation near Colorado Springs, Colorado. The case studies include descriptions of plant components and configurations, operation and maintenance procedures, reliability, relationships to public utilities, staffing, economic efficiency, and factors contributing to success. DOE

N80-24813# Honeywell, Inc., Minneapolis, Minn. Energy Resources Center.

HEAT-PUMP-CENTERED INTEGRATED COMMUNITY ENERGY SYSTEMS Final Report

Nov. 1979 214 p refs Supersedes ANL/ICES-TM-31 Prepared for Argonne National Lab., Ill.

(Contract W-31-109-eng-38)

(ANL/CNSV-TM-18; ANL/ICES-TM-31) Avail: NTIS HC A10/MF A01

A Heat Pump Centered-Integrated Community Energy System (HP-ICES) concept was explored and developed that is based on use of privately owned ice-making heat pumps in each building or complex within a community. These heat pumps will provide all of the space heating, space cooling and domestic hot water needs. All of the community input energy required is provided by electrical power, thereby eliminating a community's dependence on gas or oil supplies. The heat pumps will operate in both air and water source modes, deriving performance advantages of both. The possible forms of an HP-ICES system, the technical and economic limitations, environmental impacts and other factors are discussed from a general viewpoint. The concept is applied to a specific planned community and its performance and economic features are examined in detail. It is concluded that the HP-ICES concept is technically viable, but that its economical desirability as compared with conventional heat pump systems is hampered by much higher initial costs, and that the economic feasibility of HP-ICES systems will depend on future fuel source costs and supply and on electric power rates. DOE

N80-24814# General Accounting Office, Washington, D. C. FEDERAL GOVERNMENT NEEDS A COMPREHENSIVE PROGRAM TO CURB ITS ENERGY USE

E. B. Staats 12 Dec. 1979 66 p refs

(EMD-80-11) Avail: NTIS HC A04/MF A01

According to this GAO analysis, the Federal Government is not making a sufficient commitment to curbing its energy use. Its program to conserve energy is in disarray. Although the Congress and the President have enacted and issued legislative and executive guidance, a comprehensive and aggressive energy conservation program for the Federal sector has not been developed. The Department of Energy's efforts have been minimal and Federal agencies have resisted Energy's attempts to establish a meaningful program. The Federal Government - the Nation's largest consumer of energy needs a comprehensive, centrally directed program to curb energy use. Recommendations to the Congress, The President, and the Department of Energy to establish such a program are presented. DOE

N80-24822# Rocket Research Corp., Redmond, Wash. System Development.

HEAT-PUMP-CENTERED INTEGRATED COMMUNITY ENERGY SYSTEMS Final Report

Nov. 1979 69 p refs

(Contract W-31-109-eng-38)

(ANL/CNSV-TM-20) Avail: NTIS HC A04/MF A01

Heat-pump-centered integrated community energy systems (HP-ICES) are energy systems for communities which provide heating, cooling and/or other thermal energy services through the use of heat pumps. Since heat pumps primarily transfer energy from existing and otherwise probably unused sources, rather than convert it from electrical or chemical to thermal form, HP-ICES offer significant potential for energy savings. Secondary benefits of HP-ICES include reduction of adverse environmental effects as compared to conventional systems, reliable production of services in contrast to the increasingly frequent utility curtailments and interruptions, and delivery of services to consumers at costs lower than those for conventional systems (including acquisition, operation, and maintenance costs). The objective of this multiphase project is development and

demonstration of HP-ICES concepts leading to one or more operational systems by the end of 1984. The results of the system development phase of the HP-ICES Project are reported. Information is presented on: central heat pump and distributed heat pump ICES; potential application; waste heat availability; system performance and economics; environmental impacts; site requirements; component testing requirements; mathematical analysis of heat balance and cost relations; and performance and economic analyses of HP-ICES located near Seattle, Washington and San Antonio, Texas. DOE

N80-24838# Georgetown Univ., Washington, D. C.

GEORGETOWN UNIVERSITY GENERIC INTEGRATED COMMUNITY ENERGY SYSTEM GU ICES DEMONSTRATION PROJECT. MODIFIED WORK MANAGEMENT PLAN Final Report

Apr. 1979 330 p refs

(Contract EC-77-C-02-4488)

(COO-4488-2) Avail: NTIS HC A14/MF A01

This Phase 2 Modified Work Management Plan reflects the change from a Coal Using ICES to a Generic ICES Program. Book 2 deals with an energy audit conducted at the campus in the fall of 1978 to establish a gross baseline from which to measure and evaluate the contributions of selected alternative energy subsystems both from an energy and cost standpoint. Book 1 proceeds from a discussion of an ICES through an explanation of the scope of effort in each phase expanded into detailed task descriptions by phase together with schedules, PERT and GANTT charts, milestones and levels of effort by task for the Feasibility Analysis, and schedules for the overall program. A description of examples of alternative subsystems to be considered is also included. A detailed Management Plan for the conduct of the effort by General Electric completes the plan. Appendices related to cogeneration, life cycle costing, GE energy subsystems, the GU Master Energy Plan, and typical regulatory processes to be encountered are included. Book 2 treats the Energy Audit under the three committed task areas of System Description, Analysis and Survey, and Criteria for Energy Usage. The five major energy systems utilized at Georgetown are considered: electrical, chilled water, steam, gas and fuel oil, and city water. A top level analysis yields significant results and recommendations for further action with respect to a detailed measurements program, particularly of steam and electric power usage, over a one year period. DOE

N80-24852# Institute for Energy Analysis, Washington, D.C. FRANCE: ESTIMATES OF FUTURE ENERGY/GDP RELATIONSHIPS

Edward L. Allen Dec. 1979 67 p refs

(Contracts EY-76-C-05-0033; DE-AC05-76OR-00033)

(ORAU/IEA-79-23(M)) Avail: NTIS HC A04/MF A01

Compared with other OECD nations, France's postwar economic growth has been above average. Gross domestic product (GDP) grew at an annual rate of 4.1% in the 1970s. A high rate of new investment (fixed, nonresidential investment) was achieved during these years to bolster productivity gains. Since France depends primarily on imports for its energy supplies, energy use has become relatively efficient. Government policy emphasizes energy saving in all sectors: the E/GDP ratio increased only slightly to 1973 and thereafter fell sharply. As to the future, economic growth, as measured by GDP, is expected to moderate over the balance of this century, to a level of 2.8% annually by the 1995-2000 period. Labor force growth will decline because of decreased domestic fertility and the more restrictive immigration policy. In addition, the length of the workweek, which has remained relatively high, is expected to follow the declining trend already evident in other OECD countries. DOE

N80-24859# California Univ., Livermore. Lawrence Livermore Lab.

PROSPECTS FOR USING IMPROVED CLIMATE INFORMATION TO BETTER MANAGE ENERGY SYSTEMS

William J. Quirk and John E. Moriarty (Federal Energy Regulatory Commission, Washington, D.C.) Jan. 1980 12 p refs Presented at the Intern. Workshop on Energy/Climate Interactions, Munster, W. Germany, 3-7 Mar. 1980

01. ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

(Contract W-7405-eng-48)
(UCRL-83813: CONF-800309-2) Avail: NTIS
HC A02/MF A01

The impacts that climate anomalies have had on energy systems in the United States, and the resulting impacts on society are described. It is pointed out that better use of climate information could alleviate some of the adverse consequences of these anomalies. The possibility of international cooperation in using climate information to avoid potentially worsening conditions during a global energy shortage is also examined.

DOE

N80-24860# Alabama Univ., University. Bureau of Engineering Research.

HEAT-PUMP-CENTERED INTEGRATED COMMUNITY ENERGY SYSTEMS Final Report

Walter J. Schaetzle, C. Everett Brett, and Marvin S. Seppanen
Dec. 1979 283 p refs Supersedes ANL/ICES-TM-30
(Contract W-31-109-eng-38)

(ANL/CNSV-TM-25: ANL/ICES-TM-30) Avail: NTIS
HC A13/MF A01

The heat-pump-centered integrated community energy system supplies district heating and cooling using heat pumps and a thermal energy storage which is provided by nature in underground porous formations filled with water, i.e., aquifers. The proposed system was analyzed as demonstration projects for a downtown portion of Louisville, Kentucky, and a section of Fort Rucker, Alabama. The downtown Louisville demonstration project is tied directly to major buildings while the Fort Rucker demonstration project is tied to a dispersed subdivision of homes. The Louisville project shows a payback of approximately 3 y, while Fort Rucker is approximately 30 y. The primary difference is that at Fort Rucker new heat pumps are charged to the system. In Louisville, either new construction requiring heating and cooling systems or existing chillers are utilized.

DOE

N80-24863# Franklin Research Center, Philadelphia, Pa.
HEAT-PUMP-CENTERED INTEGRATED COMMUNITY ENERGY SYSTEMS Final Report

Richard E. Crane and Robert G. Warden (Warden (R.G.) and Assoc., Philadelphia) Dec. 1979 223 p refs Supersedes ANL/ICES-TM-26

(Contract W-31-109-eng-38)
(ANL/CNSV-TM-24: ANL/ICES-TM-26-Rev) Avail: NTIS
HC A10/MF A01

Heat-pumps-centered integrated community energy systems (HP-ICES) are energy systems for communities which provide heating, cooling and/or other thermal energy services through the use of heat pumps. Since heat pumps primarily transfer energy from existing and otherwise probably unused sources, rather than convert it from electrical or chemical to thermal form, HP-ICES offer significant potential for energy savings. Information is presented on the following: the HP-ICES concept; its application potential; variations in the basic HP-ICES concept which could lead to improved performance; applications of the concept to specific communities; design; economics; environmental impacts; and component testing requirements.

DOE

N80-24868# Oak Ridge National Lab., Tenn. Energy Div.
ENERGY AVAILABILITIES FOR STATE AND LOCAL DEVELOPMENT: 1975 DATA VOLUME

J. B. Mills, P. L. Rice, and D. P. Vogt Jan. 1980 285 p
(Contract W-7405-eng-26)

(ORNL/TM-6951) Avail: NTIS HC A13/MF A01

The supply, demand, and net imports of seven fuel types of four final consuming sectors for Bureau of Economic Analysis Areas (BEAs), states, census regions, and the nation in 1975 are presented. The data are formatted to present regional energy availability from primary extraction as well as from regional transformation processes. Extensive tables depict energy balances between availability and use for each specific fuel. A consistent base of historic and projected energy information is presented within a standard format. Such a framework should aid regional policy makers in their consideration of regional-growth issues that may be influenced by the regional energy system.

For analysis of specific regions, however, this basic data should be supplemented by additional information which only the local policy analyst can bring to bear in his assessment of the energy conditions that characterize his region.

DOE

N80-24869# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.

JAPAN: ESTIMATES OF FUTURE ENERGY/GNP RELATIONSHIPS IN ENERGY USE

J. A. Edmonds and Edward L. Allen Dec. 1979 95 p refs
(Contract EY-76-C-05-0033)

(ORAU/IEA-79-21(M)) Avail: NTIS HC A05/MF A01

As a consequence of continued rapid economic expansion, Japan's energy consumption is projected to more than double between 1976 and 2000. At the same time GNP is projected to triple, accompanied by lowering of the Japanese energy/GNP ratio by 30%. Industrial and transportation sector energy efficiency gains are expected to lead the way, with residential and commercial sector consumption growing almost abreast with GNP. The delayed home appliance revolution is expected to offset much of the gains from slow population growth. On the other hand, the Japanese automobile population explosion is expected to proliferate more energy-efficient automobiles throughout the economy, rapidly raising overall fleet performance. A significant shift toward water transport of freight also improves the overall performance of the transport sector.

DOE

N80-24870# Department of Energy, Washington, D. C. Office of Analytical Sciences.

NATIONAL ENERGY PLAN 2, MAY 1979. APPENDIX A: WORLD OIL PRICES

1979 65 p refs
(DOE/TIC-10203-App-A) Avail: NTIS HC A04/MF A01

The detailed assumptions and projections used to develop the Second National Energy Plan (NEP-2) world oil price cases are presented in three major sections. The first section presents assumptions about potential world demand and production of oil, assuming constant real future world oil prices. Included is a discussion of alternative theories of OPEC behavior. The second section presents world oil price paths generated by mathematical models of world oil supply and demand. The models calculate oil prices that act through price elasticities to change the assumed constant-price oil demand and supply conditions to achieve a balanced oil market. The final section synthesizes the various model projections into the range of world oil price cases used in NEP-2 and reports major conclusions resulting from the world oil price analysis.

DOE

N80-24871# Department of Energy, Washington, D. C. Office of Building and Community Systems.

ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS: ECONOMIC ANALYSIS

Jan. 1980 402 p
(DOE/CS-0129) Avail: NTIS HC A18/MF A01

The major economic impacts of the implementations of the standards on affected groups were assessed and the effectiveness of the standards as an investment in energy conservation was evaluated. The methodology used to evaluate the standards for the various building types and perspectives is described. The net economic effect of changes in building cost and energy use are discussed for three categories of buildings: single family residential, commercial and multifamily residential, and mobile homes. Forecasts of energy savings and national costs and benefits both with and without implementation of the standards are presented. The effects of changes in energy consumption and construction of new buildings on the national economy, including such factors as national income, investment, employment, and balance of trade are assessed.

DOE

N80-24873# National Bureau of Standards, Washington, D.C. National Engineering Lab.

EVALUATION OF ENERGY CONSERVING MODIFICATIONS FOR WATER HEATERS Final Report

Robert L. Palla, Jr. Jul. 1979 53 p refs

(PB80-133853: NBSIR-79-1783) Avail: NTIS
HC A04/MF A01 CSCL 10A

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The effects of various energy-conserving modifications on water heating energy consumption were evaluated based on laboratory tests. Nine storage-type residential water heaters, representative of standard and energy-saving electric gas, and oil fueled models currently on the market, were obtained for testing. Federally-promulgated water heat test procedures were used to measure the energy consumption of each unit before and after modifications. GRA

N80-24876# Bechtel National, Inc., San Francisco, Calif. Research and Engineering Dept.
PROJECTED ANNUAL RESOURCE REQUIREMENTS AT THE NATIONAL AND REGIONAL LEVEL FOR THE DEPARTMENT OF COMMERCE ENERGY FORECAST 1985 AND 2000

Andrea L. Watson and Ralph G. J. Zimmerman Mar. 1979
205 p Sponsored by Dept. of Commerce
(PB80-126956) Avail: NTIS HC A10/MF A01 CSCL 10A

An analysis is presented of the national and regional resource requirements (capital, material, manpower, etc.) associated with future energy development in the U.S. The analysis, using Bechtels Energy Supply Planning Model (ESPM) indicates projected cumulative capital requirements of \$1.6 trillion (January 1978 dollars) during the 1977 - 2000 forecast period. The largest requirements by energy sector are for electric power generation facilities (53%) coal-fired plants in particular. Although the U.S. is projected to become more and more dependent upon western energy resources, both capital and labor requirements are projected to move from Western to Eastern regions - by the year 2000 - again primarily because of electrical generation requirements. GRA

N80-24884# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

ENVIRONMENTAL CONTROL TECHNOLOGY FOR THE FLASH HYDROLYSIS OF COAL Progress Report, 1 Apr. - 31 Dec. 1978

Feb. 1979 81 p refs
(Contract EY-76-C-02-0016)

(BNL-50983; PR-3) Avail: NTIS HC A05/MF A01

Based on experimental results and analytical studies, preliminary environmental and economic assessments of a conceptual, industrial scale FHP-Refinery Complex were made. Three cases were considered, one for the production of pipeline gas, the second for the production of liquid hydrocarbons such as motor gasoline and liquid prepared gas LPG, and the third for the production of both liquid and gaseous effluents for each case gaseous products. Solid, liquid and gaseous products. Solid, liquid and gaseous effluents for each case were evaluated, and required effluent treatment facilities and potential problem areas identified. Thermal efficiency range from 50% to 72%, depending upon the mode of operation of the Complex, and investment costs from 834 to 936 million dollars. The installed cost of environmental equipment is estimated at about 5% of total plant investment for all three cases. DOE

N80-24885# Oak Ridge National Lab., Tenn. Environmental Sciences Div.

ANALYSIS OF ENVIRONMENTAL IMPACTS OF WATER LEVEL FLUCTUATION IN RESERVOIRS AT HYDROELECTRIC SITES

A. T. Szuha, J. M. Loar, R. R. Turner, and S. G. Hildebrand 1979 8 p refs Presented at the Waterpower 79 Intern. Conf.: Small Scale Hydropower, Washington, D.C., 1 Oct. 1979
(Contract W-7405-eng-26)

(CONF-791056-2) Avail: NTIS HC A02/MF A01

Potential significance, on a site-specific basis, of water-level-fluctuation impacts ranges from begin (run-of-the river plants) to possibly significant enough to require mitigation. It is emphasized that efforts to develop small hydroelectric sites that entail water level fluctuation should include a careful analysis of the types of impacts. The potential significance of these impacts should be evaluated as an integral part of initial studies of site feasibility. DOE

N80-24886# Niagra Univ., New York, N.Y.
ENVIRONMENTAL CONSEQUENCES OF ATMOSPHERIC

KRYPTON-85 Final Report, 1 Jan. 1977 - 30 Sep. 1979

W. L. Boeck 1979 17 p refs

(Contract EE-77-S-02-4364)

(COO-4364-2) Avail: NTIS HC A02/MF A01

Krypton-85 is a radioactive inert gas produced during normal operations of the nuclear fuel cycle. The quantities of krypton-85, that will be produced in the next century, are sufficient, if released to alter the electrical state of the atmosphere. The principal hypothesis is that an anthropogenic alteration of the electric state of the atmosphere could alter other meteorological phenomena and lead to significant environmental impacts. The goal was to explore some areas of basic science related to the evaluation of that hypothesis. The approach was primarily theoretical. The following topics were addressed: a first approximation model to estimate the effects of krypton-85 on the electrical state of the atmosphere; an analysis of the pathways between krypton-85 production and the atmosphere; an analytical model for fair weather atmospheric electricity; and a dipole model for atmospheric electricity. The results will provide a framework on which detailed models can be built. The results should provide better understanding of some topics in atmospheric electricity. DOE

N80-24888# Brookhaven National Lab., Upton, N. Y. Process Sciences Div.

ENVIRONMENTAL CONTROL TECHNOLOGY FOR ATMOSPHERIC CARBON DIOXIDE

Meyer Steinberg and Anthony S. Albanese 1980 31 p refs Presented at the Intern. Workshop on the Energy/Climate Interactions, Munster, West Germany, 3-7 Mar. 1980
(Contract EY-76-C-02-0016)

(BNL-27164; CONF-800309-1)

Avail: NTIS HC A03/MF A01

The impact of fossil fuel use in the United States on worldwide CO2 emissions and the impact of increased coal utilization on CO2 emission rates are assessed. The aspects of CO2 control are discussed as well as the available CO2 control points (CO2 removal sites). Two control scenarios are evaluated, one based on the absorption of CO2 contained in power plant flue gas by seawater; the other, based on absorption of CO2 by (mono ethanol amine-MEA). Captured CO2 is injected into the deep ocean in both cases. The analyses indicate that capture and disposal by seawater is energetically not feasible, whereas capture and disposal using MEA is a possibility. However, the economic penalties of CO2 control are significant. The use of nonfossil energy sources, such as hydroelectric, nuclear or solar energy is considered as an alternative for limiting and controlling CO2 emissions resulting from fossil energy usage. DOE

N80-24890# Environmental Protection Agency, Research Triangle Park, N.C. Emission Standards and Engineering Div.
CONTROL TECHNIQUES FOR CARBON MONOXIDE EMISSIONS Final Report

Jun. 1979 410 p refs

(PB80-140510; EPA-450/3-79-006)

Avail: NTIS HC A18/MF A01 CSCL 13B

This document characterizes carbon monoxide emission sources and controls for use by states in revising state implementation plans. It is intended for use by state and local air pollution control engineers to provide basic available information on carbon monoxide emissions from mobile sources, stationary combustion sources, and industrial process sources. Both demonstrated and feasible control strategies are presented for each source. Information is also provided on emission reduction benefits, energy requirements of controls, and annualized and operating costs of controls. GRA

N80-24896# Tennessee Valley Authority, Chattanooga. Power Research Staff.

DESIGN OF A MONITORING PROGRAM FOR ASH POND EFFLUENTS Final Report, May 1975 - Apr. 1979

F. A. Miller, III, T. V. J. Chu, and R. J. Ruane Nov. 1979
207 p refs Sponsored by EPA

(PB80-128457; PRS-41; EPA-600/7-79-236) Avail: NTIS HC A10/MF A01 CSCL 13B

A procedure is described for designing an effective monitoring program for fossil-fueled power plant ash pond effluents. Factors

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that influence effluent characteristics and are important in designing such a monitoring program were determined following a review of plant operating characteristics and ash pond effluent characteristics of TVA's fossil-fueled power plant system. A statistical procedure for determining the sampling frequency of chemical characteristics in ash pond effluents precision are described: method 1 involves selecting a precision value to estimate the population mean within a given percentage; method 2 involves calculating a precision value by subtracting an estimate of the population mean from either the ash pond effluent limitation established by EPA or a desirable water quality criterion. Method 2 gives the number of samples required to show that the effluent is in compliance with the effluent limitation or below the water quality criteria. The method chosen to compute the precision depends on the purpose of the monitoring program. The procedure was demonstrated for two TVA ash pond systems.

GRA

N80-24898# Rockwell International Corp., Newbury Park, Calif. Air Monitoring Center.

QUALITY ASSURANCE IN SUPPORT OF ENERGY RELATED MONITORING ACTIVITIES Annual Report

Mark Cher Jun. 1979 69 p refs
(Contract EPA-68-02-2412)
(PB80-135270; AMC-8303.135-AR-2; EPA-600/7-79-136; AR-2) Avail: NTIS HC A04/MF A01 CSCL 13B

A program to establish a quality assurance data base for ambient air monitoring around present and proposed energy development projects, and to provide technical assistance to enable existing monitoring networks to achieve a high level of data quality is described. Results from laboratory performance surveys carried out for the analysis of sulfate, nitrate, SO₂, NO₂, and CO and for weight measurements and high volume flow rate are given.

GRA

N80-25207# Argonne National Lab., Ill. MARKET PENETRATION OF NEW ENERGY SYSTEMS ESTIMATED BY ECONOMETRIC AND STOCHASTIC METHODOLOGY

Arvind P. S. Teotia, Chinmei Lee, and Allen S. Kennedy 1979 15 p refs Presented at the IGT Symp. on Energy Modeling 2: The Interface Between Model Builder and Decision Maker, Colorado Springs, Colo., 13-19 Aug. 1979
(Contract W-31-109-eng-38)
(CONF-790852-2) Avail: NTIS HC A02/MF A01

An econometric and stochastic model approach is used to analyze the technical, economic, and market factors influencing the possible market penetration of new energy systems. The market model methodology includes four phases: segment the new technology/end-use market; estimate the technical market; estimate the economic market; and estimate the market penetration. The market penetration of integrated community energy systems (ISCE) is estimated by this methodology. To illustrate the methodology, highlights of the ICES application are included.

DOE

N80-25213# Science Applications, Inc., McLean, Va. ASSESSMENT OF THE TECHNOLOGY TRANSFER POTENTIAL OF FEDERAL PHOTOVOLTAIC POWER SYSTEM APPLICATIONS TO COMMERCIAL MARKETS Final Report

T. F. Jaras, Michael McDonnell, and Richard A. Moyle Jun. 1979 153 p
(Contract EM-78-C-04-4261)
(ALO-4261-T8) Avail: NTIS HC A08/MF A01

An assessment of the market potential of photovoltaic power supplies is presented. Markets analyzed include the water pumping market, marine navigational aids, cathodic protection, remote general power sources, telecommunications, air navigational aids, mobile generator market, instrumentation, and utility connected applications.

DOE

N80-25332*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div. ENGINE COMPONENT IMPROVEMENT: PERFORMANCE IMPROVEMENT, JT9D-7 3.8 AR FAN Progress Report, Jan.

1978 - Feb. 1979

W. O. Gaffin 12 Jun. 1980 57 p ref
(Contract NAS3-20630)
(NASA-CR-159806; PWA-5515-114) Avail: NTIS HC A04/MF A01 CSCL 21E

A redesigned, fuel efficient fan for the JT9D-7 engine was tested. Tests were conducted to determine the effect of the 3.8 AR fan on performance, stability, operational characteristics, and noise of the JT9D-7 engine relative to the current 4.6 AR Bill-of-Material fan. The 3.8 AR fan provides increased fan efficiency due to a more advanced blade airfoil with increased chord, eliminating one part span shroud and reducing the number of fan blades and fan exit guide vanes. Engine testing at simulated cruise conditions demonstrated the predicted 1.3 percent improvement in specific fuel consumption with the redesigned 3.8 AR fan. Flight testing and sea level stand engine testing demonstrated exhaust gas temperature margins, fan and low pressure compressor stability, operational suitability, and noise levels comparable to the Bill-of-Material fan.

Author

N80-25477# Argonne National Lab., Ill. ENVIRONMENTAL CONTROL TECHNOLOGY FOR BIOMASS FLASH PYROLYSIS

J. B. L. Harkness, R. D. Doctor (Science Applications, Inc.), and W. H. Seward (Mittelhauser Corp.) 1980 32 p refs Presented at the Energy from Biomass and Wastes Conf., Orlando, Fla., 21 Jan. 1980

(Contract W-31-109-eng-38)
(CONF-800129-2) Avail: NTIS HC A03/MF A01

The effluent emission and control technologies for a dual fluid-bed pyrolysis unit is characterized. The system produces a raw products gas that is passed through a catalytic liquefaction system to produce a fuel comparable to no. 2 fuel oil. A program that will survey several biomass systems to standardize the sampling techniques, prioritize standard analyses and develop a data base so that environmental issues later may be addressed before they limit or impede the commercialization of biomass gasification and pyrolysis technologies was conducted. Emissions were related to both the current and anticipated emissions standards to generate material balances and set design parameters for effluent treatment systems. This permits an estimate to be made of the capital and operating costs associated with these technologies.

E.J.R.

N80-25481# Tennessee Valley Authority, Muscle Shoals, Ala. Emission Control Development Projects. EVALUATION OF PHYSICAL/CHEMICAL COAL CLEANING AND FLUE GAS DESULFURIZATION Final Report, Jun. 1978 - Oct. 1979

T. W. Tarkington, F. M. Kennedy, and J. G. Patterson Nov. 1979 378 p refs Sponsored by EPA
(PB80-147622; ECDP/B-5; EPA-600/7-79-250) Avail: NTIS HC A17/MF A01 CSCL 13B

The results of evaluations of physical coal cleaning (PCC), chemical coal cleaning (CCC), and coal cleaning combined with flue gas desulfurization (FGD). Process descriptions, cleaning performances, comparative capital investments, and annual revenue requirements are included.

GRA

N80-25678# National Technical Information Service, Springfield, Va.

DIESEL EXHAUST EMISSION CONTROL FOR MOTOR VEHICLES, VOLUME 2. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1978 - Jan. 1980

Diane M. Cavagnaro Feb. 1980 110 p
(PB80-805401; NTIS/PS-79/0038) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13B

Citation to worldwide research were selected that discuss the control of exhaust gases from diesel motor vehicle engines. Most of the studies are concerned with emission control through engine design; however, some studies also cover the use of fuel additives for pollution control. This updated bibliography contains 103 abstracts, 48 of which are new entries to the previous edition.

GRA

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

N80-25679# National Technical Information Service, Springfield, Va.

DIESEL EXHAUST EMISSIONS. CITATIONS FROM THE AMERICAN PETROLEUM INSTITUTE DATA BASE Progress Report, 1974 - Dec. 1980

Diane M. Cavagnaro Feb. 1980 204 p Supersedes NTIS/PS-79/0039

(PB80-805419; NTIS/PS-79/0039) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13B

This bibliography cites research reports concerning exhaust emissions from diesel motor vehicles. Topics include engine design, techniques of measuring gases, pollution control, and fuel additives. GRA

N80-25792*# United Technologies Corp., South Windsor, Conn. Power System Div.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY. VOLUME 1: SUMMARY REPORT Final Report

Jan. 1980 125 p

(Contracts DEN3-30; EC-77-A-31-1062)

(NASA-CR-159759; DOE/NASA/0030-80/1;

UTC-FCR-1333-Vol-1) Avail: NTIS HC A06/MF A01 CSCL 10A

Data and information in the area of advanced energy conversion systems for industrial cogeneration applications in the 1985-2000 time period was studied. Six current and thirty-one advanced energy conversion systems were defined and combined with appropriate balance-of-plant equipment. Twenty-six industrial processes were selected from among the high energy consuming industries to serve as a framework for the study. Each conversion system was analyzed as a cogenerator with each industrial plant. Fuel consumption, costs, and environmental intrusion were evaluated and compared to corresponding traditional values. Various cogeneration strategies were analyzed and both topping and bottoming (using industrial by-product heat) applications were included. The advanced energy conversion technologies indicated reduced fuel consumption, costs, and emissions. Typically fuel energy savings of 10 to 25 percent were predicted compared to traditional on-site furnaces and utility electricity. With the variety of industrial requirements, each advanced technology had attractive applications. Overall, fuel cells indicated the greatest fuel energy savings and emission reductions. Gas turbines and combined cycles indicated high overall annual cost savings. Steam turbines and gas turbines produced high estimated returns. In some applications, diesels were most efficient. The advanced technologies used coal-derived fuels, or coal with advanced fluid bed combustion or on-site gasification systems. R.E.S.

N80-25793*# United Technologies Corp., South Windsor, Conn. Power Systems Div.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY. VOLUME 2: INDUSTRIAL PROCESS CHARACTERISTICS Final Report

Jan. 1980 697 p refs

(Contracts DEN3-30; EC-77-A-31-1062)

(NASA-CR-159760; DOE/NASA/0030-80/2;

UTC-FCR-1333-Vol-2) Avail: NTIS HC A99/MF A01 CSCL 10A

Information and data for 26 industrial processes are presented. The following information is given for each process: (1) a description of the process including the annual energy consumption and product production and plant capacity; (2) the energy requirements of the process for each unit of production and the detailed data concerning electrical energy requirements and also hot water, steam, and direct fired thermal requirements; (3) anticipated trends affecting energy requirements with new process or production technologies; and (4) representative plant data including capacity and projected requirements through the year 2000. R.E.S.

N80-25794*# United Technologies Corp., South Windsor, Conn. Power Systems Div.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY. VOLUME 4: HEAT SOURCES, BALANCE OF PLANT AND AUXILIARY SYSTEMS Final Report

Jan. 1980 296 p

(Contracts DEN3-30; EC-77-A-31-1062)

(NASA-CR-159762; DOE/NASA/0030-80/4;

UTC-FCR-1333-Vol-4) Avail: NTIS HC A13/MF A01 CSCL 10A

Data and information established for heat sources balance of plant items, thermal energy storage, and heat pumps are presented. Design case descriptions are given along with projected performance values. Capital cost estimates for representative cogeneration plants are also presented. R.E.S.

N80-25795*# United Technologies Corp., South Windsor, Conn. Power Systems Div.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY. VOLUME 6: COMPUTER DATA Final Report

Jan. 1980 535 p

(Contracts DEN3-30; EC-77-A-31-1062)

(NASA-CR-159764; DOE/NASA/0030-80/6;

UTC-FCR-1333-Vol-6) Avail: NTIS HC A22/MF A01 CSCL 10A

The potential technical capabilities of energy conversion systems in the 1985 - 2000 time period were defined with emphasis on systems using coal, coal-derived fuels or alternate fuels. Industrial process data developed for the large energy consuming industries serve as a framework for the cogeneration applications. Ground rules for the study were established and other necessary equipment (balance-of-plant) was defined. This combination of technical information, energy conversion system data ground rules, industrial process information and balance-of-plant characteristics was analyzed to evaluate energy consumption, capital and operating costs and emissions. Data in the form of computer printouts developed for 3000 energy conversion system-industrial process combinations are presented. R.E.S.

N80-25804# Oak Ridge Associated Universities, Inc., Washington, D.C. Inst. for Energy Analysis.

ITALY: ESTIMATES OF FUTURE ENERGY/GDP RELATIONSHIPS

C. Davison and Edward L. Allen Dec. 1979 61 p refs

(Contract EY-76-C-05-0033)

(ORAU/IEA(M)-79-20 Avail: NTIS HC A04/MF A01

The Italian economy has experienced very rapid growth since World War II, accompanied by a sharp increase in the consumption of energy, the growth of which has been more rapid than the development of the economy. For the period 1960-76, energy consumption grew an average of 6.7% annually, compared with an annual growth rate of 4.6% for gross domestic product. The ratio of energy use per unit of GNP increased in every year from the early 1960s until the oil price rise in 1973 and after a brief pause then began to rise again. By 1975, when the E/GDP ratios of other industrialized OECD countries were hitting record lows, Italy's ratio was at an all-time high. This increasing E/GDP ratio was largely the result of Italy's very rapid industrial expansion and its attempt to catch up with the stage of industrial maturity already achieved in other developed countries. It is anticipated that the E/GDP ratio will decline in the future as Italy's industrial expansion slows down. Increased efficiencies will flow from the application of new technologies and replacement of old plants. Pressure from higher oil prices and structural changes in Italian society also will dampen the E/GDP ratio, as it has in other industrialized countries. GDP growth will slacken as the fertility rate continues its downward trend and the average workweek falls. It is that by the year 2000 gross energy consumption in Italy will total 6.7 quads, or about 25% above the 1976 level, and that the E/GDP index (1976 = 100) will decline to about 79, with the residential and industrial sectors accounting for almost all of the decline. DOE

N80-25827# Argonne National Lab., Ill. Office of Program Management Support.

WORLD ENERGY DATA SYSTEM (WENDS). VOLUME 1: COUNTRY DATA, AF-CO

Jun. 1979 345 p refs 11 Vol.

(Contract W-31-109-eng-38)

(ANL/PMS-79-2-Vol-1) Avail: NTIS HC A15/MF A01

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

The World Energy Data System contains organized data on those countries and international organizations that may have critical impact on the world energy scene. Country data on Afghanistan, Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Burma, Canada, China, and Colombia are included in volume 1. The following topics are covered for most of the countries: economic, demographic, and educational profiles; energy exports, imports of energy supplies; environmental considerations; power production facilities; energy industries; commercial applications of energy; research and development activities of energy; and international activities. DOE

N80-25828# Argonne National Lab., Ill. Office of Program Management Support.

WORLD ENERGY DATA SYSTEM (WENDS). VOLUME 2: COUNTRY DATA, CZ-KS

Jun. 1979 361 p refs 11 Vol.

(Contract W-31-109-eng-38)

(ANL/PMS-79-2-Vol-2) Avail: NTIS HC A16/MF A01

The World Energy Data System contains organized data on those countries and international organizations that may have critical impact on the world energy scene. Country data on Libya, Luxembourg, Malaysia, Mexico, Netherlands, New Zealand, Niger, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, and Portugal are presented. The following topics are covered for most of the countries: economic, demographic, and educational profiles; energy policy; indigenous energy resources and uses; forecasts demand, exports, imports of energy supplies; environmental considerations of energy supplies; power production facilities; energy industries; commercial applications of energy; research and development activities of energy; and international activities. DOE

N80-25829# Argonne National Lab., Ill. Office of Program Management Support.

WORLD ENERGY DATA SYSTEM (WENDS). VOLUME 2: COUNTRY DATA, LY-PO

Jun. 1979 364 p refs

(Contract W-31-109-eng-38)

(ANL/PMS-79-2-Vol-3) Avail: NTIS HC A16/MF A01

The World Energy Data System contains organized data on those countries and international organizations that may have critical impact on the world energy scene. Included in this volume, volume 2, are Czechoslovakia, Denmark, Egypt, Finland, France, Germany(East), Germany(West), Greece, Guinea, India, Indonesia, Iran, Italy, Japan, and Korea (South). The following topics are covered for most of the countries: economic, demographic, and educational profiles; energy policy; indigenous energy resources and uses; forecasts; demand, exports, imports of energy supplies; environmental considerations of energy use; power production facilities; energy industries; commercial applications of energy; research and development activities of energy; and international activities. DOE

N80-25830# Argonne National Lab., Ill. Office of Program Management Support.

WORLD ENERGY DATA SYSTEM (WENDS). VOLUME 4: COUNTRY DATA, SG-YO

Jun. 1979 407 p refs 11 Vol.

(Contract W-31-109-eng-38)

(ANL/PMS-79-2-Vol-4) Avail: NTIS HC A18/MF A01

The World Energy Data System contains organized data on those countries and international organizations that may have critical impact on the world energy scene. Included in this volume are Senegal, South Africa, Soviet Union, Spain, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Turkey, United Kingdom, United States, Upper Volta, Venezuela, and Yugoslavia. The following topics are covered for most of the countries: economic, demographic, and educational profiles; energy policy; indigenous energy resources and uses; forecasts, demand, exports, imports of energy supplies; environmental considerations of energy supplies; power production facilities; energy industries; commercial applications of energy; research and development activities of energy; and international activities. DOE

N80-25831# Argonne National Lab., Ill. Office of Program Management Support.

WORLD ENERGY DATA SYSTEM (WENDS). VOLUME 5: INTERNATIONAL ORGANIZATION DATA

Jun. 1979 156 p refs 11 Vol.

(Contract W-31-109-eng-38)

(ANL/PMS-79-2-Vol-5) Avail: NTIS HC A08/MF A01

The World Energy Data System (WENDS) contains organized data on those countries and international organization that may have critical impact on the world energy scene. WENDS has acquired and organized information on the following energy-related organizations: Asian Development Bank; European Community; InterAmerican Development Bank; International Atomic Energy Agency; International Energy Agency; Nuclear Energy Agency; United Nations; and World Bank. Within each organization grouping most of the following topics are addressed; organization background, government background, energy background (energy policy and objectives), energy research and development activities, and international activities. DOE

N80-25841# Institute of Gas Technology, Chicago, Ill.

BENEFICIAL USE OF REJECTED HEAT FROM ELECTRIC POWER PLANTS Final Summary Report

Robert W. Porter Aug. 1979 17 p refs

(Contract EC-77-S-02-4531)

(COO-4531-9) Avail: NTIS HC A02/MF A01

The in situ beneficial uses of rejected heat from steam-electric power plants are evaluated. Applications, which include direct discharge into a municipal water supply, interaction with wastewater treatment, and open field irrigation, were examined. In each case, a thermal and economic systems analysis was performed and operational, legal, and other problems were assessed. In the case of the municipal water supply, the savings in cost of closed-cycle cooling and water-heater energy appear to offset operational problems in the water supply and may be sufficient to justify public acceptance. A number of more advanced wastewater treatment processes would benefit from dilution with a portion of condenser discharge. The treated mixture would serve as makeup for a smaller modified closed cycle cooling system and the balance would constitute a water product. Unfortunately, open-field irrigation does not seem feasible due to the large land areas required. DOE

N80-25849# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

EVALUATION OF RESIDENTIAL BUILDING ENERGY PERFORMANCE STANDARDS

Mark D. Levine, David B. Goldstein, Arthur H. Lokmanhekim, and Arthur H. Rosenfeld Dec. 1979 37 p refs Presented at Conf. on Thermal Performance of the Exterior Envelopes of Buildings, Orlando, Fla., 3-5 Dec. 1979

(Contract W-7405-eng-48)

(LBL-9816; CONF-791233-2) Avail: NTIS HC A03/MF A01

The development and analysis of energy performance standards for residential buildings in the United States is described. The approach involves an assessment of the economic costs and benefits of alternative standards and provides quantitative estimates of the reduction of energy use resulting from the implementation of standards. The sensitivities of building energy use to design parameters of buildings - including size, orientation, aspect ratio, basement type, window area, and construction material - are assessed. The DOE-2 building energy utilization analysis program was used to evaluate the heating and cooling loads of residential buildings. Residential buildings were simulated in ten weather climates using hourly weather data with a variety of energy conservation measures. DOE

N80-25880# California Univ., Livermore. Lawrence Livermore Lab.

SITE AND BUILDING ENERGY-CONSERVATION STUDY: SURVEY OF BUILDING 251, DIAGNOSTIC CHEMISTRY

Oct. 1979 68 p

(Contract W-7405-eng-48)

(UCRL-15190) Avail: NTIS HC A04/MF A01

An energy-conservation study of Building 251, Diagnostic Chemistry, at Lawrence Livermore Laboratory was performed.

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The survey of Building 251 was based on a review of the design drawings, an on-site inspection of the 30,500 sq ft building, and discussions with the building manager and various operating personnel. Data were collected regarding the number of people occupying the building, operating schedules, and the energy loads imposed by installed and temporary equipment. The heating, ventilating, and air conditioning systems were investigated. The building energy systems were simulated using the DOE-1 energy program. A base year energy consumption run was made, together with simulation of the building's performance assuming installation of each of nine energy conservation opportunities (ECO's) identified. A summary of the energy savings that would result from implementation of the ECO's is presented. DOE

N80-25881# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.
INTERNATIONAL ANALYSIS OF RESIDENTIAL ENERGY USE AND CONSERVATION

Lee Schipper Oct. 1979 28 p refs Presented at Intern. Conf. on Energy Use Management, Los Angeles, 22 Oct. 1979 (Contract W-7405-eng-48)
(LBL-9383; CONF-791009-27) Avail: NTIS
HC A03/MF A01

Data were collected and are being analyzed on residential energy use from Canada, Japan, UK, West Germany, France, Italy, and Sweden. Preliminary inspection indicates that much of the variation of energy use depends on structural of lifestyle factors such as incomes, house or appliance size, hot water, and indoor temperature habits. There appears to exist a wide range of energy intensities within each narrow end use category, each of these ranges suggest that there are interesting prospects for energy conservation in any one country based on technologies or ideas common elsewhere DOE

N80-25884# Department of Energy, Washington, D. C.
PHOTOVOLTAIC ENERGY SYSTEMS: PROGRAM SUMMARY

Jan. 1980 466 p refs
(DOE/CS-0146) Avail: NTIS HC A20/MF A01

The DOE Photovoltaic Energy Systems Program is designed to expand as rapidly as possible the commercial use of photovoltaic systems through a program of research, process development in support of the manufacturing industry, tests and applications, and general support of market development. The objective of the Photovoltaic Energy Systems Program is to reduce system costs to a competitive level in both distributed and centralized grid-connected applications. The program is also examining the technical, institutional, legal, environmental and social issues involved in fostering widespread adoption of photovoltaic energy systems. Activities of the program are divided into the following subprograms: advanced research and development; technology development; systems engineering and standards; test and applications; commercialization; and planning, assessment, and integration. Summary sheets for each of the contractors in this program are presented. The summaries include project title, contractor, contract number, funding, principal investigator, and a brief description of the contract. DOE

N80-25892# California Univ., Berkeley. Energy and Resources Group.

RISK OF RENEWABLE ENERGY SOURCES: A CRITIQUE OF THE INHABER REPORT

John P. Holdren, Kent Anderson, Peter H. Gleick, Irvin Mintzer, Gregory Morris, and Mirk R. Smith (East-West Center Honolulu, Hawaii) Jun. 1979 142 p refs
(Contract W-7405-eng-48)
(ERG-79-3) Avail: NTIS HC A07/MF A01

The Inhaber report, Risk of Energy Production (Atomic Energy Control Board Report AECB-1119, Ottawa, Canada, 1978;EAPA 5:15) is refuted. Error and the consequences of correcting are described. Also discussed are the circumstances - including the roles of the author, the sponsors, and the knowledgeable technical community - that permitted to report to gain widespread credibility DOE

N80-25894# Argonne National Lab., Ill.
RELIABILITY, ENERGY AND COST EFFECTS OF WIND INTEGRATION WITH CONVENTIONAL ELECTRICAL GENERATING SYSTEMS

W. A. Buehring, K. A. Hub, C. C. Huber, J. C. Vanhuizen, and J. G. Gros (DOE, Washington, D.C.) 1979 14 p refs Presented at the 2nd Miami Intern. Conf. on Alternative Energy Sources., Miami Beach, Fla., 10-13 Dec. 1979
(Contract W-31-109-eng-38)
(CONF-791204-32) Avail: NTIS HC A02/MF A01

The importance of system integration analysis in evaluating the effects of wind powered generation on an electrical utility system was studied. For the assumed utility and wind conditions it was shown that an intermittent energy source such as wind can contribute to overall system reliability. Since reliability indices are the primary criteria for utility expansion planning, it should be possible to reduce conventional capacity installations in response to the reliability improvements associated with wind generation. With both energy and reliability benefits it appears that there is a reasonable potential for wind generators to be competitive, in limited penetrations, with conventional capacity. DOE

N80-25896# Brookhaven National Lab., Upton, N. Y.
OPTIMIZATION OF SOLAR ASSISTED HEAT PUMP SYSTEMS VIA A SIMPLE ANALYTIC APPROACH

John W. Andrews 1980 6 p refs Presented at the 2d Ann. Systems Simulation and Econ. Anal. Conf., San Diego, Calif., 23-25 Jan. 1980
(Contract EY-76-C-02-0018)
(BNL-27318; CONF-800101-17) Avail: NTIS
HC A02/MF A01

An analytic method for calculating the optimum operating temperature of the collector/storage subsystem in a solar assisted heat pump is presented. A tradeoff exists between rising heat pump coefficient of performance and falling collector efficiency as this temperature is increased, resulting in an optimum temperature whose value increases with increasing efficiency of the auxiliary energy source. Electric resistance is shown to be a poor backup to such systems. A number of options for thermally coupling the system to the ground are analyzed and compared. DOE

N80-25901# Department of Energy, Washington, D. C. Office of Buildings and Community Systems.

PROPOSED ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS: STANDARD BUILDING OPERATING CONDITIONS

Nov. 1979 79 p
(DOE/CS-0118) Avail: NTIS HC A05/MF A01

The process of developing energy budget levels for new commercial buildings, in conjunction with the energy-performance standards for new buildings, includes the use of energy-analysis computer programs. These programs are used to estimate the design energy requirements of randomly selected commercial buildings. The input to these programs includes a set of data known as the Standard Building Operating Conditions (SBOC). These SBOC consist of temperatures, human-occupancy densities and profiles, lightning-usage profiles, and the like. They describe typical conditions under which a commercial or multifamily residential building would operate during the course of a day. The standardization of the building operating conditions is described. Alternative ways that SBOC may be applied in a regulatory compliance context are discussed as well as the advantages and disadvantages of each alternative. The implications of the standardization of operating conditions are examined. DOE.

N80-25902# Department of Energy, Washington, D. C. Office of Buildings and Community Systems.

PROPOSED ENERGY-PERFORMANCE STANDARDS FOR NEW BUILDINGS: PASSIVE AND ACTIVE SOLAR-HEATING ANALYSIS

Nov. 1979 70 p
(DOE/CS-0117) Avail: NTIS HC A04/MF A01

The use of passive and active solar thermal heating technologies was analyzed in order to develop standards for new buildings.

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Maximum permissible levels of annual building design energy consumption were established for different building types in various climates. Besides reducing the use of depletable energy, the standards are intended to achieve maximum practicable increases in the use of nondepletable sources of energy. Cost and energy savings estimates were developed for optimally-sized passive solar systems corresponding to the prototype house characteristics represented by each point on the conservation cost/performance curves (from previous studies). An analysis was performed for each of the ten (Atlanta, Burbank, Chicago, Fresno, Ft. Worth, Houston, Minneapolis, Phoenix, Portland, and Washington) representative cities in the conservation study analysis. The key elements of the methodology were: thermal performance estimation, optimum system size determination, and sensitivity analysis. DOE

N80-25904# California Univ., Berkeley, Lawrence Berkeley Lab. Energy and Environment Div.
SOLAR ENERGY PROGRAM. CHAPTER FROM THE ENERGY AND ENVIRONMENT DIVISION REPORT Annual Report

Aug. 1979 42 p refs
(Contract W-7405-eng-48)
(LBL-9630) Avail: NTIS HC A03/MF A01

Important aspects of assessing solar applications are discussed. The amount and character of circumsolar radiation is examined with respect to geographic location, climate, season, time of day, and observed wavelength. The major optical, physical, and chemical considerations involved in designing, building, and operating a solar receiver are evaluated. The application of passive solar design concepts to the nonresidential building sector are explored. R.C.T.

N80-25919# Environmental Protection Agency, Research Triangle Park, N.C. Office of Air Quality Planning and Standards.

NATIONAL EMISSIONS DATA SYSTEM (NEDS), FUEL USE REPORT

Aug. 1979 127 p
(PB80-146905; EPA-450/4-79-020) Avail: NTIS HC A07/MF A01 CSCL 21D

Annual estimates of total consumption of major fuels such as coal, fuel, oil, natural gas, gasoline, and diesel fuel are summarized. Estimates of the consumption of a number of other comparatively minor fuels are also included. The data are distributed according to major categories of air pollutant emissions as a whole and for individual states, territories, and the District of Columbia. GRA

N80-25923# Argonne National Lab., Ill.
CONSEQUENCES OF INCREASED COAL UTILIZATION

Arnold J. Goldberg, L. J. Hoover, and Terrance Surtles 1979 42 p ref Presented at 72nd Ann. Am. Inst. of Chem. Engr. Meeting, San Francisco, 25-29 Nov. 1979 Prepared jointly with Brookhaven Nat. Lab.; Los Alamos Sci. Lab., California Univ. Lawrence Berkeley Lab., Oak Ridge Nat. Lab., and Pacific Northwest Labs.

(Contract W-31-109-eng-38)
(CONF-791108-16) Avail: NTIS HC A03/MF A01

The consequences of increasing coal use to meet the proposed goals of the National Energy Plan (1977) were regionally analyzed. Ten technical areas were considered: siting, air quality, long-range transport of sulfur dioxide, water quality, availability, solid wastes, socioeconomic, national economics, and occupational safety and health effects. The results of the analyses are summarized. DOE

N80-25926# Department of Energy, Washington, D. C. Div. of Environmental Control Technology.

DIVISION OF ENVIRONMENTAL CONTROL TECHNOLOGY PROGRAM, 1978 Annual Report

Jun. 1979 259 p refs
(DOE/EV-0042; AR-2) Avail: NTIS HC A12/MF A01

The independent overview and assessment of environmental control aspects of both the U.S. Department of Energy's research, development, and demonstration programs and the Nation's energy policies and the reduction of potential environmental hazards at

the radioactively contaminated sites that are presently owned or were formerly used by the Government are reviewed. A short summary is presented of objectives, approach, progress and results, future plans, and a reference bibliography for each research, development, or assessment project within the program areas described. DOE

N80-25927# Argonne National Lab., Idaho Falls, Idaho.
ENVIRONMENTAL ASSESSMENTS OF ALTERNATIVE ENERGY STRATEGIES IN THE UNITED STATES

Stephen W. Ballou and Arthur Katz (DOE, Washington, D.C.) 1979 18 p refs Presented at the Intern. Inst. for Appl. Systems Analysis, Vienna, 5-9 Nov. 1979
(Contract W-31-109-eng-38)
(CONF-791172-1) Avail: NTIS HC A02/MF A01

The evaluation of the regional impacts of future energy development is discussed. The impacts described for 1990 are based on a national energy projection (scenario) that assumes medium energy demand and fuel supply through 1990, but does not incorporate the policies of the 1978 National Energy Act. County level patterns for utility, industry and mining activities for 1990 are developed from the federal region totals. Energy sources addressed are coal, nuclear, oil, oil shale, gas, geothermal, hydroelectric, and solar. The impact of these county-level patterns of utility, industry, and mining activities on the air, water, and land resources of the country and on the socioeconomic and health and safety aspects of the nation's welfare are analyzed. DOE

N80-25928# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ENVIRONMENTAL ASSESSMENT OF SMALL WIND SYSTEMS Progress Report

Kathryn Lawrence, Carol Strojjan, and Daniel O'Donnell Feb. 1980 37 p refs
(Contract EG-77-C-01-4042)

(SERI/PR-354-420) Avail: NTIS HC A03/MF A01

The first formal product of the environmental assessment of small wind energy conversion systems (SWECS) study is presented. An overview of the study's structure, planned activities, and a synopsis of task progress is given. DOE

N80-25930# Automotive Testing Labs., Inc., Aurora, Colo.
A STUDY OF EMISSIONS FROM PASSENGER CARS IN SIX CITIES, VOLUME A Final Report

Jan. 1979 868 p 2 Vol.
(Contract EPA-68-03-2593)
(PB80-149800; EPA-460/3-78-011A) Avail: NTIS HC A99/MF A01 CSCL 13B

This is the first of two volumes presenting results from a series of exhaust emission and fuel economy tests performed on a representative sample of vehicles in six U.S. cities. Data presented in the following sections are generated in appendix form as part of a contract with the EPA to perform work for the FY 77 Passenger Car Emission Factor Program. Volume A includes a technical discussion of test and data handling procedures, laboratory facility descriptions, and test instrument maintenance and calibration practices. Pertinent data concerning vehicle sample composition and results of Federal Test Procedure, Highway Fuel Economy and Federal Short Cycle Tests are also presented. GRA

N80-25936# Battelle Columbus Labs., Ohio.
METHODS FOR ANALYZING INORGANIC COMPOUNDS IN PARTICLES EMITTED FROM STATIONARY SOURCES Interim Report, Jan. 1977 - Jul. 1978

William M. Henry Sep. 1979 130 p refs
(Contract EPA-68-02-2296)
(PB80-141781) Avail: NTIS HC A07/MF A01 CSCL 14B

Methods to identify and measure inorganic compounds in particulate emissions which emanate from sources using or processing fossil fuels were developed. Large masses, 20 to 100 grams of field samples were collected representative of a range of both coal and oil-fired fly ashes, and the selected methodology development efforts were evaluated on these field

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samples as well as synthesized samples. Fourier transform infrared spectroscopy, X-ray diffraction, and chemical phase separations and analyses are the methods which have provided the most definitive identification of inorganic compounds. The structural findings by these methods are complemented by complete cation-anion chemical determinations. GRA

N80-25940# Bureau of Mines, Salt Lake City, Utah. Research Center.

FLUE GAS DESULFURIZATION BY THE MODIFIED CITRATE PROCESS: REPORT OF INVESTIGATIONS

R. H. Lien, D. A. Martin, and W. I. Nissen 1979 24 p refs (PB80-134836; BM-RI-8403) Avail: NTIS HC A02/MF A01 CSCL 13B

A flue gas desulfurization process was developed. The process known as the citrate process, involves absorption of sulfur dioxide (SO₂) in a buffered solution of citric acid. As an adjunct to the citrate process, bench scale research shows that SO₂-loaded citrate or glycolate solutions can be regenerated by countercurrent contact with steam (stripping) in packed towers. Stripping steam requirements were determined for treatment of 0.25, .50, 1.0, and 2.0% SO₂ waste gases. Steam requirements decreased with increasing SO₂ concentrations in the simulated waste gases. GRA

N80-25943# Gulf South Research Inst., New Orleans, La. **RESEARCH TO IDENTIFY COMPONENTS OF ENERGY-RELATED WASTES: A STATE-OF-THE-ART REPORT Final Report, Nov. 1976 - Nov. 1978**

J. E. Gebhart and Mary M. McKown Dec. 1979 526 p (Contract EPA-68-03-2487) (PB80-137961; EPA-600/7-79-255) Avail: NTIS HC A23/MF A01 CSCL 13B

Pertinent abstracts from a survey of current (post 1976) research projects were categorized according to energy-related activity. Subjects include coal strip mines, oil refineries, oil shale operations, coal-fired power plants, geothermal energy production, coal liquefaction plants, and potential quality control standards. Abstracts of available technical reports are also presented using the same energy categories. These reports were obtained from a variety of sources, including MEDLINE, TOXLINE, BIOSIS, CAIN, NTIS, DIALOG, and Chemical Abstracts. Federal energy research centers supplied a large number of pertinent documents. This state-of-the-art summary is provided as an aid to researchers concerned with the environmental effects of energy-related activities. GRA

N80-25947# TRW Defense and Space Systems Group, Redondo Beach, Calif.

THE USE OF pH AND CHLORIDE ELECTRODES FOR THE AUTOMATIC CONTROL OF FLUE GAS DESULFURIZATION SYSTEMS Final Report, Sep. 1978 - Jul. 1979

Clinton Ung, Toby Accian, and Ray Maddalone Nov. 1979 80 p ref (Contract EPA-68-02-2165) (PB80-138464; EPA-600/2-79-202) Avail: NTIS HC A05/MF A01 CSCL 13B

The applicability of chloride and pH electrodes in automated control systems was investigated via a survey of chloride and pH electrodes in different flue gas desulfurization (FGD) systems and an evaluation of an industrial pH electrodes system. The survey showed that chloride ion measurements were necessary only where high chloride values correspond with FGD unit corrosion and when chloride values were used at correction factors in pH calculations. Chloride ion measurements are unnecessary for most of the surveyed companies. All survey companies use pH measurement to control scaling or to attain optimum performance in FGD units. The most common pH electrode problem was residue buildup (scaling) around the electrode, caused by the use of non-self-cleaning (standard) pH electrodes. The performance of self-cleaning and standard industrial pH electrodes was evaluated. GRA

N80-26003# California Univ., Livermore. Lawrence Livermore Lab.

CLIMATE PROGRAM PLAN, VOLUME 1

Jan. 1980 90 p refs 2 Vol.

(Contract W-7405-eng-48)

(DOE/EV-0062/1) Avail: NTIS HC A05/MF A01

The perceived and potential effects of energy technologies on climate that merit assessment are discussed along with the need for research on the prediction of weather and climate variations and assessment of their effects on power production. The need for assessing the cycles and budgets of the entire range of substances emitted in power production by the many technologies now in use is emphasized. To provide the basis for assessing the impacts of these emissions, specialized, mission-oriented research to improve understanding of processes that determine how these emissions are transported, transformed, and scavenged in the atmosphere, and of the natural processes that can be affected by energy activities are suggested. This latter category includes potential modification of surface properties caused, for example, by large arrays of solar collectors, extensive biomass production and wind power modification of the boundary layer. DOE

N80-26219# Office of Technology Assessment, Washington, D. C.

IMPACT OF ADVANCED GROUP RAPID TRANSIT TECHNOLOGY

Jan. 1980 88 p

(PB80-153323; OTA-T-106; LC-80-600001) Avail: NTIS HC A04/MF A01 CSCL 13B

This assessment of advanced group rapid transit (AGRT) was made in response to a request of the House Committee on Appropriations to evaluate the need for this technology and its relationship to national mass transportation goals. Increases in traffic congestion, petroleum shortages, and decreasing mobility for the transit-dependent reflect a growing need for more efficient and effective transportation options. The need for further advances in automated guideway transit (AGT) technology, are examined and their potential impacts on various stakeholder groups are evaluated. GRA

N80-26441# Little (Arthur D.), Inc., Cambridge, Mass.

SURVEY OF POTENTIAL PROCESSES FOR THE MANUFACTURING OF ALUMINUM

Dec. 1979 84 p refs

(Contract W-31-109-eng-38)

(ANL/OEPM-79-4) Avail: NTIS HC A05/MF A01

Alternative processes to the Hall-Heroult cell for the production of primary aluminum direct carbothermic reduction of alumina are considered: reduction of bauxite to an aluminum silicon alloy; the subchloride process; the disproportionation of aluminum sulphide; the production through a nitride intermediate; and electrolysis of aluminum chloride aluminum sulphide and aluminum nitride; and plating from nonaqueous solvents. Energy consumption requirements for these techniques are compared with current Hall-Heroult technology and with projected improved technology - particularly titanium diboride cathodes and permanent anodes. The major conclusion is that the only alternative technology at present is the Alcoa chloride electrolysis process but that sulphide and nitride electrolytic processes offer potential advantages in the future. With the exception of thermal reduction to an aluminum-silicon alloy, none of the carbothermic processes is competitive because they require electric furnaces. Significant improvements in energy consumption could be achieved with titanium diboride cathodes in the Hall-Heroult cell. DOE

N80-26550# Department of Energy, Washington, D. C. Federal Energy Management Program.

ARCHITECTS AND ENGINEERS GUIDE TO ENERGY CONSERVATION IN EXISTING BUILDINGS

1 Feb. 1980 468 p

(DOE/CS-0132) Avail: NTIS HC A20/MF A01

A field-tested approach to identifying, analyzing, and recommending action on the wide range of opportunities and options available to reduce energy use in most existing buildings is offered. Besides a review of the principles of energy use and conservation, the manual provides a step-by-step methodology for assessing and improving the year-round energy performance of buildings, as well as a series of forms, charts, and nomographs designed

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to enhance and simplify the work of those architects and engineers whose practice includes the analysis and modification of existing buildings to reduce both fuel consumption and operating costs.

A.R.H.

N80-26568# Kaiser Engineers, Oakland, Calif.
SITE AND BUILDING ENERGY CONSERVATION STUDY: SURVEY OF BUILDING 435, MFE RESEARCH
Oct. 1979 70 p Prepared in cooperation with Consultants Computation Bureau, Oakland, Calif. Prepared for Calif. Univ., Livermore; Lawrence Livermore Lab.
(Contract W-7405-eng-48)
(UCRL-15198; REPT-79-72-RE) Avail: NTIS HC A04/MF A01

Review of the design drawings, an on-site inspection of the 49,700-sq ft building, and discussions with the building manager and various operating personnel are discussed. Data were collected regarding the number of people occupying the building, operating schedules, and the energy loads imposed by installed and temporary equipment. The heating, ventilating, and air conditioning systems were investigated. The building energy systems were simulated using the DOE-1 energy program. A base-year energy consumption run was made, together with simulations of the building's performance assuming installation of each of eleven energy-conservation opportunities (ECO's) identified. A summary of the energy savings that would result from implementation of the ECO's is given. DOE

N80-26600# Environmental Law Inst., Washington, D. C.
STATE OPTIONS IN LIGHTING: EFFICIENCY STANDARDS FOR EXISTING PUBLIC BUILDINGS
Frank Meeker Jun. 1979 51 p refs
(Contract EM-78-C-01-5255)
(DOE/CS-5255/2) Avail: NTIS HC A04/MF A01

Requirements and options for state lighting efficiency standards for existing public buildings under the Energy Policy and Conservation Act are discussed. It is recommended that states adopt a requirement that owners of all public buildings submit reports of lighting energy audits and estimates of energy savings from modifications to comply with substantive standards. It is further recommended that while filing of reports should be mandatory, substantive compliance, at least initially, need not be. It is recommended that exemptions from the standards be limited to small buildings and that variances under a mandatory standard be available only when an applicant can show insufficient capital to make required modifications, even though they would soon pay for themselves in reduced operating costs. It is suggested that a lighting standard of the kind recommended should substantially reduce wasted energy in lighting, be simple enough to be easily understood and applied, be technically and economically reasonable, and allow for needed exemptions without loopholes. E.D.K.

N80-26627# Science Applications, Inc., La Jolla, Calif.
STATE-OF-THE-ART ASSESSMENT OF HYBRID HEAT PUMPS Final Report
M. H. Blatt and R. C. Erickson Dec. 1979 171 p refs
(EPRI Proj. 1201-6)
(EPRI-EM-1261) Avail: NTIS HC A08/MF A01

The hybrid heat pump is evaluated and is compared with other heating, ventilating, and air conditioning (HVAC) system options. A hybrid heat pump is an HVAC system which includes an electrically driven heat pump and supplementally fired gas or oil boiler. This system was compared with heat pumps, oil-fired boilers, and gas-fired boilers. DOE

N80-26670# Argonne National Lab., Ill.
CLASSIFICATION AND EVALUATION OF ELECTRIC MOTORS AND PUMPS
Feb. 1980 251 p refs
(Contract W-31-109-eng-38)
(DOE/CS-0147) Avail: NTIS HC A12/MF A01

Classification and evaluation of electric motors and pumps are discussed. The industrial, transportation, commercial, agricultural, and municipal sectors of the US economy are studied. The range of electric motors included all ac and dc integral and

fractional hp units equalling or exceeding 1/6 hp. However, units of less than 1/6 hp and those in use in other than the previously defined sectors were treated to ensure completeness. Pump equipment covered included the wide range of fluid handling equipment powered by all energy forms. The range of sizes analyzed correlated with those for motors, roughly 1/6 to 20,000 shaft hp. An analysis task called for developing scenarios for the policy options based on labeling and standards, evaluating barriers to their implementation, and then evaluating probable results. DOE

N80-26749# Central Intelligence Agency, Washington, D.C.
THE WORLD OIL MARKET IN THE YEARS AHEAD: A RESEARCH PAPER
Aug. 1979 87 p
(ER-79-10327U) Avail: NTIS HC A05/MF A01

A review of the oil market before 1973, during the period 1973 to 1978, and at the present time is given. The outlook for the world oil market over the next several years is analyzed. Oil production in the industrial countries, supplies from the developing countries, net exports from communist countries, and OPEC supplies are discussed. Alternative energy sources and the energy supply outlook for OECD countries are also considered. Other topics covered are factors affecting demand, the future energy market, and oil supplies in the long term. J.M.S.

N80-26772*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
GEOTHERMAL DIRECT HEAT USE: MARKET POTENTIAL/PENETRATION ANALYSIS FOR FEDERAL REGION 9
William Powell, ed. and Kenneth Tang, ed. May 1980 337 p
(Contract NAS7-100)
(NASA-CR-163267; JPL-Pub-80-41) Avail: NTIS HC A15/MF A01 CSCL 10B

A preliminary study was made of the potential for geothermal direct heat use in Arizona, California, Hawaii, and Nevada (Federal Region 9). An analysis was made of each state to: (1) define the resource, based on the latest available data; (2) assess the potential market growth for geothermal energy; and (3) estimate the market penetration, projected to 2020. Findings of the study include the following: (1) Potentially economical hydrothermal resources exist in all four states of the Region; however, the resource data base is largely incomplete, particularly for low to moderate temperature resources. (2) In terms of beneficial heat, the total hydrothermal resource identified so far for the four states is on the order of 43 Quads, including an estimated 34 Quads of high temperature resources which are suitable for direct as well as electrical applications. (3) In California, Hawaii, and Nevada, the industrial market sector has somewhat greater potential for penetration than the residential/commercial sector. In Arizona, however, the situation is reversed, due to the collocation of two major metropolitan areas (Phoenix and Tucson) with potential geothermal resources. R.E.S.

N80-26784*# Aerospace Corp., El Segundo, Calif.
CENTRAL STATION APPLICATIONS PLANNING ACTIVITIES AND SUPPORTING STUDIES Final Report
S. L. Leonard and B. Siegel Apr. 1980 117 p refs
(Contract JPL-955434)
(NASA-CR-163042; JPL-9950-372; ATR-80(7820-04)-2) Avail: NTIS HC A06/MF A01 CSCL 10B

The application of photovoltaic technology in central station (utility) power generation plants is considered. A program of data collection and analysis designed to provide additional information about the subset of the utility market that was identified as the initial target for photovoltaic penetration, the oil-dependent utilities (especially municipals) of the U.S. Sunbelt, is described along with a series of interviews designed to ascertain utility industry opinions about the National Photovoltaic Program as it relates to central station applications. J.M.S.

N80-26786# Committee on Science and Technology (U. S. House).
OVERSIGHT: INDUSTRIAL ENERGY CONSERVATION, VOLUME 10

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Washington 1979 327 p refs Hearing before Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., 96th Congr., 1st Sess., no. 49, 11 Sep. 1979 (GPO-53-020) Avail: SOD

Testimony delivered and statements received in support of industrial energy conservation through cogeneration are presented. The Federal government's role and policy on industrial energy conservation is discussed. R.E.S.

N80-26787# Central Technical Inst. TNO, Apeldoorn (Netherlands). Afdeling Warmte- en Koudetechniek. **LECTURES ON HEAT TECHNOLOGY IN THE NETHERLANDS [VOORDRACHTEN VAN DE 39 STE VAKANTIE-LEERANG VOOR WARMTE- EN KOUDE-TECHNIEK, GEHOUDEN OP 23 EN 24 AUGUSTUS, 1977]**

1977 69 p refs In DUTCH; ENGLISH summary Lectures of the 39th Summer Course on Heat Technol., 23-24 Aug. 1977 Prepared in cooperation with Koninklijke Inst. van Ingenieurs, The Hague, Netherlands Technische Vereniging voor Verwarming en Luchtbehandeling
Avail: NTIS HC A04/MF A01; Central Tech. Inst., Apeldoorn, Netherlands FL 30

Lectures were given dealing with heat-activated heat pumps, heat pumps in home heating, air/air heat pumps, energy consumption and possible savings in office buildings, solar water heating, and design of a home solar heating unit through use of a mathematical model.

N80-26789# Central Technical Inst. TNO, Apeldoorn (Netherlands). Afdeling Warmte- en Koudetechniek. **SURVEY OF FOREIGN RESEARCH IN THE FIELD OF HEAT PUMPS FOR THE HEATING OF DWELLINGS [OVERZICHT VAN BUITENLANDSE ONDERZOEKEN AAN WARMTEPOMPEN VOOR WONINGVERWARMING]**

W. E. J. deBeyer *In its* Lectures on Heat Technol. in the Netherlands 1977 p 19-29 refs In DUTCH

Avail: NTIS HC A04/MF A01; Central Tech. Inst., Apeldoorn, Netherlands FL 30

The literature of the U.S.A., Germany, France, Sweden, Denmark, Switzerland, and England shows that parallel and often overlapping research is being done. Topics covered are: heat recovery; cycle systems; waste heat recovery; cryogenics; unitary heat pumps; thermal flow; and mono and bivalent heat pumps. Economic aspects are also discussed. Author (ESA)

N80-26790# Central Technical Inst. TNO, Apeldoorn (Netherlands). Afdeling Warmte- en Koudetechniek.

CASE STUDY OF AN AIR TO AIR HEAT PUMP [PRAKTIJKONDERZOEK AAN EEN LUCHT/LUCHT WARMTEPOMP]
J. F. vanderHorst *In its* Lectures on Heat Technol. in the Netherlands 1977 p 31-38 refs In DUTCH

Avail: NTIS HC A04/MF A01; Central Tech. Inst., Apeldoorn, Netherlands FL 30

A commercially available, electrically operated air-to-air heat pump was installed and tested in a single family dwelling in the Netherlands. The unit functioned reliably, but no energy savings was possible. Air transport via the evaporator and condenser was insufficient, and did not permit the manufacturers specifications to be met. Author (ESA)

N80-26791# Technische Physische Dienst TNO-TH, Delft (Netherlands).

EXAMINATION OF ENERGY CONSUMPTION AND THE POSSIBILITIES OF ENERGY SAVINGS IN OFFICE BUILDINGS [ONDERZOEK OER HET ENERGIEVERBRUIK EN OVER DE MOGELJKHEDEN TOT ENERGIEBESPARING IN UTILITEITS-GEBOUWEN]

P. Euser, M. Hugenholtz (Adviesbureau), and P. W. Deerns (Bureau Deerns) *In* Central Tech. Inst. Lectures on Heat Technol. in the Netherlands 1977 p 39-50 refs In DUTCH

Avail: NTIS HC A04/MF A01; Central Tech. Inst., Apeldoorn, Netherlands, FL 30

Projected energy savings were computed for various building

shapes and orientations with respect to the Sun. The effects of making better use of daylight, of using lower light levels, of directing light at work areas, and of continuously regulating the levels of artificial lighting, are shown. Author (ESA)

N80-26808# Kaiser Engineers, Oakland, Calif. **SITE AND BUILDING ENERGY-CONSERVATION STUDY: SURVEY OF BUILDING 3, EXPERIMENTAL PHYSICS**
Oct. 1979 106 p Prepared in cooperation with Consultants Computation Bureau, Oakland, Calif. Prepared for Calif. Univ., Livermore, Lawrence Livermore Lab. (Contract W-7405-eng-48)
(UCRL-15195; REPT-79-65-RE) Avail: NTIS HC A06/MF A01

An energy conservation study of Building 3, Experimental Physics was conducted. The survey was based on a detailed review of the as-built drawings, an onsite inspection of the 100,000-sq ft building, and discussions with the building manager and various operating personnel. Data were collected regarding the number of people occupying the building, operating schedules, and the energy loads imposed by installed and temporary equipment. The heating, ventilating and air conditioning systems were investigated. A base-year energy-consumption run was made, together with simulations of the building's performance assuming installation of each of nine energy conservation opportunities (ECO's) and combinations identified. The energy savings resulting from the implementation of the ECO's are summarized. DOE

N80-26810# TRW Systems Group, McLean, Va. **COMPARISON OF COSTS FOR AUTOMOBILE ENERGY CONSERVATION VS SYNTHETIC FUEL PRODUCTION**

Richard Gorman and Kenneth L. Heitner 1980 32 p refs Presented at the 5th Symp. on Automotive Propulsion Systems, Dearborn, Mich., 14 Apr. 1980 (Contract AC01-79PE-70151)

(CONFL-800419-1) Avail: NTIS HC A03/MF A01

The analysis suggests that there are a large number of potential technical options for reducing energy consumption in automobiles. Furthermore, the cost to the user of purchasing these conservation options is less than the discounted cost of purchasing the additional fuel required if the conservation option is not chosen. There is a significant cost savings even if fuel costs remain at current levels. These savings would increase if fuel prices continue to rise or if more costly than synthetic fuels, at least for another 15 to 20 years. Cost effective conservation could enable new vehicles to reach 40 to 50 mpg corporate average fuel economy by the year 2000. It is clear that the potential for making these changes exists, but better data are needed to evaluate many of these options and to ensure the development and implementation of those that are desirable. DOE

N80-26817# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

PROJECTS FROM FEDERAL REGION 9: DEPARTMENT OF ENERGY APPROPRIATE ENERGY TECHNOLOGY PROGRAM, PART 2

C. W. Case, H. R. Clark, J. Kay, F. B. Lucarelli, and S. Rizer Jan. 1980 50 p refs

(Contract W-7405-eng-48)
(LBL-10098) Avail: NTIS HC A03/MF A01

Details and progress of appropriate energy technology programs in Region 9 (Arizona, California, and Hawaii) are presented. Each on-going project is individually described and includes details on direct and indirect energy savings. Also included are information on innovative features, regional or national demonstration possibilities, and aspects of the project which can be replicated elsewhere either on a regional or national scale. R.E.S.

N80-26833# Institut Francais de l'Energie, Paris. **GUIDE FOR ENERGY COMPATIBILITY**

M. J. Braun and J. Lefebvre May 1979 160 p refs In FRENCH (NP-24016; Rept-65) Avail: NTIS (US Sales Only)

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HC A08/MF A01: DOE Depository Libraries

A guide for the energy manager in the acquisition and processing of data necessary for energy conservation is presented. Energy conservation is defined and its objectives outlined. The principles and characteristics of measurement devices used are given. The use of the measurements in the establishment of energy balances is described. Examples are given of establishments that have instituted energy conservation plans. Tables are presented of comparative characteristics, by manufacturer and by type of measurement device, for 300 manufacturers operating in the French market. DOE

N80-26861# Department of Energy, Washington, D. C. Office of Energy Technology.

SOLAR, GEOTHERMAL, ELECTRIC AND STORAGE SYSTEMS PROGRAM SUMMARY DOCUMENT, FY 1980 Jul. 1979 449 p Sponsored by DOE

(DOE/ET-0102) Avail: NTIS HC A19/MF A01

Current and planned programs in solar technology, geothermal energy, electric energy systems, and energy storage systems are covered. After national energy policy with respect to these programs is introduced, the program structure, FY 1980 budget request, strategies, and management are identified. For each energy technology program, activity areas are described and their status outlined. Program aspects which crosscut all energy technologies (e.g., regional activities, commercialization, environmental and socioeconomic aspects, small and minority business utilization, and international programs) are described. DOE

N80-26881# American Association for the Advancement of Science, Washington, D.C. Office of Public Sector Programs. **ENERGY AND RESOURCE RECOVERY FROM SOLID WASTE: REPORT FROM A WORKSHOP CONSIDERING PROBLEMS IDENTIFIED BY THE INTERGOVERNMENTAL SCIENCE, ENGINEERING, AND TECHNOLOGY ADVISORY PANEL**

1979 237 p refs Conf. held in Lanham, Md., 24-26 Sep. 1979

(Grant NSF OPA-78-24464)

(PB80-150790; AAAS/PUB-79/R/17; NSF/RA-790345) Avail: NTIS HC A11/MF A01 CSCL 13B

Problem areas considered by a workshop on energy and resource recovery from solid waste include: institutional and economic issues; environment and health issues; production technology issues; and use technology issues. Separate working groups, set up to consider each of these issues, prepared draft reports which make up the separate sections of this report. GRA

N80-26882# Illinois Inst. of Natural Resources, Springfield. **ILLINOIS STATE PLAN: ENERGY CONSERVATION IN INSTITUTIONS (INSTITUTIONAL BUILDINGS GRANT PROGRAM)**

Steven K. Thomas, Steven L. Tuma, and John Shum 15 Aug. 1979 96 p Prepared in cooperation with Contract Research Corp., Chicago

(PB80-148182) Avail: NTIS HC A05/MF A01 CSCL 10A

The Illinois state plan for the Institutional Buildings Grant Program is presented. The plan addresses very narrow legislative requirements of the Energy Conservation Policy Act. The plan illustrates the strategies and commitments to achieve full implementation of the Energy Grant Program in Illinois. GRA

N80-26907# National Oceanic and Atmospheric Administration, Boulder, Colo. Atmospheric Physics and Chemistry Lab.

MECHANISMS AND RATES OF FORMATION OF SULFUR AEROSOLS IN POWER PLANT PLUMES

R. F. Pueschel and Y. Mamane (Technion - Israel Inst. of Tech.) In WMO The Long-Range Transport of Pollutants and its Relation to Gen. Circulation Including Stratospheric/Tropospheric Exchange Processes 1979 p 141-148 refs

Avail: NTIS HC A19/MF A01

Aerosol size distributions, aerosol elemental composition, and the concentrations of fine particles and trace gases at three typical locales in order to explore the potential effects on the

environment of coal-fired power plant operations. The three cases are the plume proper of a 2150 megawatt power plant burning low sulfur coal, the atmosphere outside but close to the plume, and the atmosphere of a region hundreds of miles away from any industrial operation. The aerosol dynamics, discussed in terms of the lumped mode heterodisperse coagulation model show that the formation rates of condensation nuclei are similar for the power plant plume and the rural atmosphere. However, the rural aerosol is of natural origin and is dominated by organic particles, whereas the plume aerosol consists of siliceous spheres mixed with sulfate particles. The aerosol dynamics further show that the accumulation mode at around 0.1 micron radius is the most persistent feature of the atmospheric aerosol with turnover times of weeks to months. The particle concentration and modal radius of this mode is larger in the plume and its immediate vicinity than it is in the rural atmosphere. The data also show a significant increase in aerosol concentration in the plume at the coarse particle mode of radii larger than 1 micron. However, rapid settling of these relatively large particles results in turnover times of only hours. M.G.

N80-26942# Washington Univ., St. Louis, Mo. Center for Air Pollution Impact and Trend Analysis.

SYNOPTIC-SCALE DISTRIBUTION OF MAN-MADE AEROSOLS

R. B. Husar and D. E. Patterson In WMO The Long-Range Transport of Pollutants and its Relation to Gen. Circulation Including Stratospheric/Tropospheric Exchange Processes 1979 12 p refs

(Grants EPA-R-803896; EPA-R-806548)

Avail: NTIS HC A19/MF A01

Sulfate aerosol from fossil fuel combustion can be monitored on the regional scale by relating it to reduced visual range measured at most meteorological stations. The synoptic or regional scale is shown to be appropriate for the impact assessment of sulfates and other aerosols. A global pollution dispersion model is presented, based upon projected fossil fuel combustion and hemispheric winds. Author (ESA)

N80-26956# Brookhaven National Lab., Upton, N. Y. Progress Sciences Div.

ENVIRONMENTAL CONTROL TECHNOLOGY FOR ATMOSPHERIC CARBON DIOXIDE Final Report

Anthony S. Albanese and Meyer Steinberg Sep. 1979 58 p refs

(Contracts EY-76-C-02-0016; DE-AC02-76CH-00016)

(BNL-51116) Avail: NTIS HC A04/MF A01

The impact of fossil fuel use in the United States on worldwide CO₂ emissions and the impact of increased coal utilization on CO₂ emission rates are assessed. The aspects of CO₂ control are discussed as well as the available CO₂ control points (CO₂ removal sites). The primary factor affecting the practicability of a CO₂ control system is the energy required by the control system. Of the three potential CO₂ control points, removal from the stacks of fossil fuel power plants appears to require the least amount of energy. Estimates of the energy required to capture and recover CO₂ from coal-fired power plant stacks by various processes are presented. Although capture and recovery of CO₂ is an important consideration in the overall scheme of CO₂ control, disposal or reuse of recovered CO₂ may be the weakest link in the CO₂ control chain. Of the several options considered, deep ocean storage appears to be the most promising. Two control scenarios are evaluated, one based on the absorption of CO₂ contained in power plant flue gas by seawater; the other, based on absorption of CO₂ by monoethanolamine (MEA). Captured CO₂ is injected into the deep ocean in both cases. Analysis indicate that capture and disposal by seawater is not feasible, whereas capture and disposal using MEA is a possibility. However, the economic penalties of CO₂ control are significant; for example, at a CO₂ removal efficiency of 50%, it is estimated that the power generation efficiency of a conventional coal fired power plant would be reduced from 34 to about 25%. The cost of power generation would be expected to double. For 90% CO₂ removal, power generation efficiency is reduced to between 15 and 6% and the cost of power generation increases by a factor of from 4 to 7. DOE

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N80-26958# Colorado Univ., Boulder.
HETEROGENEOUS CHEMISTRY OF IMPORTANCE IN DECISIONS CONCERNING THE ENVIRONMENTAL IMPACT OF ENERGY PRODUCTION AND THE SITING OF NEW ENERGY SOURCES Progress Report, 1 Mar. 1979 - 29 Feb. 1980

A. W. Castleman, Jr. Feb. 1980 17 p refs
(Contract EP-78-S-02-4776)

(COO-4776-2) Avail: NTIS HC A02/MF A01

The following are reported: (1) the formation, stability, and structure of ion-clusters both by high pressure mass spectrometric experiments and approximate molecular orbital quantum mechanical calculations; (2) the exchange of energy and angular momentum during ion-molecule association reactions using computer dynamics calculations; (3) related experimental and theoretical studies of nucleation and solvation phenomena; (4) laser photophysics of ion clusters including measurement of cross sections for photodissociation, fluorescence, and energy exchange by pulsed infrared techniques; (5) the growth, stability, and structure of weakly-bound van der Waals and charge-transfer complexes employing electric deflection techniques and taking advantage of the first-order Stark effect; and (6) the multiphoton ionization of metal atom clusters to prove the transition from the isolated atomic to the condensed metallic state, and to elucidate their electronic states and potential as sites for the catalytic conversion of absorbed pollutants. DOE

N80-27207# Environmental Law Inst., Washington, D. C.
ENERGY-EFFICIENT PROCUREMENT IN STATE AND LOCAL GOVERNMENTS

Joe W. Russell, Jr. Jul. 1979 70 p refs
(Contract EM-78-C-01-5255)

(DOE/CS-5255/1) Avail: NTIS HC A04/MF A01

State and local governments have been slow in preparing and implementing plans for energy conservation with respect to the development of energy efficient standards and policies. This lack of compliance with the Energy Policy and Conservation Act is due to a lack of reliable information on many energy-consuming products, a resistance to change on the part of purchasing officials to their superiors, and reluctance in the tax revolt era to spend money in order to save money and energy as well. To overcome these obstacles, states and localities should consider mandating energy-efficient procurement practices through either executive orders or legislation. In addition, states and localities should consider adopting institutional arrangements, such as centralized purchasing and joint or cooperative purchasing that will facilitate energy-efficient procurement. Life cycle costs should be considered as bid evaluation criterion. To further state and local efforts in this area, the federal government should provide technical and financial assistance to an organization of purchasing officials to establish an information clearinghouse. A.R.H.

N80-27239# Massachusetts Inst. of Tech., Cambridge. Center for Transportation Studies.

POTENTIAL CHANGE STRATEGIES IN URBAN TRANSPORTATION: AN OVERVIEW AND TENTATIVE APPRAISAL Final Report, Jul. 1975 - Jan. 1978

Alan Altshuler, James Womack, and John Pucher Dec. 1979 87 p refs

(Contract DOT-OST-50240)

(PB80-155278; DOT/RSPA/DPB/50-79/8) Avail: NTIS HC A05/MF A01 CSCL 13B

Innovations in the urban transportation system which combine political feasibility and cost effectiveness are identified. Problems of urban transportation in the United States are emphasized.

GRA

N80-27355# Federal Aviation Administration, Washington, D. C. Office of Environment and Energy.

ENERGY CONSERVATION POTENTIAL OF GENERAL AVIATION ACTIVITY

Sep. 1979 52 p refs

(AD-A081182; FAA/EE-79-20)

Avail: NTIS

HC A04/MF A01 CSCL 01/2

Three approaches for reducing energy consumption were investigated: hardware modification, pilot education, and air traffic

control. It is recommended that research into new aircraft engine designs, automatic mixture controls, conventional engine fuel saving improvements, composite materials development, and aerodynamic drag reduction continue and that this hardware be introduced into the fleet when cost, reliability and safety considerations allow. It is further recommended that the pilot awareness and education programs listed above be implemented by the FAA and the general aviation industry; and finally, that the ATC actions listed should be further evaluated to determine whether the anticipated fuel savings justify their implementation. GRA

N80-27361*# Curtiss-Wright Corp., Wood-Ridge, N.J.
PERFORMANCE, EMISSIONS, AND PHYSICAL CHARACTERISTICS OF A ROTATING COMBUSTION AIRCRAFT ENGINE, SUPPLEMENT A

R. K. Lamping, I. Manning, D. Myers, and B. Tjoa May 1980 74 p

(Contract NAS3-20808)

(NASA-CR-135119; CW-WR-76-028.3)

Avail: NTIS

HC A04/MF A01 CSCL 21E

Testing was conducted using the basic RC2-75 engine, to which several modifications were incorporated which were designed to reduce the hydrocarbon emissions and reduce the specific fuel consumption. The modifications included close-in surface gap spark plugs, increased compression ratio rotors, and provisions for utilizing either side or peripheral intake ports, or a combination of the two if required. The proposed EPA emissions requirements were met using the normal peripheral porting. The specific fuel economy demonstrated for the modified RC2-75 was 283 g/kW-hr at 75% power and 101 brake mean effective pressure (BMEP) and 272.5 g/kW-hr at 75% power and 111 BMEP. The latter would result from rating the engine for takeoff at 285 hp and 5500 rpm, instead of 6000 rpm. E.D.K.

N80-27364*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.

CF6-6D ENGINE PERFORMANCE DETERIORATION

Ray H. Wulf, W. H. Kramer, J. E. Pass, and J. J. Smith Jan. 1980 286 p refs

(Contract NAS3-20631)

(NASA-CR-159786; R80AEG218)

Avail: NTIS

HC A13/MF A01 CSCL 21E

Cruise cockpit recordings and test cell performance data in conjunction with hardware inspection data from airline overhaul shops were analyzed to define the extent and magnitude of performance deterioration of the General Electric CF6-6D model engine. These studies successfully isolated short-term deterioration from the longer term, and defined areas where a significant reduction in aircraft energy requirements for the 1980's can be realized. Unrestored losses which remain after engine refurbishment represent over 70% of the loss at engine shop visit. Sixty-three percent of the unrestored losses are cost-effective to restore which could reduce fuel consumed by CF6-6D engines in 1980 by 10.9 million gallons. Author

N80-27803*# Wichita State Univ., Kans.

FEASIBILITY STUDY OF AILERON AND SPOILER CONTROL SYSTEMS FOR LARGE HORIZONTAL AXIS WIND TURBINES Final Report

W. H. Wentz, Jr., M. H. Snyder, and J. T. Calhoun May 1980 69 p refs

(Grant NsG-3277; Contract EX-76-I-01-1028)

(NASA-CR-159856; DOE/NASA/3277-1; WER-10) Avail: NTIS HC A04/MF A01 CSCL 10A

The feasibility of using aileron or spoiler controls as alternates to pitch control for large horizontal axis wind turbines was studied. The NASA Mod-0 100 kw machine was used as the basis for the study. Specific performance studies were conducted for 20% chord ailerons over the outboard 30% span, and for 10% chord spoilers over the same portion of the span. Both control systems utilized control deflections up to 60 deg. Results of the study show that either ailerons or spoilers can provide the control necessary to limit turbine power in high wind conditions. The aileron system, as designed, provides overspeed protection at hurricane wind speeds, low wind speed starting torque of

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778 N-m (574 ft. lb) at 3.6 m/sec, and a 1.3 to 1.5% increase in annual energy compared to a fixed pitch rotor. The aileron control system preliminary design study includes aileron loads analysis and the design of a failsafe flyweight actuator for overspeed protection in the event of a hydraulic system failure.

L.F.M.

N80-27805*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

IMPACT OF PROPULSION SYSTEM R AND D ON ELECTRIC VEHICLE PERFORMANCE AND COST

Harvey J. Schwartz and Andrew L. Gordan 22 May 1980
16 p refs Presented at 3d Intern. Electric Vehicle Exposition and Conf., St. Louis, 20-22 May 1980

(Contract EC-77-A-31-1044)

(NASA-TM-81548; DOE/NASA/1044-9; E-504) Avail: NTIS HC A02/MF A01 CSCL 10B

The efficiency, weight, and manufacturing cost of the propulsion subsystem (motor, motor controller, transmission, and differential, but excluding the battery) are major factors in the purchase price and cost of ownership of a traffic-compatible electric vehicle. The relative impact of each was studied, and the conclusions reached are that propulsion system technology advances can result in a major reduction of the sticker price of an electric vehicle and a smaller, but significant, reduction in overall cost of ownership.

L.F.M.

N80-28244# General Accounting Office, Washington, D. C. International Div.

US ENERGY ASSISTANCE TO DEVELOPING COUNTRIES: CLARIFICATION AND COORDINATION NEEDED Report to the Congress

28 Mar. 1980 72 p

(PB80-162720; ID-80-7) Avail: NTIS HC A04/MF A01 CSCL 05D

An assessment of U.S. energy assistance to developing countries is given. Primary Federal agencies involved include the Departments of State and Energy, the International Development Cooperation Agency, and the Agency for International Development. Energy assistance activities could be improved with the establishment of comprehensive U.S. policy, clarification of the roles and relationships of the agencies, and better coordination among involved agencies and international organizations. GRA

N80-28265*# Eaton Engineering and Research Center, Southfield, Mich.

SMALL PASSENGER CAR TRANSMISSION TEST-CHEVROLET 200 TRANSMISSION Final Report

M. P. Bujold Mar. 1980 381 p

(Contracts DEN3-124; EC-77-A-31-1044)

(NASA-CR-159835; DOE/NASA/0124-1; ERC-L1B-79168) Avail: NTIS HC A17/MF A01 CSCL 13F

The small passenger car transmission was tested to supply electric vehicle manufacturers with technical information regarding the performance of commercially available transmissions which would enable them to design a more energy efficient vehicle. With this information the manufacturers could estimate vehicle driving range as well as speed and torque requirements for specific road load performance characteristics. A 1979 Chevrolet Model 200 automatic transmission was tested per a passenger car automatic transmission test code (SAE J651b) which required drive performance, coast performance, and no load test conditions. The transmission attained maximum efficiencies in the mid-eighty percent range for both drive performance tests and coast performance tests. Torque, speed and efficiency curves map the complete performance characteristics for Chevrolet Model 200 transmission.

L.F.M.

SOLAR ENERGY

Includes solar collectors, solar cells, solar heating and cooling systems, and solar generators.

A80-32856 # Solar central receiver hybrid - A cost effective future power alternative. D. G. Beshore, C. N. Bolton, and J. E. Montague (Martin Marietta Aerospace, Denver, Colo.). *American Institute of Aeronautics and Astronautics, International Meeting and Technical Display on Global Technology 2000, Baltimore, Md., May 6-8, 1980, Paper 80-0841*. 8 p. 5 refs.

System analyses and conceptual designs of solar central receiver hybrid concepts using molten salt (60% NaNO₃, 40% KNO₃ by weight) and fossil fired nonsolar energy sources (coal, oil, or gas) have been performed. Analyses have developed plant configurations with various solar energy storage capacities and fossil fuels. Economic analyses support the final configuration selection based on minimization of the cost of energy produced from the plant. A 500 MWe commercial plant size installed for a 1990 initial year of operation is competitive with new coal, oil, and nuclear power generation sources. This hybrid plant will save an estimated 5 million barrels of oil per year. (Author)

A80-32867 # An experimental evaluation of thermosiphon solar water heaters with closed loop freeze protection. J. Bogart (Utah, University, Salt Lake City, Utah). *American Institute of Aeronautics and Astronautics, International Meeting and Technical Display on Global Technology 2000, Baltimore, Md., May 6-8, 1980, Paper 80-0869*. 11 p. 8 refs. NSF-supported research.

The purpose of this research was to examine the performances of two thermosiphon hot water heaters. One system ran a 50-50 ethylene glycol-water solution through a flat plate type collector and a copper coil heat exchanger placed inside the storage tank. The other system is conventional and ran the storage tank water through the collector with open pipes into and out of the storage tank (i.e. no heat exchanger). Obviously the heat exchanger system will perform less efficiently because of higher fluid viscosity and losses in the heat exchanger. But because this system will not freeze, it could be used in winter and doesn't need draining to prevent pipe freezing. The research centered on determining the exact extent of the decrease in efficiency of this type of system from the more conventional type of system. The results showed that the system with the heat exchanger performed, on the average, 9% less efficiently than the system without the heat exchanger. This figure is acceptable and such an ethylene glycol system is recommended for use in winter or when there is a possibility of freezing on cool nights from radiation losses. (Author)

A80-32933 A thin-film polycrystalline photoelectrochemical cell with 8% solar conversion efficiency. G. Hodes (Weizmann Institute of Science, Rehovot, Israel). *Nature*, vol. 285, May 1, 1980, p. 29, 30. 6 refs.

A thin-film polycrystalline CdSe(0.65)Te(0.35)/polysulfide-based photoelectrochemical solar cell with an energy conversion efficiency of up to 8% is presented. Cell electrodes were prepared by painting a slurry of sintered CdSe(0.65)Te(0.35) powder onto a Ti substrate and then annealing in an inert atmosphere and etching by various means. Solar efficiencies of the electrodes immersed in an aqueous electrolyte 1 M in KOH, Na₂S and S with a counter electrode of sulfide brass gauze of up to 5% were obtained following a HCl:HNO₃ etch, up to 5.5% following etching in dilute aqueous CrO₃ and up to 8.0% following photoetching and K₂CrO₄ treat-

ment. The spectral response of the anode in polysulfide solution exhibits a short-wavelength cutoff due to electrolyte absorption, a flat plateau region, and a fairly sharp long-wavelength cut-off indicating an effective band gap of about 1.45 eV, similar to that of CdTe. Output stability has been found to decrease with increasing output current, remaining stable for more than 21 h at a current of 20 mA/sq cm. A.L.W.

A80-33184 Solar industrial process heat. S. L. Sargent, B. H. Glenn, and D. W. Kearney (Solar Energy Research Institute, Golden, Colo.). *Environmental Science and Technology*, vol. 14, May 1980, p. 518-522.

The article reports on the Solar IPH (industrial process heat) Conference organized for the DOE's Agricultural and Industrial Systems Branch, which provided a forum for interaction between researchers and potential users of solar IPH systems. In addition, the status of existing IPH products was examined, and the technical readiness and expected future developments of solar IPH systems and components was reviewed. Attention is given to solar IPH field tests results, typical operating temperatures of solar IPH technologies, and market considerations. M.E.P.

A80-33401 Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volumes 1, 2 & 3. Congress sponsored by the International Solar Energy Society. Edited by K. W. Boer (Delaware, University, Newark, Del.) and B. H. Glenn (Solar Energy Research Institute, Golden, Colo.). Elmsford, N.Y., Pergamon Press, Inc., 1979. Vol. 1, 981 p.; vol. 2, 768 p.; vol. 3, 612 p. Price of three volumes, \$275.

Papers are presented on such topics as solar agriculture, fuels from biomass, photochemical and thermochemical processes, solar heating and cooling of buildings, solar air heaters, low temperature collectors, concentrator collector performance, linear concentrators, nonimaging optics, solar heat storage, open cycle cooling, solar/heat pump systems, and solar domestic water heaters. Also considered are solar ponds, industrial process heat, high temperature storage, design methods for solar thermal systems, concentrating optics, advanced receivers, controls for solar systems, solar energy in developing countries, passive systems, materials and innovative systems, and greenhouses and solariums. Photovoltaics is considered in detail. B.J.

A80-33402 Nitrogen fertilizer production by solar energy. R. W. Treharne, D. R. Moles, M. R. Bruce, C. K. McKibben (Charles F. Kettering Research Laboratory, Yellow Springs, Ohio), and B. K. Rein (Nebraska, University, Lincoln, Neb.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2-5. 7 refs. Research supported by the Rockefeller Foundation; Contract No. EY-76-C-02-4094.

A prototype system designed to produce nitrogen fertilizer on a farm using solar power has been developed for field testing. The system consumes only air, water, limestone and electrical power in the production of nitrogen fertilizer and is designed to be powered by a solar photovoltaic array. In the basic chemical process of the system, the nitrogen and oxygen in air are combined to produce nitrogen oxide by means of an electric arc driven by the solar array. The nitrogen oxides then are reacted with water and limestone to produce calcium nitrate fertilizer to be fed to crop land via a solar-powered irrigation system. (Author)

A80-33403 Development and evaluation of a multiple use solar energy system for agriculture. M. A. Hellickson, W. H. Peterson, and L. R. Verma (South Dakota State University, Brookings, S. Dak.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 6-9.

Solar energy has been shown to be a technically feasible alternative for crop drying and agricultural space heating applica-

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tions, but economics, engineering and optimization are preventing widespread application of this alternative energy resource. Research in the Department of Agricultural Engineering at South Dakota State University has led to a solar energy intensifier system that appears to have excellent potential for solving these problems. The system incorporates the low temperature rise and continuous air flow characteristics of crop drying and agricultural space heating applications with the economic advantages of a large area solar reflector to achieve significant system cost reductions and simplifications.

(Author)

A80-33404 **The application of existing solar energy collecting equipment in agriculture, horticulture and fishculture.** F. Vogt (Central London, Polytechnic, London, England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 10-14. 15 refs.

A80-33405 **Computer simulation for optimization of solar energy storage and utilization for crop drying in Ohio.** R. N. Misra and H. M. Keener (Ohio Agricultural Research and Development Center, Wooster, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 20-24. Research supported by the U.S. Department of Energy and U.S. Science and Education Administration.

A80-33408 **High intensity mass algae culture requirements and limitations.** G. L. Mauldin (New Mexico Solar Energy Institute, Las Cruces, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 41-45. 18 refs.

The design of algae culture units intended to maximize the growth of algae in sunlight is discussed, considering CO₂ and oxygen supply, culture depth, temperature control, and cell suspension density. Emphasis is placed on photosynthesis, photorespiration, the partial processes involved, rates of oxygenation of ribulose-1,5-bisphosphate, and the net quantities of ATP and NADPH which may be utilized from a given quantity of light with regard to C₄ and C₃ plants. It is shown that maximum efficiencies of solar energy conversion to chemical potential energy in biomass can only be achieved when the photon flux density is the rate-limiting factor, which requires that the O₂ and CO₂ concentrations at the carboxylation site must be maintained such that the carboxylase reaction is proceeding near maximum rate, and the oxygenase activity is completely or nearly completely inhibited. J.P.B.

A80-33421 **Association of chlorophyll with surfactants on a particle surface.** G. R. Seely (Charles F. Kettering Research Laboratory, Yellow Springs, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 112-116. 11 refs.

The proposed model system for the imitation of photosynthesis employs polyethylene particles swollen to about four times their dry volume with a low molecular weight diluent, such as undecane. Spectra of chlorophyll absorbed to these particles are characteristic of the surfactant adsorbed with it; the pigment remains strongly fluorescent at relatively high surface coverages. Chlorophyll adsorption data are presented for various concentrations of N,N-dimethylmyristamide, a non-ionic surfactant. V.L.

A80-33423 **Chemical heat pumps using a slurry of metal salt ammoniates in an inert solvent.** W. E. Wentworth, D. W. Johnston (Houston, University, Houston, Tex.), and W. M. Raldow (Kungl. Tekniska Hogskolan, Stockholm, Sweden). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June

1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 122-125. 6 refs. Contract No. N68305-77-C-0043.

The decomposition of metal salt complexes can be used in chemical heat pump reactions for solar heating and cooling. It is shown that the decomposition of CaCl₂.8NH₃ and SrCl₂.8NH₃ can be carried out effectively as a slurry or suspension in an inert solvent. The reaction rates are increased by an order of magnitude and the reactions appear to be more complete. Three solvents were considered and the results showed that the nature of the solvent is important. (Author)

A80-33425 **Feasibility of a large scale solar power generation system suitable for the arid and semi-arid zones.** D. P. Rao, S. V. Babu, and V. S. Rao (Indian Institute of Technology, Kanpur, India). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 130-134.

A80-33426 **Heat and mass transfer analysis of a chemical converter/heat exchanger for the SO₂/SO₃ distributed solar energy collection system.** C. H. Li and E. W. Schmidt (Rocket Research Co., Redmond, Wash.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 135-139. 8 refs. Contract No. N00173-78-C-0272.

Three different designs of chemical converter-heat exchangers, as applied to a SO₂/SO₃ distributed solar energy collection system, were studied. All three designs comprise spiral passages wound around a cylindrical cavity into which the sunlight is focused. The innermost passage serves as the chemical converter, while the remaining outer passages serve as the heat exchanger. Detailed mathematical models are developed to predict and compare the steady-state performances of the chemical converter-heat exchangers. The results of the models indicate that significant mass transfer resistance exists between the fluid and the catalyst wall coating. They also indicate that the reverse reaction of SO₂ recombining with O₂ could be important near the exit of the chemical converter. Unfortunately this effect has been neglected in the existing kinetic data. (Author)

A80-33427 **Solar energy collection using the reversible ammonia dissociation reaction.** J. H. Wright and T. G. Lenz (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 140-144. 8 refs.

An experimental program has been developed to verify the predicted performance of a solar-thermochemical receiver utilizing ammonia as the working fluid in a closed-loop energy collection and transport system. Specifically, a 10 kW(th) NH₃ dissociation reactor-heat exchanger assembly has been designed. It consists of 43 catalyst filled tubes mounted around the perimeter of a one foot diameter cavity. A counter-flow heat exchanger wraps around the assembly to transfer the sensible heat from the exiting dissociated gas mixture to the incoming ammonia. In addition, a single-tube experiment has been designed to simulate a single tube of the 10 kW(th) reactor to provide design verification information. (Author)

A80-33428 **Ammonia dissociation for solar thermochemical absorbers.** O. M. Williams and P. O. Carden (Australian National University, Canberra, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 145-148. 5 refs.

A high pressure ammonia dissociator has been tested for solar thermochemical absorber operation. High thermal energy storage efficiencies are obtained when the dissociation reaction proceeds towards completion. A 90% efficient long-life cavity absorber operated at the focus of a paraboloidal concentrator can be based on nickel alloy tube technology and has potential for meeting a cost

goal of 10 US dollars per square metre of collector area. The stored chemical energy is transported to a central plant where high grade heat is released during ammonia synthesis. It is shown that the maximum value of available work defined by the Gibbs' free energy change for the synthesis reaction may be approached provided the temperature profile of the synthesis reactor is suitably tailored. The sources of available work are identified in order to facilitate matching the high grade heat output to the input of a heat engine.

(Author)

A80-33429 **Development of the sulfuric acid-water chemical heat pump/chemical energy storage system for solar heating and cooling.** C. C. Hiller (Sandia Laboratories, Livermore, Calif.) and E. C. Clark (Rocket Research Co., Redmond, Wash.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 149-153. 9 refs. Research supported by the U.S. Department of Energy.

A80-33430 **Moderate temperature solar thermochemical systems - An application of Diels-Alder chemistry.** T. G. Lenz and L. S. Hegedus (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 154-158. 17 refs.

Diels-Alder systems are investigated with regard to their thermodynamic, kinetic, and physical properties. Liquid phase Diels-Alder chemistry, with reversible catalytic reactions available over the temperature range of 100-500 C, could be useful in solar-chemical energy conversion systems. Characteristics are given for the 1,3 cyclooctadiene-diethyl maleate-adduct system chosen on the basis of best-estimate match of the criteria used to evaluate solar thermochemical systems. A need for further laboratory research is emphasized. V.L.

A80-33431 **Solar flash pyrolysis of biomass.** M. J. Antal, Jr. (Princeton University, Princeton, N.J.), M. Rodot, C. Royere, and A. Vialaron (CNRS, Odeillo, Pyrénées-Orientales, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 159-163. 26 refs. Research supported by the Solar Thermal Test Facilities Users Association and Centre National de la Recherche Scientifique.

The use of solar heat for biomass gasification is discussed with reference to the chemistry of the process and projected economics of solar powered biomass gasification systems. Particular consideration is given to flash pyrolysis by direct solar gasification which is the most economical method of biomass gasification. The cost of the gas derived from wastes is estimated at \$2.85 per MM Btu and the cost of the power tower is found to be a fraction of the overall cost of the facility. V.L.

A80-33432 **Australian programme for solar heating and cooling.** W. R. W. Read (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 168-172.

A80-33434 **Solar City - Mount Cotton.** S. V. Szokolay (Queensland, University, Brisbane, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 178-182.

The design of a solar demonstration house built for the proposed Solar City project near Brisbane is presented. The solar systems of the house include space heating and air conditioning, hot water supply (coupled to the above), swimming pool heating system, and a token amount of photovoltaic electricity generation. The main criterion of the design is the thermal efficiency of the building.

Design data are given for the generator, evaporator, condenser and absorber. V.L.

A80-33435 **The Belgian solar heating R & D program.** A. Pilatte (Mons, Faculté Polytechnique, Mons, Belgium). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 183-186.

A80-33438 **Solar energy projects for heating of buildings in Germany.** F. J. Friedrich (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 195-199.

A80-33439 **French programs of research and experimentation aiming at the development of solar energy in buildings.** M. Bellanger (Commissariat à l'Energie Solaire, Paris, France), M. Rodot (CNRS, Paris, France), and J. P. Marie (Ministère de l'Équipement, Paris, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 200-203.

A80-33440 **Industrial solar energy activity in Monaco.** J. H. Millar (Flextube, S.A., Monaco). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 210-214.

A80-33447 **Derivation of efficiency and loss factors for solar air heaters.** B. F. Parker (Kentucky, University, Lexington, Ky.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 244-248. 8 refs.

A80-33448 * **The effects of air leaks on solar air heating systems.** R. Elkin and M. Cash (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 249-253. 5 refs.

This paper presents the results of an investigation to determine the effects of leakages in collector and duct work on the system performance of a typical single-family residence solar air heating system. Positive (leakage out) and negative (leakage in) pressure systems were examined. Collector and duct leakage rates were varied from 10 to 30 percent of the system flow rate. Within the range of leakage rates investigated, solar contribution to heated space and domestic hot water loads was found to be reduced up to 30 percent from the no-leak system contribution with duct leakage equally divided between supply and return duct; with supply duct leakage greater than return leakage a reduction of up to 35 percent was noted. The negative pressure system exhibited a reduction in solar contribution somewhat larger than the positive pressure system for the same leakage rates. (Author)

A80-33449 **New air-heating collector design and performance.** H. Koizumi, Y. Kawada, K. Matsui, and T. Ariga (Toshiba Corp., Consumer Products Engineering Laboratory, Kawasaki, Japan). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 254-258. 5 refs.

Thermal performance data are presented for a solar collector consisting of a glass cover, a transparent plastic film, and a corrugated aluminum absorber. Outdoor tests were performed, and results were compared with those for three other collectors. Results show that, under typical operating conditions, the new collector has a 16% greater efficiency than the collector used in the first Toshiba solar house. Its light weight, easy assembly, and lower cost make it suitable for many applications. B.J.

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A80-33450 The characterization of crushed glass as a transpired air heating solar collector material. R. K. Collier (California, University, Los Alamos, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 264-268. 3 refs. Research sponsored by the U.S. Department of Energy.

The use of crushed glass matrices as the heat-absorbing media in air heating solar collectors is investigated. An experimental program was undertaken to characterize the most likely candidate glass types and sizes by measuring pressure drops, optical extinction coefficients, and volumetric heat transfer coefficients. Bed efficiencies were also measured and found to be similar to those expected for screen matrices unless critical amounts of clear glass were used as a top layer, which results in lowered efficiency. (Author)

A80-33451 Design and performance of a roof integrated solar air heater. M. K. Peck and D. Proctor (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 269-273. 13 refs.

A closed-loop space heating system is presented which combines solar air heaters and a rockbed thermal store located under the floor of the house. The system heats the rooms by radiation and convection from the floor and so avoids the need for some of the ductwork and controls used in conventional solar air-heating systems. A mathematical model is proposed for the evaluation of different integrated roof collector designs and for the comparison of the predicted and the measured performance. The limited experimental data presented validate the mathematical model used to design the air heater. V.L.

A80-33452 An experimental investigation into the effect of plate thermal capacity on the performance of solar water heating systems. A. W. K. MacGregor (Napier College, Edinburgh, Scotland). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 278-282. Research supported by the Science Research Council of England.

A80-33453 Experimental study on flow distribution in channels of flat-plate solar collectors using I.R. thermography. R. Lazzarin (Padova, Università, Padua, Italy), M. Pacetti, and G. Latini (Ancona, Università, Ancona, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 283-287.

A80-33454 Theoretical and experimental investigation of the flow in a flat plate collector. A.-M. Dalbert-Conseil, J.-L. Peube, F. Penot, and J.-F. Robert (Poitiers, Université, Poitiers, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 288-292. 5 refs.

A80-33455 Forced convection in solar collectors. D. M. McEligot (Arizona, University, Tucson, Ariz.) and C. A. Bankston (California, University, Los Alamos, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 293-297. 10 refs. Research supported by the U.S. Department of Energy, University of Arizona, and NSF.

The sensitivity of the solar collector performance to the forced convective heat transfer between an absorber and coolant is studied. It is concluded that the thermal performance of water-cooled flat plate collectors is generally insensitive to the internal forced convective problem. V.T.

A80-33456 Analysis of matrix air heaters. D. A. Neeper (California, University, Los Alamos, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 298-301. 5 refs. Research supported by the U.S. Department of Energy.

By using a physical analogy, this paper develops an analytic expression that approximates Beckman's (1978) calculated bed efficiency. This analytic expression for bed efficiency should be useful for computation of overall collector efficiency. Furthermore, it is shown that under certain stringent assumptions the bed efficiency may be compared with the flat-plate collector parameter $F(R)$ in order to compare the expected performance of a matrix collector with that of a flat plate. (Author)

A80-33457 Thermal performance of compounds used to improve heat transfer in solar collectors. S. A. Mumma (Arizona State University, Tempe, Ariz.) and D. G. Hansen (Tennessee Valley Authority, Knoxville, Tenn.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 307-311.

The thermal conductances of potential thermal conducting materials for the improvement of heat exchange between the absorber plate and the heat transfer fluid in solar collectors are measured. Thermal conductances of the Therman heat transfer cements T-802, T-85 and E-1, the Devcon plastic steels A and SF, bronze putty R, plastic aluminum F, lead putty L and stainless steel putty ST, Wakefield thermal conducting paste and Pelco colloidal silver paste were determined from the heat flux through two copper bars joined by the heat transfer material. Conductances are found to range between 1063.5 and 3836.1 W/sq m per C, and to represent an order of magnitude improvement over the lack of a conducting material. Calculations for specific absorber designs show 13-77% increases in total useful collector gain brought about by the use of the material found to have the highest conductance, Therman T-802. A.L.W.

A80-33458 Heat transfer through collector glass covers. K.-E. Hassan (Centre for Solar Energy Studies, Tripoli, Libya). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 312-316. 7 refs.

Analysis is carried out for radiant exchange between two parallel isothermal plates of infinite dimensions separated by a number of transparent absorbing surfaces, taking into consideration the conductance between the surfaces involved. An extension of the so-called 'radiosity method' is used and the problem is expressed as a system of algebraic equations. In the absence of conductance, these equations are linear and could be put in a more convenient dimensionless form. The solution for the special case of solar collector covers made of a number of transparent (usually glass) plates is solved and compared with the results in the literature. A solution is also given for the temperature distribution within a thick plate subjected to radiation and conductance. (Author)

A80-33459 Three dimensional ray tracing through concentric tubular elements using vector methods. S. H. Janke (Montana State University, Bozeman, Mont.) and R. F. Boehm (Utah, University, Salt Lake City, Utah). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 317-321.

Using vector methods, a three dimensional ray trace is developed for a direct ray incident upon a tubular element of circular cross section. This ray approaches the element in a plane not perpendicular to the long axis, but rather in a plane always parallel to that axis. Relations are developed for the various angles of incidence and refraction as the ray is partially transmitted and/or internally reflected, for its in-glass path length, and for the minimum distance from the fraction passed to the interior cavity and the long axis. The

results are useful in determining a transmittance absorptance product for such an element with concentric absorber of circular section.

(Author)

A80-33460 Cylindrical glass tubes for flat plate collector covers. W. M. Worek and Z. Lavan (Illinois Institute of Technology, Chicago, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 322-326.

A80-33461 The effect of pressure on the performance of cylindrical solar collectors. W. M. Worek and Z. Lavan (Illinois Institute of Technology, Chicago, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 327-330.

The combined effect of vacuum and a selective absorbing surface is extensively used in high temperature solar collectors. In the analysis of such collectors it is usually assumed that radiation is the primary mode of heat loss and that all other modes of heat transfer can be neglected. The present work is concerned with the variation of collector heat loss with pressure in the annulus between the absorber and the outer glass envelope of a single Owens-Illinois Sunpak collector tube. In particular, the results show the effect of pressure on conduction heat loss and the pressure level at which conduction heat loss can be neglected.

(Author)

A80-33462 Effect of off-south orientation on optimum conditions for maximum solar energy absorbed by flat plate collector augmented by plane reflector. I. S. Taha and S. M. Eldighidy (King Abdul Aziz University, Jeddah, Saudi Arabia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 332-336. 9 refs.

A80-33463 The unitary solar collector - A new approach to low-cost, flat-plate systems. R. A. Erb (Franklin Institute, Philadelphia, Pa.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 338-341.

The unitary solar collector is a seamless, glazed, flat-plate collector panel coextruded from thermoplastic material (e.g., clear UV-stabilized and black polycarbonate for an air-heating system). The advantages of this new system include: low cost, light weight, good structural strength, capability for mass production, and design possibilities not practical with conventional systems. Prototype panels (10 cm wide) have been coextruded in polycarbonate. A small-scale test in Florida under stagnant flow conditions for over 2.5 years (reaching temperatures to 137 C) has shown that the panels withstand these severe conditions.

(Author)

A80-33464 Low cost high temperature adhesive bonded solar collectors. R. E. Dame and J. J. Dalton (Mega Engineering, Silver Spring, Md.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 343-347. 17 refs.

A80-33465 Integration of solar collectors in large prefabricated roof/wall sections. D. L. Spencer (Iowa University, Iowa City, Iowa) and R. A. Strub (Component Homes, Inc., Iowa City, Iowa). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 348-352.

A80-33466 Testing the performance of solar collectors under standard conditions. W. Dittes and D. R. Goettling (Stuttgart, Universität, Stuttgart, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 355-359. 11 refs.

The paper compares standard test procedures for solar collectors as proposed by ASHRAE/NBS, BSE, DFVLR, and NASA. ASHRAE/NBS recommend outdoor tests, while BSE admits both outdoor and indoor tests. According to DFVLR and NASA, solar collectors are tested with a solar simulator. In two cases the efficiency is calculated by the quotient of the useful heat rate and the incident radiation. In the third case, the efficiency is computed using the difference of the maximum useful heat rate and the rate of heat loss divided by the incident radiation. Consideration is given to the measurement of the rate of heat loss, determination of the standard flow rate and other standard conditions, and the determination of the efficiency curve.

V.L.

A80-33467 Equations for representing the UL-dependence in collector test procedures. E. C. Shewen and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 360-364. 10 refs.

Various methods of accounting for collector heat loss coefficient variability are reviewed. A new method is presented which is particularly suited to being implemented in the three-factor test procedure described by Smith and Weiss (1977).

V.T.

A80-33468 Tests of all-day collector performance. C. D. Beach, J. C. Huggins, and J. D. Roland (Florida Solar Energy Center, Cape Canaveral, Fla.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 370-374.

As part of a program to evaluate collectors used in the national solar heating and cooling demonstration program, 23 flat-plate collectors were tested for efficiency while they operated for an entire day at a constant inlet temperature and flow rate. As many as four all-day tests were performed on some of the collectors to provide data at different operating temperatures and for various types of days. When efficiencies are referenced to ambient temperature and total available solar irradiance, in a manner analogous to the plots of ASHRAE collector efficiency data, results show a performance advantage for glass covers as compared to plastic. Results also show a wide variation in performance among collectors with selective absorber surfaces but much less variation among those with flat black coatings. While the all-day test data are easier to interpret than ASHRAE performance curves, and also simplify collector comparison, more test time is required to make a conclusive evaluation.

(Author)

A80-33469 Experimental evaluation of zero radiation heat loss testing of rear duct air-heating solar collectors. P. P. Yaneske and I. C. Wiles (Strathclyde, University, Glasgow, Scotland). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 375-379. 5 refs. Research supported by the Glynwed Group Services.

A80-33470 CSIRO collector test facilities. D. Proctor and M. K. Peck (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 380-384. 13 refs.

The paper describes the collector testing facilities used by the CSIRO Division of Mechanical Engineering in Australia. It is shown that the equipment is used to obtain the absolute performance characteristics of solar collectors for research purposes, and on a 'fee for service' basis for manufacturers. The high temperature test rig and the solar simulator are described, as well as the test procedure and data reduction.

M.E.P.

A80-33471 Laboratory tests for flat plate solar collectors. K. Kraus, E. Hahne, and J. Sohns (Stuttgart, Universität, Stuttgart,

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West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 385-389. 8 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045-A.

A80-33472 Proposed method for testing of radiative cooling flat-plate collectors. H. L. Connell and G. T. Pytlinski (New Mexico State University, Las Cruces, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 391-395. 11 refs.

A80-33473 An evaluation of the influence of heat transfer fluid properties and flow rate on flat plate solar collector efficiency. W. Youngblood, W. Schultz, R. Barber (Wyle Laboratories, Huntsville, Ala.), and E. R. Streed (National Bureau of Standards, Center for Building Technology, Washington, D.C.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 396-400. Contract No. EG-77-C-01-4050.

A80-33474 Weatherability test of plastic glazing materials for collectors. A. F. Clark (California, University, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 401-404. Contract No. W-7405-eng-48.

Various plastics were tested by exposing them to direct sunlight (about 8 suns) and also to accelerated weathering. The plastics tested included acrylics, weatherable vinyl (PVC), polyethylene (PE), polypropylene (PP), Tedlar coated fiberglass, and Tedlar coated vinyl. Comparable exposures gave consistent degradations. Heat seals degraded rapidly, especially at the edges. Acrylics lasted for the equivalent of 20 years; weatherable PE performs adequately for about a year, weatherable PVC for two years, Tedlar coated PVC for eight years. B.J.

A80-33475 Results of long term natural weathering effects on solar collectors under stagnation conditions. B. Henderson, W. E. Schultz, and R. Barber (Wyle Laboratories, Huntsville, Ala.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 405-407.

A80-33476 A method for balancing flow rates in rows of parallel collectors. R. T. Lydon, R. P. Smith, and E. M. Barber, Jr. (Sunsearch, Inc., Guilford, Conn.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 408-412. Research supported by Enthone, Inc.

The development of a method for balancing flow rates in long rows of parallel-plumbed, liquid cooled solar collectors is described. The development effort involved computer simulations, testing and hardware development. The advantages of this method include increased thermal efficiency of long rows of solar heat collectors, ease of use, low cost, and ability to fit into internally manifolded collectors. (Author)

A80-33477 Small-scale solar simulator for indoor testing of collector modules and materials. D. P. Grimmer and L. Bronisz (California, University, Los Alamos, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 413-416. 6 refs. Research sponsored by the U.S. Department of Energy.

A small-scale solar simulator has been constructed for the indoor testing of collector modules and materials at LASL. The simulator design follows general construction guidelines suggested in the work of Yass and Curtis of NASA-Lewis, but modifications were necessary to insure a + or - 10% uniform flux over a 0.1 sq m area.

Considerable adjustments were necessary to achieve desired performance for the testing of collector modules and materials. These adjustments and details of simulator construction, including design schematics and simulator mounting, are described. Also presented are flux maps for the twelve-lamp array. Finally, construction materials costs are discussed for this inexpensive solar simulator suitable for many testing applications. (Author)

A80-33478 Design of an inexpensive solar simulator. P. Krusi and R. Schmid (Sydney, University, Sydney, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 417-421. 9 refs. Research supported by the University of Sydney.

An inexpensive solar simulator (about \$10,000 Australian) has been developed for an indoor solar collector test facility. The light subsystem of the simulator employs 18 compact source iodide 1000-W lamps mounted in a hexagonal pattern on a yoke. These lamps are sealed beam discharge lamps of the metal halide type, which provide good spectral match to sunlight, require no maintenance, have compact size, low cost, and a lifetime expectancy of 1000 hr. Results are presented for a single glass, selective flat-plate collector tested on the solar simulator as well as on an outdoor test rig. V.L.

A80-33479 Prediction of long-term performance of closed-loop concentrating solar collector systems. W. A. Ryan, S. A. Klein, and W. A. Beckman (Wisconsin, University, Madison, Wis.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 430-433. 7 refs.

A80-33480* Analysis and two years of testing of the vee-trough concentrator/evacuated tube solar collector. M. K. Selcuk and A. Aghan (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 434-438. 5 refs. Contract No. E(49-26)-1024.

The paper summarizes the mathematical analysis and presents the experimental results for a vee-trough/evacuated tube collector (VTETC). Test results reported represent the performance of the VTETC based on an aperture area. The effectiveness of vee-trough reflectors is demonstrated by comparing the useful heat collected by a receiver tube with and without concentrators. V.T.

A80-33481 Evaluation of linear concentrating collectors. S. M. Jeter (Georgia Institute of Technology, Atlanta, Ga.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 439-443. 10 refs.

A modeling procedure particularly useful for linear concentrating collectors is presented. Thermal, hydraulic, and optical (including off-normal degradation) effects can be considered. Example evaluation of performance parameters and collector output projections are presented. (Author)

A80-33482 A data analysis program for collector testing. J. H. McDowell and R. B. Uselton (Northrup, Inc., Hutchins, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 444-448.

A sun-collector data analysis program is presented which accurately calculates specific volume and enthalpy, collector geometry and performance. Features used in the data analysis include a multivariate stepwise regression program which may be used for statistical analysis of specified parameters. This module provides a statistical method for determining correlation between all parameters and shows the least squares fit to a line between the dependent and the independents. The program also provides the user with the ability

to perform hourly or daily integration on a number of specified parameters. A collector performance predictor equation is derived using heat loss and heat collection data sets. V.L.

A80-33483 Design and development of a paraboloidal dish solar collector for intermediate temperature service. D. A. Kugath, G. Drenker, and A. A. Koenig (General Electric Co., King of Prussia, Pa.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 449-453.

A80-33484 Economic analysis of a point focusing concentrating collector system. W. E. Rogers, D. N. Borton, M. P. Rice (Rensselaer Polytechnic Institute, Troy, N.Y.), and R. J. Rogers (Power Kinetics, Inc., Troy, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 454-458. Research supported by the U.S. Department of Energy and New York State Energy Research and Development Authority.

An analysis of a point focusing concentrating collector system is presented. A 70 kW thermal parabolic Fresnel reflector point focusing concentrating solar collector developed for the business community is described; the factors of risk, use of land, capital costs, working capital requirements, solar system performance, and solar availability are discussed. An example is given of a company requiring 760 megawatt hours of steam a year which would return energy at the cost of \$9.20 per megawatt hour. A.T.

A80-33485 Suntec/Hexcel parabolic trough. G. G. Brucker and J. H. Davison (Suntec Systems, Inc., St. Paul, Minn.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 459-463.

The paper presents the technical data on the line-focusing collectors with single-axis tracking and the experimental tests to demonstrate the effects of collector spacing and orientation on annual energy output. Solar energy must be capable of supplying energy to the industrial process market which will require temperatures over 500 F; these can be supplied by such line-focusing collectors. The collector layout, the receiver assembly and the collector testing are discussed concluding that the physical layout is one of the most significant variables which can affect the performance of a solar collector system. A.T.

A80-33486 Analysis of experimental test results on a high temperature receiver model. G. Francia (Genova, Università; Ansaldo S.p.A., Genoa, Italy), A. Barutti, and R. Floris (Ansaldo S.p.A., Genoa, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 464-468.

This paper presents some of the results obtained from the experimental tests on a high-temperature receiver model within the frame of EEC Demonstration Solar Power Plant Project. The main results presented are related to the influence of an anti-radiating structure on the receiver efficiency; the validation of computer programs for calculating the solar energy density distribution on the absorbing pipes, and the definition of a philosophy for the control system of a water-steam cooled solar receiver. (Author)

A80-33487 Environmental testing of solar reflector structures. R. E. Allred, D. W. Miller, and B. L. Butler (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 472-476. 10 refs. Contract No. DE-AC04-76DP-00789.

The reflector support structure of a concentrating solar collector provides and maintains the required shape for the reflective surface; it must perform its functions to the required accuracy over a 20-30 year life cycle with a minimum of maintenance. A program to determine the aging behavior of candidate reflector support materials

and processes has been conducted since 1975. Materials evaluated include laminates, sandwiches and molded structures constructed of metals, ceramics, forest products and fiber-reinforced composites. Accelerated temperature-humidity cycling data and real time exposures indicate that a variety of material constructions may eventually meet the operational and lifetime requirements. Constructions which performed well in this study include plywood, fiberglass skin and core sandwiches, melamine skin/paper core sandwiches, aluminum skin/aluminum core sandwiches, and molded structures of sheet molding compound with integral ribs. The data also indicate that designers should be particularly concerned about maintaining thermal compatibility throughout the reflector structure, producing high integrity adhesive bonds, protecting the reflective surface from corrosion and using moisture-insensitive materials. (Author)

A80-33488 Midtemperature Solar Systems Test Facility /MSSTF/ system test results, winter season. T. D. Harrison and W. H. McCulloch (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 477-481. 6 refs. Contract No. DE-AC04-76DP-00789.

A80-33489 Theoretical and experimental study of parabolic troughs and paraboloidal dish concentrators with plane absorbers. A. Lucifredi, E. Ravina (Genova, Università, Genoa, Italy), M. Bisagni, and P. Castellazzi (Ansaldo S.p.A., Genoa, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 482-486.

A80-33490 Application of ASHRAE Standard 93-77 for testing concentrating collectors for the purpose of predicting all day performance. B. D. Wood, P. J. Fiore, and C. R. Christopherson (Arizona State University, Tempe, Ariz.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 487-491. 10 refs. Research supported by the U.S. Department of Energy.

A80-33491 Low cost, low technology 3.4x concentrating collector for industrial/agricultural applications. A. F. Naccach (Aton Solar Manufacturing, Novato, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 492-495. 14 refs.

A80-33492 * Low cost vee-trough evacuated tube collector module. M. K. Selcuk (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 496-500.

A low cost solar collector capable of operating at 150-200 C is described. An evacuated tube receiver is combined with asymmetric vee-trough concentrators. Peak efficiencies of about 40% at 120 C and 30% at 180 C are expected. Predicted future collector cost is \$70/sq m which yields an energy cost of \$4.20/GJ at 120 C. During the development of the vee trough/evacuated tube collector both mathematical models to predict thermal and optical performance were developed and tests run to verify theory. The asymmetric vee trough concentrator increases the solar flux intensity for an average value of 2 for year-round performance. Optimized collector module has reflector angles of 55 deg/85 deg. The aperture plane is tilted to the latitude. The reflector is made of electropolished aluminum. The supporting frame is formed by bending sheet metal. Evacuated tube receivers are Pyrex, 15 cm diam and 2.4 m long. The module has 12 tubes on right and left sides altogether. Attainable operation at temperatures on the order of 150-200 C are suitable for absorption refrigeration and power generation via Rankine engines. (Author)

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A80-33493 **Nonevacuated high temperature linear Fresnel lens and second stage CPC type collector with large tolerance for tracking errors.** M. Collares-Pereira (Chicago, University, Chicago, Ill.; Centro de Fisica da Materia Condensada, Lisbon, Portugal), J. O'Gallagher, A. Rabl, and R. Winston (Chicago, University, Chicago, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 501-505. 11 refs. Contract No. EY-77-S-02-2446.

The paper describes the fabrication and testing of a prototype ideal type collector, consisting of a nonimaging Fresnel lens and a secondary concentrator of the compound parabolic concentrator (CPC) type with a tubular receiver. The geometric concentration ratio is 16, which is the maximum possible concentration consistent with the requirements that (1) the collector perform properly with a fixed tilt position for the tracking axis (polar mount), and (2) the tracking be accomplished by means of a simple clock drive. The test results confirm the large acceptance angle of the design (6 deg). B.J.

A80-33494 **Development of a 3X CPC with evacuated receiver.** R. W. Ballheim (Chamberlain Manufacturing Corp., Waterloo, Iowa). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 506-510. Contract No. ET-78-C-04-4239.

This paper presents some of the considerations involved in the design and development of a 2.6X compound parabolic concentrator (CPC) with an evacuated receiver. A truncated version of a CPC trough reflector system and the General Electric Company tubular evacuated receiver have been integrated with a mass producible collector design suitable for operation at 250 to 450 F. The key criterion for optimization of the design was minimization of the cost per BTU collected annually at an operating temperature of 400 F. A ray tracing program was used in conjunction with a heat gain math model to compare the effect of collector parameters on the annual performance of the collector. The parameters studied included CPC acceptance angle, truncation height, reflector error, receiver placement error, glazing transmissivity, receiver tube transmissivity, reflector material reflectivity, and insolation diffuse/beam-ratio. An optimum design is selected and performance predictions on an annual basis are presented for specified design conditions. (Author)

A80-33495 **Experimental and theoretical evaluation of a novel concentrating solar energy collection system.** A. B. Maish and J. T. Beard (Virginia, University, Charlottesville, Va.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 511-515. Research supported by the Solar Associates Co.

A new concentrating solar energy system was evaluated theoretically and experimentally at the University of Virginia Solar Test Facility. The modular, two-axis tracking collector combined an aluminized mylar reflector with a flat-plate absorber. Radiation collected from the 7-sq-m frontal area was concentrated by a factor of five, making the collector suitable for intermediate temperature applications. The thermal performance of the collector was determined theoretically on a digital computer using a nodal approach to model the heat transfer processes. Collector sensitivities to environmental parameters were calculated. An experimental testing program conducted according to the ASHRAE testing standards verified the predicted results. (Author)

A80-33496 **Optical analysis of the fixed spherical mirror/tracking linear receiver solar concentrator including statistically distributed reflector slope errors.** M. J. O'Neill (E-Systems, Inc., Energy Technology Center, Dallas, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 516-520.

A80-33497 **Cylindrical 'elastical' concentrating solar collectors.** J. F. Tan, D. Langridge, C. D. Letham, and P. G. McCormick

(Western Australia, University, Nedlands, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 522-525. Research supported by the Solar Energy Research Institute of Western Australia.

The paper includes a theoretical analysis of the elastical shape and gives examples of computed ray traces plotted for various rim angles. Also included is a theoretical plot of incidence factor versus concentration ratio for three different rim angles. Experimental performance figures for an elastical collector are presented for two different concentration ratios. (Author)

A80-33498 **Parabolic trough collector with thermal or photovoltaic receiver.** G. Bado, R. Floris, and G. Tomei (Ansaldo S.p.A., Genoa, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p.

526-530.

The paper describes a universal parabolic trough collector which is suitable to concentrate solar radiation onto both a strip of photovoltaic cells or the opening of a thermal linear cavity receiver. A supporting structure and receivers can be used at every latitude with only a few modifications of the construction layout. V.T.

A80-33499 **A unique new Fresnel lens solar concentrator.** M. J. O'Neill (E-Systems, Inc., Energy Technology Center, Dallas, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 531-535.

A new Fresnel lens solar concentrator has been developed. The design of each prism in the lens has been optimized for maximal transmittance. Additionally, the new lens provides a smaller solar image and allows shorter focal lengths to be used than for prior lenses. A prototype combined photothermal/photovoltaic collector has been built and successfully tested, fully confirming the theoretical performance of the new concentrator. The paper presents the theory, configuration and performance of the new concentrator. (Author)

A80-33500 **Hybrid silicone-glass Fresnel lens as concentrator for photovoltaic applications.** E. Lorenzo and G. Sala (Madrid, Universidad Politécnica, Madrid, Spain). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 536-539. 8 refs.

A80-33501 **Applications of CPC's in solar energy - An overview.** M. Collares-Pereira, J. O'Gallagher, A. Rabl, R. Winston (Chicago, University, Chicago, Ill.), R. Cole, A. Gorski, W. McIntire, K. Reed, and W. Schertz (Argonne National Laboratory, Argonne, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 542-546. 19 refs. Contracts No. EY-76-S-02-4446; No. W-31-109-eng-38.

The principles of compound parabolic concentrators (CPC) are outlined. CPC thermal collectors with evacuated and nonevacuated receivers are discussed. Consideration is given to photovoltaic applications, second stage concentrators, and asymmetric CPCs. V.T.

A80-33502 **Incidence angle modifier and average optical efficiency of parabolic trough collectors.** H. Gaul and A. Rabl (Solar Energy Research Institute, Golden, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 547-551. 12 refs. Contract No. EG-77-C-01-4042.

A80-33503 **The geometrical vector flux and some new nonimaging concentrators.** R. Winston (Chicago, University, Chicago, Ill.) and W. T. Welford (Imperial College of Science and Technology, London, England). In: Sun II; Proceedings of the Silver Jubilee

Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 552-556. 7 refs. Research supported by the U.S. Department of Energy.

In the present paper, the geometrical vector flux - a quantity related to measures of illumination - is defined, and some of its properties are used to develop new forms of nonimaging concentrators. It is shown that the lines of flow of the geometrical vector flux form no-flux surfaces along which, under appropriate conditions, mirrors can be placed without disturbing the flux field. V.P.

A80-33504 A stationary prism concentrator for solar cells. D. R. Mills, J. E. Giutronich, and E. Harting (New South Wales, University, Kensington, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 561-564.

A80-33505 Optical and thermal properties of truncated compound circular arc concentrators. R. E. Jones, Jr. and G. C. Anderson (Lakehead University, Thunder Bay, Ontario, Canada). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 565-569. 8 refs. Research supported by the National Research Council of Canada.

An economical way to form non-focusing concentrators would be to support aluminized plastic films at the edges, and inflate them into circular cylinders. Here, the optical and thermal properties of circular arc approximations to truncated compound parabolic concentrators are investigated. Annual solar fractions for residential heating loads are found to be nearly the same for low and medium concentrations. (Author)

A80-33506 A non-tracking inflated cylindrical solar concentrator. J. W. Gerich (California, University, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 570-574. 6 refs. Contract No. W-7405-eng-48.

A concentrating solar collector is being developed to produce pressurized hot water up to a temperature of 175 C. The collector structure consists mainly of an inflated thin-film plastic cylinder that is clear on the upper portion and is an aluminized reflector on the lower portion. The reflector concentrates sunlight on a receiver tube which is jacketed with a heat transfer suppressing, thin-film plastic cylinder. The first experimental collectors verified the performance modeling codes. The second generation collectors now being constructed address cost considerations and ease of fabrication, installation, and maintenance. It is found that the installed cost of the inflated concentrator is likely to be one-fifth that of parabolic trough concentrators. An experimental apparatus is built to measure the total hemispherical emittance of full size receiver tubes. Test results indicate a rather dramatic increase in the room temperature value at typical concentrator operating temperatures. (Author)

A80-33507 The actual benefits of thermally stratified storage in a small and a medium size solar system. C. W. J. van Koppen, J. P. S. Thomas, and W. R. Veltkamp (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 576-580. 5 refs.

Thermally stratified storage in solar power systems is examined, utilizing a simulation model and comparing results with previous observations made on two actual solar heating systems in the Netherlands. Although the benefits of stratification are small when the mass flow rate is large, the good agreement between the simulation and experimental results indicates that a more widespread utilization of thermally stratified storage in combination with much lower collector flow rates than usual will lead to considerable improvements in the performance of solar space heating and hot

water supply systems. Experiments have also shown that the floating inlet, which is a wide, thin-walled, flexible plastic hose connected to the inlet stud for delivering the hot water from the collector at exactly the level of temperature in the storage tank, improves the stratification by a factor of 2 compared to natural stratification.

J.P.B.

A80-33508 Economical optimum TES size via marginal analysis. W. Kahan and R. C. Estes (Singer Co., Fairfield, N.J.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 581-585. Contract No. EG-77-C-03-1467.

The paper presents an analytical derivation of the relationship between the economically optimum thermal energy storage (TES) size in a solar energy system and different parameters. These parameters are local weather persistence, solar energy collection efficiency, component costs, and energy cost. V.T.

A80-33509 Effects of baffles on thermal stratification in thermocline storage tanks. E. I. H. Lin and W. T. Sha (Argonne National Laboratory, Argonne, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 586-590. Research sponsored by the U.S. Department of Energy.

A80-33524 Open-cycle solar air conditioner. H. I. Robison, S. H. Houston (South Carolina University, Conway, S.C.), W. Harper (Horry-Georgetown Technical College, Conway, S.C.), J. W. Mitchell, M. J. Brandemuehl, and J. J. Jurinak (Wisconsin, University, Madison, Wis.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 667-669. Research supported by the Coastal Educational Foundation, Horry County Higher Education Commission, University of South Carolina, and Horry-Georgetown Technical College.

An open-cycle solar air conditioner is presented which uses rotary heat wheels to dehumidify the air and to recover the heat of sorption. The solar air conditioner will be used to obtain low temperature reactivation data for other combinations of sensible and latent heat wheels. This information will be used with the transient simulated computer program data to accurately simulate operation with different desiccants in various configurations. V.L.

A80-33525 Solar operated crossflow desiccant cooling system. V. Mei, W. Worek, B. Mathiprakasham, Z. Lavan, and D. Gidaspo (Illinois Institute of Technology, Chicago, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 671-675. Contract No. EG-77-C-03-1589.

A cross-cooled solar powered air conditioning system using silica gel is being studied. The system consists of two identical fixed bed dehumidifiers. One dehumidifies while the other is being regenerated. Cross-cooling is achieved with air flowing through rectangular channels and the process stream flows in perpendicular channels which are lined with paper-like sheets consisting of micron size silica gel particles held in a Teflon web. A prototype dehumidifier was constructed and tested and the results are compared with computer simulation predictions. A complete cooling system based on optimum COP and minimum pressure drop (for a given size) will be designed, built and tested. Preliminary calculations predict a COP of about 0.50 with 82 C regeneration temperature. Due to the low pressure drop in the channels the electric coefficient of performance (EER) is very high. (Author)

A80-33526 Solar cooling through cycles using microporous solid adsorbents. F. Meunier and B. Mischler (Paris XI, Université, Orsay, Essonne, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 676-680. 7 refs. Commission of the European Communities Contract No. 524-78-2-ESF.

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A80-33527 Design and operation of a liquid-desiccant type solar air conditioning system. A. Johannsen (South African Council for Scientific and Industrial Research, National Mechanical Engineering Research Institute, Pretoria, Republic of South Africa). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 681-685. 6 refs.

The design and operation of a full-scale experimental liquid desiccant-type solar air conditioning system is discussed. The system was designed for 20 kW of peak cooling capacity and 24 kW of peak heating capacity using 52 sq m of double glazed regenerating collectors and triethylene glycol as desiccant. The COP of the entire system defined as the ratio of the plant cooling capacity to the energy reaching the collectors, varied from 25 to 33 per cent at collector temperatures between 75 and 80 C and cooling tower leaving water temperature of 25 C. (Author)

A80-33528 Theoretical and experimental investigations of a countercurrent solar regenerator. P. Gandhidasan (University of the West Indies, Saint Augustine, Trinidad and Tobago), V. Sriramulu, and M. C. Gupta (Indian Institute of Technology, Madras, India). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 686-690. 5 refs.

The heat and mass transfer processes occurring in a countercurrent solar regenerator are investigated theoretically. The rate of mass transfer is predicted by determining the point of flow reversal and treating the region between the solution film and the point of flow reversal as a stagnant layer through which mass transfer takes place only by diffusion. The use of approximate as well as numerical methods in solving the governing equations is discussed. Experiments using calcium chloride solution as the absorbent, and conducted for different flow rates of solution and air have yielded results in agreement with theoretical predictions. In addition, the ratio of solution to air velocity is found to be an important parameter influencing performance. J.P.B.

A80-33529 Test results of the solar powered Rankine cycle refrigerator installed in the experimental house. E. Nishiyama, J. Kai, M. Sugihara, K. Kashiwamura (Mitsubishi Electric Corp., Central Research Laboratory, Amagasaki, Japan), and M. Ohtsubo (Mitsubishi Electric Corp., Consumer Products Research Laboratory, Kamakura, Japan). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 691-695. Research sponsored by the Ministry of International Trade and Industry of Japan.

The paper discusses the design principles and the structure of the solar powered heating and cooling system and Rankine cycle refrigerator used for two years in an experimental house. Flat plate-type solar collectors were used; for the high temperature storage material, water was used for the first year and ammonium alum the second, and the chilled water tank used water along with sodium acetate trihydrate as the heat storage material. Design conditions of the high temperature storage unit are given, including maximum storage enthalpy of 10,500 kcal at about 94 C. Attention is given to the Rankine cycle refrigerator, utilizing a two-fluids system and a sliding vane-type expander. The performance of the collectors, heat storage units, and refrigerator was found to be almost the same as shown by laboratory tests, while revealing no signs of deterioration. J.P.B.

A80-33530 Two stage evaporative cooling using a rockbed associated with the active clearview solar collector. J. F. Peck, H. J. Kessler, and T. L. Thompson (Arizona, University, Tucson, Ariz.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 697-701. Research supported by the Tucson Gas and Electric Co., Arizona Solar Energy Research Commission, University of Arizona, U.S. Department of Agriculture, and ERDA.

Two-stage evaporative cooling (TSEC) is discussed, as well as the design, behavior and performance of a rockbed as the storage medium, and the use of such systems in two homes in Tucson. TSEC is attained by precooling air without humidification before further cooling by evaporation; by integrating such a system with an active hot air solar space heating system, many of the same components are useful the entire year. Attention is given to the rockbed, which is constructed similarly to a standard 1.4 m deep basement, and the movement of heat through the rockbed is examined utilizing the thermal wave concept. TSEC performed well in the hot, dry climate of the Southwest, and the large rockbed is found essentially to add a third stage to standard TSEC since it makes use of cool nighttime temperatures produced by nocturnal radiation. J.P.B.

A80-33532 Experimental investigation on control modes for an absorption chiller of low capacity. R. M. Lazzarin (Padova, Università, Padua, Italy) and B. Boldrin (CNR, Laboratorio per la Tecnica del Freddo, Padua, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 710-714. Research supported by the Consiglio Nazionale delle Ricerche.

Various control modes have been examined for a solar-powered absorption chiller, via an experimental study on a water-lithium bromide absorption unit of low capacity. The efficiency of ON-OFF cycling is found to decrease strongly when ON-OFF frequencies or STOP length increase. Variation of the heating fluid flow rate to the generator is more suitable, but the control range is restricted. Also possible is heating fluid temperature variation, but transient operation may penalize performance. J.P.B.

A80-33533 Evaluation of performance enhancement of solar powered absorption chiller with an improved control strategy using the BNL-built hardware simulator. P. C. Auh (Brookhaven National Laboratory, Upton, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 715-719. Research sponsored by the U.S. Department of Energy.

A80-33534 Solar powered environment control - Criteria and realization. J. L. Lando, I. Vardi, J. M. Bourne, Y. Kimchi, J. Ben-Dror (TADIRAN Israel Electronic Industries, Ltd., Tel Aviv, Israel), and G. Grossman (Technion - Israel Institute of Technology, Haifa, Israel). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 720-724.

A 50 TR lithium bromide absorption chiller is described, which consists of two hermetically sealed steel drums, each having two heat exchangers. A computerized analytical model is discussed, which was developed to predict machine performance under different operating conditions. Very good agreement was found between the computer values and results of experiments made for more than a year on a 50 TR machine. Higher than normal heat transfer coefficients were obtained, and the machine functioned at generator temperatures as low as 59 C, and at cooling water as low as 15 C. J.P.B.

A80-33535 Some design aspects of air cooled solar powered LiBr-H₂O absorption cycle air conditioning systems. W. W. S. Charters (Melbourne, University, Melbourne, Australia) and W. D. Chen. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 725-728.

A80-33536 Solar absorption cycle cooling installations in Sydney, Australia. G. B. Smith and M. Riley (New South Wales Institute of Technology, Broadway, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 729-733.

The paper deals with two installations of widely different cooling capacity that were used to assess the suitability and economic viability of solar absorption cycle cooling in the temperate, often humid, coastal climate of Sydney. The relative performance of the collectors is discussed, and the difficulties encountered in achieving expected performance are noted. V.P.

A80-33537 Experimental comparison between solar assisted compression and absorption heat pump. R. Lazzarin, M. Sovrano (Padova, Università, Padua, Italy), R. Camporese, and G. Scalabrin (CNR, Laboratorio per la Tecnica del Freddo, Padua, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 734-738. 6 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A80-33538 On the use of a zeolite 13X-H₂O intermittent cycle for the application to solar climatization of buildings. F. Meunier, B. Mischler (Paris XI, Université, Orsay, Essonne, France), J. J. Guillemainot, and M. H. Simonot (Dijon, Université, Dijon, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 739-743. Commission of the European Communities Contract No. 524-78-1-ESF.

It is noted that an important problem in solar cooling is the temperature of the heat sink. It is shown that the zeolite 13X-H₂O cycle allows for an air cooled heat sink. Attention is also given to the need for providing cooling of the buildings as well as hot water in summer and heating in the winter. A solution is suggested which uses an intermittent cycle in order to solve these problems. M.E.P.

A80-33539 A direct solar-heated R22-DMF absorption refrigerator. I. Takeshita and S. Hozumi (Matsushita Electric Industrial Co., Ltd., Moriguchi, Osaka, Japan). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 744-748.

Testing was undertaken on a solar absorption air conditioning system comprising a combined solar collector, refrigerant vapor generator and solution heat-exchanger. Fluorocarbon R22 was used as the refrigerant and n,n-dimethylformamide as the absorbent. The results show that the thermal COP of the absorption refrigerator is 0.51 - 0.53 and the system COP is 0.23 - 0.24. The cooling effect is about 1800 kcal/h for an insolation of 700 - 800 kcal/sq m and the effective collector area of 10.6/sq m. (Author)

A80-33540 Theoretical and experimental investigations of an intermittent solar refrigerator. A. Venkatesh, V. Sriramulu, and M. C. Gupta (Indian Institute of Technology, Madras, India). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 749-753. 8 refs.

A80-33541 Reducing solar costs with the Solar-Assisted-Templifier. A. Weinstein and G. J. Van Zuiden (Westinghouse Electric Corp., Falls Church, Va.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 757-761.

The concept of a solar-assisted heat pump is based on the assumption that it is more efficient to collect solar energy at lower temperatures (40-120 F) and then boost it to the required temperature with a heat pump. The Solar-Assisted-Templifier, a series solar heat pump system capable of meeting heating loads requiring temperatures up to 220 F, is shown to reduce collector area and initial costs up to 50%; generate after-tax rates of return in excess of 8%, and reduce payback periods to less than 10 years. V.L.

A80-33542 A design method for parallel solar-heat pump systems. J. V. Anderson, J. W. Mitchell, and W. A. Beckman (Wisconsin, University, Madison, Wis.). In: Sun II; Proceedings of the

Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 763-766. 5 refs. Research supported by the U.S. Department of Energy.

A procedure has been developed for predicting the thermal performance of a parallel solar-heat pump system for residential space and water heating. The performance of the system is calculated first using a method such as that of the f-chart (Beckman, et al., 1977). The remaining portion of the load that is met by the heat pump is determined from calculations based on the bin method for a heat pump only system. The procedure accounts for the interaction of the two systems to yield the performance of the combined system. The predicted results are compared to those from detailed simulations, and are found to agree to within 2 percent. (Author)

A80-33543 Economics of solar-assisted heat pump heating systems for residential use. W. F. Bessler and B.-C. Hwang (General Electric Co., Schenectady, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 767-771. Contract No. EG-78-C-03-1719.

A80-33544 Comparison of combined solar heat pump systems to conventional alternatives. P. J. Hughes, J. H. Morehouse (Science Applications, Inc., McLean, Va.), and T. Swanson (Mueller Associates, Inc., Baltimore, Md.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 772-776. 20 refs. Contract No. DE-8C04-78CS-34261.

This analysis is distinguished from past studies by the method of thermal and economic comparison. Since the purpose of space conditioning equipment is to provide thermal comfort, models have been formulated to force this requirement on all systems. The thermal performance maps (fraction of the load met with free energy vs. collector area) presented herein include the effects of the comfort requirement and of parasitic energy consumption for blower and pump operation. Economic comparisons are made after sizing collectors and storage for the combined solar heat pump systems; the sizing technique establishes a thermal design point for each system. This, combined with life cycle cost analysis, allows collector cost goals to be established which, if met, would allow combined solar heat pump systems to compete with conventional alternatives. (Author)

A80-33545 A solar operated water-Li Br absorption refrigeration machine used also as heat pump - Technical and economic analysis. A. Cocchi, G. Raffellini (Bologna, Università, Bologna, Italy), and V. Stopponi (Industrie Merloni Fabriano, Fabriano, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 777-781. 5 refs.

A80-33546 A comparative study of solar assisted heat pump systems for Canadian locations. M. Chandrashekar, N. T. Le, H. F. Sullivan, and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 782-786. Research supported by the Canadian Electrical Association.

The feasibility of solar assisted heat pump systems for space heating and domestic hot water preheating in Canada is examined by simulating the performance of these systems on a computer using WATSUN. Simulations are carried out using meteorological data for seven representative Canadian cities, two different building types, and six types of system configurations. Results of the study show that the solar assisted heat pump systems conserve significant amounts of energy over resistance heating and heat pump systems. On the life cycle unit cost basis, solar assisted heat pump system costs are relatively insensitive to location: Liquid based dual source solar assisted heat pump systems are found to be cost effective over resistance heating (but not over an air-to-air heat pump) system at

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some of the locations for multiplex units. They are not cost effective for single family dwellings at the present time. (Author)

A80-33547 Computer simulation of ground coupled storage in a series solar assisted heat pump system. J. W. Andrews and P. D. Metz (Brookhaven National Laboratory, Upton, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 787-791. 7 refs. Research sponsored by the U.S. Department of Energy.

A quantitative study of the effect of thermal coupling between the ground and the heat storage element of a series solar assisted heat pump system is presented. The transient simulation computer program TRNSYS is used to simulate the solar portion of this system. A program to simulate the thermal interaction of the storage element with the ground is incorporated into TRNSYS as a sub-routine. This program calculates heat flow through the ground in discrete steps over space and time. Boundary conditions are established. The ground coupled storage is driven by thermal inputs from the solar portion of the system and from the changing ambient and ground temperatures. (Author)

A80-33548 Heat pump impact upon solar collection design and cost. J. W. Andrews (Brookhaven National Laboratory, Upton, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 792-796. 9 refs. Research sponsored by the U.S. Department of Energy.

Required collector area in series solar assisted heat pump systems is determined for three cities as a function of collector performance characteristics and compared with systems in which the solar-derived heat is used directly. Effect on system performance of improvements in heat pump performance is discussed. A cost vs yield analysis of several existing collectors is performed. (Author)

A80-33549 Earth coils and geo-thermal wells used as solar energy storage devices. J. E. Bose (Oklahoma State University, Stillwater, Okla.), C. W. Ledbetter (A.C. Service Co., Stillwater, Okla.), and J. R. Partin (Geo-Systems, Inc., Stillwater, Okla.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 797-801. 9 refs. Contract No. EM-78-S-01-4257.

A field demonstration laboratory using unprepared earth as a heat/sink storage device has been designed, constructed, and operated successfully during the 1977-78 winter, the 1978 summer, and the 1978-79 winter months. A 1,000-foot earth coil system was operated during the 1977-78 and 1978-79 winters and provided the necessary heat source for a commercial, 27,000 Btu/Hr. heat pump. The test provided base line data to determine earth coil lengths for sustained operation without solar input. A 250-foot geo-thermal well was drilled and used as a heat rejection system during the 1978 summer season and as a heat source during the 1978-79 winter season. The 250-foot well was used as a heat storage device for a 200 sq ft solar system and as the heat source for a 33,000 Btu/Hr. heat pump. The study has shown that both systems, earth coils and geo-thermal wells, provide excellent heat storage devices for solar energy since temperature drawdown which occurs over long, sustained operation can be minimized. (Author)

A80-33550 A solar assisted heat pump experiment. A. Cordier, A. Dreuil, and G. Gessinn (Toulouse III, Université, Toulouse, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 802-806. 6 refs.

A heat pump whose evaporator is made up of a series of solar collectors has been operating for three years at the University of Toulouse (France). A description is given of the solar collectors used, which have neither glass nor insulation, and a comparison is made between the experimental results obtained and the predictions of a

mathematical model. This model is then used to study a solar heating system with heat pump whose evaporator is fed with water circulating in collectors having neither glass nor insulation. (Author)

A80-33551 Some performance characteristics of the UNIMELB air source solar boosted heat pump system. W. W. S. Charters (Melbourne, University, Melbourne, Australia) and C. W. Dixon. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 807-811. 6 refs. Research supported by the Electrical Research Board and Australian Research Grants Committee.

The University of Melbourne Solar Boosted Heat Pump combines solar technology and heat pump technology in a single flat plate evaporator heat pump unit using Freon 12 as the working fluid. By collecting the solar energy incident on the unit at high effectiveness as the evaporator collector plate operates just above or below ambient temperature and adding this to the ambient air heat exchange, this unit provides a performance level about twice that of the same heat pump unit at the same operational temperature differential with the plate shaded. In addition, the outdoor flat plate evaporator is design optimized to operate using natural convection thereby eliminating the need for an outdoor fan. This provides cost savings and also ensures a quieter operation of the unit. Reverse cycle operation of the unit gives a capability for air conditioning as well as the direct heating capacity allowing better utilization of the installed equipment on an annual basis for most climate zones. (Author)

A80-33552 Experimental performance study of a series solar heat pump. E. A. Kush (Brookhaven National Laboratory, Upton, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 812-816. 5 refs. Research sponsored by the U.S. Department of Energy.

The results of the tests of a residential size liquid-to-liquid heat pump assembled from off-the-shelf components are reported. The results indicate that an increased coefficient of performance is obtained at evaporating temperatures as high as 96 F by using variable compressor speed, large heat exchangers, and proper selection of expansion device. The results apply also to heat pump nonsolar sources, such as reclaim or geothermal heat. V.L.

A80-33554 Comparison on the performance of a solar assisted heat pump and an air source heat pump in a northern climate. D. W. Spencer, B. Murphy, J. Healey, and R. Stewart (New York, State University, Albany, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 830-833. Research supported by the New York State Energy Research and Development Authority.

A80-33555 Development of an effective solar fraction. L. Palmiter (National Center for Appropriate Technology, Butte, Mont.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 843-846.

The concept of effective solar fraction is developed as a correction to the conventional solar fraction. The effective solar fraction accounts for solar system coefficient of performance, auxiliary system efficiency, area and U-value of wall replaced by the solar system. The effective solar fraction makes it possible to compare solar space heating systems of any type and is directly related to dollar and energy savings. The proposed concept is illustrated by examples. V.L.

A80-33556 Real time identification of parameters in building models. D. K. Hays (Solar Environmental Engineering Co., Fort Collins, Colo.), B. W. Parkinson (Rockwell International Corp., El Segundo, Calif.), and C. B. Winn (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress,

Atlanta, Ga., May 28-June 1, 1979. Volume 1.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 847-851. 5 refs.

A method for identifying various physical parameters of a building in real time has been developed. This method is directly applicable to improved control strategies for space heating and system performance evaluation. The development as well as the results of computer simulations of the identification techniques are presented. (Author)

A80-33557 Adaptive control for a multiple tank, multiple temperature solar energy storage system. L. F. Jesch and A. Zekios (Birmingham, University, Birmingham, England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 852-856. 13 refs. Research supported by the Bournville Village Trust.

A closed-circuit solar water system with a microprocessor-based programmable control is presented. The system has two sets of transparent plastic collectors with a total surface area of 120 sq m, two external heat exchangers, two insulated dump tanks, three separate storage tanks, and four sets of variable flow rate pumps. The programmable control system performs logging and command functions and is capable of adapting the scanning rate and limiting values to the changing needs of the operating conditions. V.L.

A80-33558 Mass flow considerations for solar air heating systems. T. A. Newell, S. R. Swanson, and R. F. Boehm (Utah, University, Salt Lake City, Utah). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 857-861. 10 refs.

This paper presents the results from a computer simulation study of the mass flow rate effect in solar air collector/rock bin storage systems. The results show that there can be a fairly wide range of mass flow rates in a solar air heating system over which the system's performance does not vary significantly. Two aspects of a solar air heating system are shown to contribute to the system's performance insensitivity to mass flow rate. The implications of a solar air heating system's mass flow rate has a direct impact on the economic and design considerations of the system. (Author)

A80-33559 Solar heating systems in Scandinavian climate - Reality or daydreams. V. Girdo (Kungl. Tekniska Hogskolan, Stockholm, Sweden). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 863-867.

The paper considers solar heating system in the Scandinavian climate, covering the energy requirements for buildings and the efficiency of solar radiation in Sweden. It is expected to save up to 0-0.5 TWh/yr up to 1985 and about 8-12 TWh/yr up to 1995, with the total energy consumption for Swedish buildings of about 170 TWh gross/yr. The heat from local solar heating systems should cost 0.07-0.09 \$/kWh with 100% of self-sufficiency. This may mean that the costs for solar heating systems will be at least double the costs of conventional heating systems. A.T.

A80-33560 A survey of existing solar system simulation methods. P. L. Versteegen (Science Applications, Inc., McLean, Va.) and D. E. Cassel (Mueller Associates, Inc., Baltimore, Md.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 869-873. Contract No. DE-8C04-78CS-34261.

A survey was made of various analysis methods that exist for the design and study of solar heating and cooling systems, both for buildings and agricultural and industrial process applications. The survey includes analysis techniques for both active and passive solar systems. The survey is divided in two categories of methods: the computer methods that require a large-scale or mini-computer, and hand methods under which is listed everything else. The various

methods were analyzed and their capabilities and characteristics displayed in a series of tables. (Author)

A80-33561 Solar heating simulation - Accuracy and precision of a model using daily data. A. E. McGarity (Swarthmore College, Swarthmore, Pa.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 879-883. 6 refs.

A80-33562 The layout of solar hot water systems, using statistical meteorological and heat demand data. P. Kesselring and A. Duppenhaller (Zürich Eidgenössische Technische Hochschule, Würenlingen, Switzerland). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 884-888.

A80-33563 Simulation of the FSEC solar cooling system. H. Klee (Central Florida, University, Orlando, Fla.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 889-893.

A TRNSYS simulation of the Florida Solar Energy Center solar cooling system was developed. The simulation is site specific incorporating all appropriate building thermal characteristics, system control logic and one month's measured weather data at the center. A simulation summary provides complete information about solar fraction, average collector efficiency, average room temperature, etc., in order to evaluate system performance. (Author)

A80-33564 User perspectives of selected solar energy system design tools. T. T. Lewis, G. P. Toomey, and T. L. Webster (PRC Energy Analysis Co., McLean, Va.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 895-899.

The paper presents solar energy system sizing methods which are classified by levels of complexity into four groups: (1) handbook calculation methods, (2) hand-held calculator methods, (3) simplified computer program methods, and (4) detailed computer program methods. The handbook and calculator methods should be used for preliminary sizing and initial estimates. The simplified and detailed computer methods are suitable for final design and parametric studies provided they are applied to the standard systems on which the program methodology is based. All methods are sensitive to user load inputs. V.L.

A80-33565 Study of the nonlinear dynamics of a flat-plate collector. A. J. De Ron (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 900-904. 5 refs.

For the design and control of a solar collector, knowledge of its nonlinear dynamics may be very important. It is demonstrated that simulations using a complete nonlinear model confirm the tentative conclusions obtained by analysis of a linearized model. The study results in a hybrid collector model: linear for insolation changes, nonlinear for flow changes. The influence of the wind speed and ambient temperature are ignored because these are small compared with the influences caused by the insolation and the flow. It is concluded that the transient effect, as defined in the literature, is almost only a nonzero effect for flow variations. (Author)

A80-33566 The Saskatchewan Conservation House - A year of performance data. R. W. Besant, R. S. Dumont, and G. J. Schoenau (Saskatchewan, University, Saskatoon, Canada). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 907-911. 5 refs.

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The Saskatchewan Conservation House, completed in 1977, is a residence designed to provide 100% solar space heating in a cold climate. Heating is primarily by passive solar gain and internal heat generation from normal electricity usage and from people. The performance of the house is reviewed over the period starting from January 1978 to the present date. V.P.

A80-33567 Honeywell General Offices concentrating collector system - Installation and operation. R. C. Gee (Solar Energy Research Institute, Golden, Colo.) and P. D. Kruger (Honeywell Energy Resources Center, Minneapolis, Minn.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 912-915.

The paper describes a solar energy system for Honeywell's General Offices in Minneapolis, Minn. Consideration is given to solar cooling, heating, solar domestic hot water, and thermal storage. System installation and operation problems are discussed. V.T.

A80-33568 A manufactured solar home. M. P. Scofield, A. S. Lau, K. H. Liebelt (Idaho National Engineering Laboratory, Idaho Falls, Idaho), and N. R. Shinn (Boise Cascade Corp., Boise, Idaho). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 916-918.

The paper deals with an active solar heating and cooling system installed in two nearly identical solar houses. The system uses simple air collectors, rock storage, and a heat exchanger to preheat hot water. Summer cooling is provided by blowing cool night air through the rock bed and then circulating house air through the cool rocks. V.P.

A80-33569 Report on five years of operating experience with four pioneer school heating experiments. L. O. Herwig and E. Doering (U.S. Department of Energy, Solar Energy Div., Washington, D.C.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 919-923.

The four 'proof-of-concept' school heating experiments undertaken in 1974 are chronicled and analyzed. It is shown that these large-scale user-oriented projects have met a wide range of general objectives, including projected system performance requirements for thermal energy production. V.P.

A80-33570 Solar heating and cooling performance in CSU Solar House III. D. S. Ward and H. S. Oberoi (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 928-932. Research supported by the U.S. Department of Energy.

A80-33571 Comparative performance of two types of evacuated tube solar collectors in a residential heating and cooling system - A progress report. T. M. Conway, W. S. Duff, G. O. G. Lof, and R. G. Pratt (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 933-937. Research supported by the U.S. Department of Energy.

A80-33572 The operation results of the Yazaki Experimental Solar House One and the Ishibashi Solar House. T. Ishibashi (Yazaki Shigen Co., Ltd., Hamamatsu, Shizuoka, Japan). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 938-942.

A80-33573 Solar heating and hot water supply system of Fuji Electric Solar House. M. Nishio and S. Sugiura (Fuji Electric Co., Ltd., Yokosuka, Kanagawa, Japan). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979.

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Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 948-952.

A80-33574 Analysis of solar water heating systems. W. E. Buckles, S. A. Klein, and J. A. Duffie (Wisconsin, University, Madison, Wis.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 959-963. 8 refs.

Several different types of solar domestic water heating systems have appeared on the market during the past few years. The paper presents a study of the comparative performance of four common types of solar domestic water heating systems: (1) single tank/external heat exchanger; (2) double tank/external heat exchanger; (3) single tank/internal heat exchanger; and (4) double tank/internal heat exchanger. The purpose of this study is to determine the applicability of the F-chart method to the design of the various types of solar water heating systems now available. A simulation approach is chosen to investigate the thermal performance of the four types of representative systems. It is shown that the F-chart method, as modified to account for auxiliary energy losses, can be used to provide estimates of the long-term average performance of all four systems, even though it was derived for the two tank/external heat exchanger system. S.D.

A80-33575 Design and evaluation of solar installation workshops and the HUD solar DHW installation guidelines. P. Hollander and M. O'Neill (Franklin Research Center, Philadelphia, Pa.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 964-966.

A80-33576 Performance vs prediction for four classes of solar hot water systems. J. G. Bergman (Delaware, University, Newark, Del.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 967-971.

The paper reports on a project whose major goal was to assess the performance of four actual solar heat water systems and to do so in a manner which would permit meaningful comparisons with F-chart (or similar) predictions for long-term behavior. To accomplish this objective, the actual daily performance of each system is successfully characterized using multiple regression techniques, and these performances are then extrapolated for comparison with the values predicted by the F-chart. A schematic which outlines the methodology is given. The methodology is rather a tool whereby daily measured performance can be interpreted and extrapolated to yield estimates for average long-term solar fraction. This methodology also permits one to quickly assess the effects of system modifications on long-term performance. S.D.

A80-33577 Experimental system performance and comparison with computer predictions for six solar domestic hot water systems. A. H. Fanney and S. T. Liu (National Bureau of Standards, Thermal Solar Group, Washington, D.C.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 972-976. Research sponsored by the U.S. Department of Energy.

The paper considers the experimental system performance of six solar domestic hot water systems and compares it with computer predictions. Three computer programs, F-chart, SOLCOST, and TRNSYS, are utilized for the design of solar space heating and domestic hot water systems; the accuracy of their predictions must be verified with experimental data, and this paper describes the test facility and the experimental results and compares them with the computer predictions for the first eight months of the operation. A.T.

A80-33578 The thermal performance of solar water heaters in the UK. J. L. J. Rosenfeld (Shell Research, Ltd., Thornton Research Centre, Chester, England). In: Sun II; Proceedings of the

Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 977-981. 5 refs.

As a contribution to the preparation of a code of practice by the British Standards Institution technical committee on solar water heaters, the long-term thermal performance of domestic solar water heaters has been estimated, using a computer program developed at Thornton Research Centre. This model is described, and results are presented showing the effect on thermal performance of varying some system parameters. The results are consistent with those obtained by others using models incorporating different kinds of approximations, and with the scant experimental data. (Author)

A80-33579 Mean monthly performance of solar water heaters with natural circulation. M. Daneshyar (University of Technology, Isfahan, Iran). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 983-987. 7 refs. Research supported by the Ministry of Science and Higher Education of Iran.

The predictions of the transient performance of a natural circulation solar water heater obtained by a theoretical method have been compared with experimental data. The comparisons have shown that transient and final system temperatures can be predicted with an accuracy of about 10%. The prediction method has, therefore, been used in order to study the mean monthly performance of a natural circulation solar water heater with no drawoff at a particular location, and the predicted instantaneous values of the mean storage tank temperatures and collection efficiencies for a mean day of each month are presented and discussed. (Author)

A80-33580 Solar plus waste heat recovery hybrid water heating system. E. T. Pitkin (Connecticut, University, Storrs, Conn.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 988-992.

The potential of combining heat recovery from waste water with a solar hot water system is examined via computer simulation. The simulation program is first verified by comparison with data from a real solar water heater. It is then used to show that approximately one third of domestic water heat can be obtained from waste hot water. (Author)

A80-33581 Design of the solar water heater system for TVA's Memphis Initiative. T. M. Carney (Tennessee Valley Authority; Tennessee, University, Chattanooga, Tenn.) and F. R. Robertson (Tennessee Valley Authority, Knoxville, Tenn.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 993-997.

The design constraints imposed on solar water heaters by requiring off-peak electrical auxiliary power are described. A two-tank system satisfying these constraints is proposed, and components are sized using the FCHART simulation and a life cycle return criterion. Experimental confirmation of the off-peak auxiliary performance is included. The system resulting from this study is being used in TVA's Memphis Initiative. (Author)

A80-33582 Membrane stratified solar ponds. J. R. Hull (Iowa State University of Science and Technology; U.S. Department of Energy, Ames Laboratory, Ames, Iowa). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1000-1004. 12 refs. Research supported by the Iowa State University of Science and Technology and U.S. Department of Energy.

The membrane stratified solar pond is a body of liquid utilizing closely spaced transparent membranes to quench convective heat transfer in the top part of the pond. Several suitable pond liquids and membrane materials are discussed. Conditions for suppression of convection are described for several membrane geometries, and

radiation transmission is discussed for the horizontal sheet configuration. Thermal behavior is similar to that of salt gradient solar ponds, but much deeper heat storage layers are feasible. In some cases aquaculture farming may be suitable in the storage layer. (Author)

A80-33583 Construction and initial operation of the Miamisburg salt-gradient solar pond. R. S. Bryant (Miamisburg City, Parks and Recreation Dept., Miamisburg, Ohio), R. P. Bowser, and L. J. Wittenberg (Monsanto Research Corp., Miamisburg, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1005-1009. 10 refs. Contract No. DE-AC04-76DP-00053.

The construction and operation of the largest salt-gradient solar pond is examined. The pond is 2020 sq m in area and was installed for \$35/sq m. A new technique was successfully demonstrated for the formation of the gradient zone in which fresh water was injected horizontally below the surface of the concentrated salt solution; without any useful heat removed, the storage layer water of 18.5% NaCl reached a temperature of 51.1 C and a minimum temperature of 28.4 C. The projected heat cost is 2.5 cents/kW-hr based on amortization of 10% per year. A.T.

A80-33584 Control of gradient zone boundaries. C. E. Nielsen (Ohio State University, Columbus, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1010-1014. 9 refs. Research supported by the Ohio State University and U.S. Department of Energy.

The role of zone boundaries in salinity gradient solar ponds is reviewed and the factors influencing boundary equilibrium are discussed. It is pointed out that the equilibrium positions of boundaries can be substantially changed without loss of internal gradient zone stability. Such changes are brought about by modifying the salinity profile through the use of liquid injection and transfer procedures adapted from earlier injection experiments. Given a well-defined process combining diffusion and liquid injection or transfer, the equilibrium salinity profile is readily calculated. A continuous liquid injection procedure is described that modifies the salinity profile and changes the salinity gradient at zone boundaries. It is shown qualitatively that injection produces the expected gradient modification. S.D.

A80-33585 Salt concentration gradient solar ponds - Modeling and optimization. T. S. Jayadev and J. Henderson (Solar Energy Research Institute, Golden, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1015-1019.

The paper discusses a computer simulation program, SOLPOND, for predicting the thermal performance of salinity gradient solar ponds. Finite element techniques are used to model pond thermal performance, and the program is structured to perform discrete time solutions. This program is used for several illustrative examples. Simulation results highlight pond sensitivity to seasonal load profile, storage layer depth, and optical transmission through the salt solution. Thermal losses through the pond edges are evaluated for several pond sizes and found to be significant for ponds as large as 100 m. A simple economical optimization technique to maximize delivered energy per capital cost is also presented. S.D.

A80-33586 The development and demonstration of a solar pond for heating greenhouses. T. H. Short, P. C. Badger, and W. L. Roller (U.S. Department of Agriculture, Ohio Agricultural Research and Development Center, Wooster, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1021-1025. 9 refs.

The paper describes a solar pond for demonstrating space heating of a commercial greenhouse. Another greenhouse of the same

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size and shape was heated with natural gas and compared with the solar-pond-greenhouse system. The solar pond was tested and modified to improve its efficiency and a polystyrene-pellet nighttime insulation is being developed for large greenhouses. This new combination is projected to provide all the greenhouse heat by passive and active solar technology, but some solar operational problems still exist. A.T.

A80-33587 The physics of a saturated $\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$ non-convecting solar pond. T. L. Ochs and J. O. Bradley (Nevada, University, Boulder City, Nev.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1026-1028.

A80-33588 The application of shallow solar ponds for industrial process heat - Case histories. A. B. Casamajor (California, University, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1029-1032. 5 refs. Contract No. W-7405-eng-48.

The shallow-solar-pond collector system developed by the Lawrence Livermore Laboratory is approaching commercialization. Three prototype or demonstration projects, Sohio Petroleum Company, Sweet Sue Kitchens, and Fort Benning, are described. A critique of each project points out the significant factors that affect the individual projects and shallow-solar-pond technology in general. Particular attention is drawn to problems encountered and solutions proposed. Finally, possible marketing organization and strategies are discussed. (Author)

A80-33589 Solar energy system with heat pump augmentation for industrial process heat - An update. H. F. Schuler, D. F. Rost, and G. Ameduri (General Extrusions, Inc., Youngstown, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1034-1036.

In September, 1977, General Extrusions completed installation of a solar energy system with heat pump augmentation to furnish power for a cleaning tank in their aluminum anodizing line. The array was 100 modules (304 sq m) of their Model LTC-367 Solar Collector and the heat pump was a Westinghouse Templifier TBP060. During the last 261 days the solar system has been operated 83 days supplying energy to the process. 31 days of potential operation were missed as the plant operated on a five day a week schedule much of the time. A mini-computer-based energy monitor system is under construction for this solar system and will give detailed operational results as well as automatic control. (Author)

A80-33590 Operation of an industrial solar drying system. E. J. Carnegie, P. W. Niles, and W. B. Stine (California Polytechnic State University, San Luis Obispo, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1037-1041. 6 refs. Contract No. EY-76-C-05-5123.

The paper describes a solar hot air raisin and prune drying system in Fresno, Calif. The solar heating system consists of 1951 sq m of solar collectors, a 396 sq m rock storage facility, and a heat recovery unit. The operation of this system is described, and the actual operation is compared on a day-to-day basis to a computer simulation program used in the analysis and design of this project. It was concluded that this system will produce more energy than required to build it, and will pay back its cost within 11 to 17 years. A.T.

A80-33591 Application of solar energy to food industry - A distillery. F. Moisan (CNRS, Paris, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1042-1045.

The use of concentration collectors will permit to produce steam for various industrial processes, especially in the food industry. A project, presently developed in France, is applied to a distillery; 5000 sq m of collecting area will save 360 tons of fuel per year; the cost of collectors, if they are mass produced, will permit the competitiveness of solar heat versus fuel at middle term. (Author)

A80-33592 A prototype of solar linear concentrators plant installed to supply industrial heat. O. A. Barra, E. P. Carratelli (Calabria, Università, Arcavacata, Italy), and A. Barutti (Ansaldo Dim/Isol, Cornigliano, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1046-1050. 9 refs. Research sponsored by the Birra Peroni Italian Factories.

A 50 sq m solar linear concentrator plant with cavity boilers has been realized in a brewery to evaluate the applicability of using solar energy to supply industrial process heat in the 120-300 C range. The aims of this plant include the experimental testing of a mathematical computer model to obtain a general computer code simulating the heat and mass transfer phenomena in the plant, measuring the plant and cavity boiler photothermal conversion efficiency, and solving the problems arising from the joining of the solar plant with the preexisting brewery water-steam network. Linear parabolic concentrators which track the sun were used, having mirrors with an 0.86 reflectivity; the plant is used to overheat pressurized water before entering the traditional boilers for vaporization. Preliminary experimental results indicate that thermal losses from the Cu pipes are strongly dependent on atmospheric conditions, necessitating the soldering of the pyrex glass and the Al-Fe boiler envelope. J.P.B.

A80-33593 Solar energy for kilning malt. C. C. Smith (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1051-1055. Research supported by the Fleischmann Malting Co.

A technical and economic feasibility study was conducted at Colorado State University on the use of solar energy for kilning malt. The study showed that an economic optimum results when the kiln cycle peak demand coincides with the maximum solar output. Therefore the objective of the system design study was to maximize the use of solar supplied heat by scheduling kilning operations with regard to the diurnal solar period. (Author)

A80-33594 Solar heat generation for industrial process heating applications. W. R. W. Read (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1056-1060.

The use of solar energy for industrial applications is discussed, including characteristics of industrial systems, design approaches, and the results of two demonstration programs. A solar energy system consisting of 94 sq m of double-glazed collectors mounted in a series-parallel arrangement and connected by a heat transfer loop to a 20 cu m storage tank was used for can warming at a soft drink manufacturing plant. Data taken over an 18-month period show collector efficiency of 32% and utilization efficiency of 72%. A second system of 178 sq m of double- and single-glazed collector units were used to provide some of the heat for beer pasteurizing. Data for the four months of January to April, 1979, indicate monthly solar energy utilization efficiencies of 75%, 66%, 63%, and 53%. It is concluded from these programs that solar heat generating systems can be successfully integrated with suitable industrial process heating applications. J.P.B.

A80-33595* The Point-Focusing Thermal and Electric Applications Project - A progress report. A. T. Marriott (California

Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1062-1066. 9 refs. Research supported by the U.S. Department of Energy.

The paper discusses the Point-Focusing Thermal and Electric Applications Project which encompasses three primary activities: (1) applications analysis and development, in which potential markets for small power systems (less than 10 MWe) are identified and characterized in order to provide requirements for design and information for activities relating to market development; (2) systems engineering and development, for analyses that will define the most appropriate small power system designs based on specific user requirements; and (3) experiment implementation and test, which deals with the design and placement of engineering experiments in various applications environments in order to test the readiness of the selected technology in an operational setting. Progress to date and/or key results are discussed throughout the text. S.D.

A80-33596 Small solar plants for electricity supply. J.-P. Durand and L. Pirot (Société d'Etudes Thermiques et d'Energie Solaire, Montargis, Loiret, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1067-1071.

By describing the solar project for Diakhao in Senegal, Western Africa, this paper introduces the present stage of technology developed by SOFRETES. Taking in account the environment of remote areas of this part of the world and the technology based on practical applications, a low temperature solar thermal conversion technology is used including flat plate collectors, hot water, thermal storage and Rankine cycle thermal loop. This paper describes the demand for electricity of a small African community (Diakhao) and the solar technology selected to satisfy this demand. Components and their integration in the system are described. Factory tests are planned to take place at the end of this year. The Diakhao solar plant will be under operation in 1980. (Author)

A80-33597 The International Energy Agency Small Solar Power Plants Project. A. C. Kalt (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1077-1081.

The SSPS Project (Small Solar Power Systems Project) includes the design and erection of two solar power plants of different technical concepts, on the same site, with a view toward evaluating and comparing the relative economic viability of such plants. One plant is a distributed collector system and the other a central receiver system. Objectives and design goals of the SSPS Project are presented, followed by a discussion of basic technical specifications and of technical design baseline. The two plants are to be built on a common site near Almería, southern Spain. S.D.

A80-33598 Performance and cost optimisation of small solar power stations. J. E. Feustel (Maschinenfabrik Augsburg-Nürnberg AG, Munich, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1082-1086.

Small solar farm power systems using parabolic trough collectors and power conversion systems following the Rankine principle are discussed. Overall system efficiency is considered in terms of the selection of optimum operational temperature, storage size, and design day; it is noted that collector field efficiency drops with increasing temperature, while power conversion efficiency increases with higher temperature. Attention is also given to optical, thermal, and transmission losses with regard to the collector field, and a two stage screw expander in the 100 kW range is described with regard to

the prime mover cycle. The planning and realization of a number of solar farm projects in the 50-500 kW range, as well as the development of a combined solar power-diesel power station are also discussed. J.P.B.

A80-33599 30/50 kWE solar thermal power plant of the distributed type. R. Koehne (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für technische Physik, Stuttgart, West Germany) and M. Kraft (M.A.N.-Neue Technologie, Munich, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1087-1089.

A joint project between M.A.N., Germany and AUXINI, Spain is presented which describes a small solar thermal power plant of the distributed type delivering a maximum electric power output of 30 kW and 50 kW resp. if a storage is used additionally to the collector field. The plant built up at Getafe near Madrid, Spain, consists presently of a first collector field with parabolic trough collectors mounted rigidly on a platform which is tracked azimuthally. Collector system efficiencies have been measured and are compared with theoretically predicted values from a transient simulation model. Different temperature spreads and inlet temperatures (between 60 . . . 240 C) are investigated and some results of the measured collector system efficiencies regarding also the influence of dust covers on the glass mirrors are given. (Author)

A80-33600 The Ansaldo 35 kW solar power system. G. Bado, G. Tomei (Ansaldo S.p.A., Genoa, Italy), T. Angelino, M. Gaia, and E. Macchi (Milano, Politecnico, Milan, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1090-1094.

The conceptual design of a 35 kW solar power system based on the use of linear concentrating collectors is presented. Each collector module consists of two parabolic troughs capable of both elevational and azimuthal alignment. The thermal engine of the system is an organic fluid (perfluorocarbon) multistage turbine prime mover with an efficiency of 25% at 300 C collectors' cooling loop exit temperature. The system is designed for stand alone and for grid-connected operation and, if requested, for the combined generation of power and heat. (Author)

A80-33601 Research and development on solar energy for electric and mechanical power generation. R. Almanza, J. Garibay, S. López, F. Muñoz, and R. Zárate (Universidad Nacional Autónoma de México, Mexico City, Mexico). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1095-1099. 8 refs.

A review of the development of solar energy for electric and mechanical power generation is presented. The first thermal mechanical conversion system under study is a device of 1/2 kW made of focusing collectors which follows the sun during the day. The system consisting of 24 sq m of collectors uses steam as a working fluid, and it is connected to a piston engine. A new system has been started to generate 35 kW which will consist of about 1000 sq m of parabolic collectors with an absorption tube of Cr(x)O(y). A.T.

A80-33602 Small solar thermal power plants. G. Prast (Philips Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1100-1104.

The most important use of small solar thermal power plants is expected to be in the rural areas of developing countries, where power for irrigation is an essential need. A solar power plant of a few kW capacity needed for this purpose must have a very high reliability, as for such units hardly any service will be available. An attempt is being made to develop a solar thermal power plant which

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attains pertinent requirements. The discussion focuses on a short description of the system, the collector system, the Sterling engine, and the latent heat storage system. It is shown that it is possible to construct small solar thermal power systems by collecting heat with focusing collectors, storing the heat for short periods in a latent heat storage, and transforming the heat with a free-piston Sterling engine. S.D.

A80-33603 **Midtemperature Solar Thermal Systems Design Handbook - Parabolic troughs.** R. W. Harrigan (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1106-1110.

This paper outlines ongoing efforts at Sandia Laboratories (SLA) to develop a Solar Thermal System's Design Handbook. The handbook deals, at this time, only with parabolic trough collector systems operating up to 315 C (600 F). While useful to anyone doing solar thermal design involving parabolic troughs, the handbook application is primarily aimed at commercial Architectural and Engineering firms. Publication of the handbook is anticipated for the Fall 1979. Updating of the handbook is expected to occur continuously as the rapidly developing solar technology matures.

(Author)

A80-33604 **Solar thermal-electric power plant with distributed collectors 100 to 1000 kWe.** G. Mordchelles-Regnier, G. Dahan, and J.-L. Boy-Marcotte (Société Bertin et Cie., Plaisir, Yvelines, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1111-1115.

The design parameters for a medium-sized (100-1000 kWe) concentrating collector solar thermal power station intended to provide energy with little maintenance and at competitive costs in remote regions are discussed. Consideration is given to the selection of operating temperature, type and degree of solar energy concentration, and thermal engine and organic working fluid, and to system optimization. The parabolic cylindrical collectors with mobile aluminum mirrors rotating around stationary receiver tubes and the Rankine-cycle turbine engines selected for the system are presented. A measured net energy conversion efficiency of 10 percent for the system is noted, and possible industrial applications of the system in the production and recovery of heat are indicated. A.L.W.

A80-33605 **Solar thermal electric power in the range of medium size units - The French programme 'THEK'.** G. Peri, J. Desautel, B. Imbert, M. Audibert, R. Pasquetti, J. P. Battistelli (Aix-Marseille I, Université, Marseille, France), J. Deflandre, and J. P. Trainsein (CNRS, Paris, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1121-1124.

The French THEK program of solar energy utilization is concerned with the design of small heliower units utilizing the parabolic dish and modular helio-to-thermal converters. The study, design, realization, and experimentation of two full-scale prototype modules using segmented parabolic dishes are discussed. These modules incorporated three types of exchangers differing in shape (semi-cavity and flat), tubing, and material (copper and iron), and two concentration ratios (170 and 230) were tested. Attention is given to the installation of a thermal loop, an automatic system of regulation, and exchanger, and a steam generator. The effects of optical and thermal losses on efficiency are noted, and the use of a better glass for the mirrors and a higher concentration ratio to improve efficiency are considered. S.D.

A80-33606 **A solar thermal-electric experimental plant.** M. Ruback and W. D. Beverly (Boeing Engineering and Construction Co., Seattle, Wash.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1125-1129.

One approach to generating electricity from solar energy is to employ an open Brayton-cycle in a central receiver type solar thermal-electric power plant. A nine-month study was conducted to develop a conceptual design and definition of an open Brayton-cycle experimental plant of about 1.5 MW electrical output. The paper deals with the assumptions, analyses, and results of the conceptual design effort. The solar plant is assumed to be composed of four subsystems: (1) the collector (or heliostat) subsystem; (2) the receiver subsystem; (3) the electrical power generation subsystem; and (4) the master control subsystem. Attention is given to the parametric analyses and design studies which led to this plant configuration. S.D.

A80-33607 **A self supporting solar power system for an isolated community.** M. J. Bignon (CETHEL, Paris, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1130-1133.

The paper describes a 500 kW self-supporting combined solar-thermal power production system suited to the needs of an isolated community. Attention is given to the solar receiver, the condensing steam turbine chosen for maintenance and operating reasons, and the mirror field comprised of 120 to 150 or more heliostats with a reflecting area of about 54 sq m each. The tracking system is made by computed coordinates, and each heliostat has its own micro-processor to control the position. The dry condenser used for the power production system is considered, as well as the conventional Diesel engine with a generator when power is required for startup, or when the storage is low. Emphasis is placed on economic factors. J.P.B.

A80-33608 **The solar ten megawatt pilot plant.** R. W. Hallet, Jr. and R. L. Gervais (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1137-1140.

The paper describes the system requirements, characteristics, and operating modes of a 10-megawatt solar thermal central receiver pilot plant located in the Mojave desert. The system can be characterized as a surrounded field configuration with radial stagger heliostat layout, capable of generating 10 MWe net directly from insolation, and 7 MWe net from thermal storage. Attention is given to system control utilizing computers, and the capability to orient the reflective surface such that the mirrors can be stowed vertical or inverted, and open-loop control. Requirements for the receiver subsystem are presented, including maximum incident power of about 47 MWt and maximum flux level of 0.31 MWt/sq m. The thermal storage subsystem is described, considering the central storage unit, thermal charging loop, and heat-extraction loop. Also discussed is the electrical power generating subsystem which consists of a nominal 12.5 MWe (gross) turbine-generator set, and includes an in-line demineralizer and polisher. J.P.B.

A80-33609 **Thermal fatigue analysis of the Department of Energy Barstow Pilot Plant.** J. F. Jones (Sandia Laboratories, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1141-1145. 6 refs. Contract No. DE-AC04-76DP-00789.

This paper discusses two types of thermal fatigue which might occur in the Department of Energy Barstow Pilot Plant: fatigue due to oscillations of the point of departure from nucleate boiling (DNB) in the once-through boiler and fatigue due to the daily cycling of the plant. The results of the two fatigue calculations indicate that the Barstow Pilot Plant should not have a serious fatigue problem from either DNB oscillations or daily cycling, although the design life does not greatly exceed the desired 30 years. In addition, the possible

mitigating effects of tube bending are considered, but it is found that little improvement in fatigue life can be expected from this source.

(Author)

A80-33610 Sodium cooled solar central receiver power station. T. L. Johnson, L. E. Glasgow, W. B. Thomson, and A. Z. Frangos (Rockwell International Corp., Energy Systems Group, Canoga Park, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1146-1150. Contract No. EG-77-C-03-1483.

A study of a sodium system central receiver-type solar thermal power plant is presented. The sodium system central receiver plant is similar to the water/steam system to be built in Barstow; however, liquid sodium is heated in the receiver at the top of the tower instead of water, and steam is generated at the ground level using sodium-to-water heat exchangers. The economic analysis shows that these plants with storage duration of about 13-hr capability have a busbar energy cost comparable to or less than that for new fossil-fueled electric generating plants.

A.T.

A80-33611 A solar-fossil hybrid power system using a combined cycle. E. Y. Lam (Bechtel National, Inc., San Francisco, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1151-1155. Contract No. DE-AC03-78ET-21050.

This paper describes a solar central receiver hybrid power system concept which uses a gas turbine/heat recovery steam generator/steam turbine combined cycle to generate electricity from both solar and fossil fuel energy. The concept description dwells primarily on a near term 100 MWe (net) system that utilizes a state-of-the-art combined cycle with a gas turbine inlet temperature of 1093 C (2000 F). This system is implementable in the 1985 time frame. An advanced system that uses an inlet temperature of 1316 C (2400 F) is also described. Performance comparisons of these two systems are given. Major advantages of the system concept as well as its technical issues are highlighted.

(Author)

A80-33612 Assessment of solar hybrid repowering for electric utilities. D. J. Groves, Jr., J. D. Maddox (Public Service Company of New Mexico, Albuquerque, N.M.), W. R. Lang (Stearns-Roger Engineering Co., Denver, Colo.), and W. G. Parker (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1156-1160. Research supported by the Electric Power Research Institute, Western Energy Supply and Transmission Associates, Arizona Power Authority, Public Service Company of Oklahoma, San Diego Gas and Electric Co., and Tucumcari Power and Light; Contract No. EG-77-C-03-1608.

An assessment of the solar hybrid repowering concept for electric utility application is presented. The concept consists of locating solar hardware connected to existing gas-fueled and oil-fueled electric generation units to displace the fossil fuel used during daylight hours. The market potential was established by a survey of utilities in the southwestern U.S.; a cost benefit analysis indicates that the solar hybrid repowering concept can be attractive for utility applications when compared with conventional electric power generation. A conceptual design was prepared for a 50% solar repowering based on the central receiver concept designed for a 10-MWe pilot plant.

A.T.

A80-33613 Economic implications of a low cost heliostat design. C. R. Easton and J. B. Blackmon (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1161-1165.

Design and costs of a prototype heliostat for the Central Receiver Solar Thermal Power System are presented and comparisons

made with commonly manufactured items. Central receiver thermal energy costs are shown to be competitive with fossil fuels. (Author)

A80-33614 Utility problems of central tower solar plant in Italy. D. Borgese and G. Cefaratti (Ente Nazionale per l'Energia Elettrica, Milan, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1167-1171.

A80-33615 Economic analysis of the STEPS in Japan. T. Tani, S. Sawata, T. Tanaka, M. Kamimoto, K. Sakuta, N. Ezawa, and T. Horigome (Ministry of International Trade and Industry, Electro-technical Laboratory, Tokyo, Japan). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1172-1176. 6 refs.

The simulation program was developed for the estimation of optimum electrical energy cost of STEPS (Solar Thermal Electric Power System) in Japan using hourly normal solar flux data, various collector area, storage capacities, turbine inlet temperatures and cost model. In Japan, the minimum electrical energy costs of the distributed system and the tower heliostat system were estimated from viewpoints of the collector area, storage capacities and electric capacities.

(Author)

A80-33616 The cost and value of washing heliostats. E. D. Eason (Sandia Laboratories, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1177-1180. 6 refs. Contract No. DE-AC04-76DP-00789.

An equation is derived for the washing frequency that minimizes cost per unit energy for solar collectors of any type. Central receiver heliostats of two designs are used in an example, and the results for Albuquerque soiling rates show that washing 15-30 times per year is worthwhile. The optimal frequency is directly or inversely proportional to the square root of the relevant parameters, but it is not sensitive to number of collectors or plant size. The frequency for minimum cost per unit energy corresponds to the strategy of washing whenever the value of the extra energy from cleaner mirrors will pay for the cost of the wash.

(Author)

A80-33617 Physical and chemical properties of phase change materials for application in solar tower and solar farm plants. D. Heine, F. Heess, and M. Groll (Stuttgart, Universität, Stuttgart, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1187-1191. 7 refs.

Latent heat storage materials for use in the temperature ranges 200 to 450 C and 700 to 900 C are investigated with reference to their corrosion resistance against container materials and thermodynamic stability. The mass loss and corrosion rate for the materials applicable in the range 200-450 C differ considerably from each other. The material combinations for 700-900 C have no significant differences in their corrosion rates and are classified as corrosion resistant. The storage media for the temperature range 700-900 C, MgCl₂, NaCl, and KF, have been found thermally stable; no changes have been observed within the first 30 cycles.

V.L.

A80-33618 Solar design by the 'Cosine Hour' method. U. Bossel (Solentec GmbH, Adelebsen, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1195-1198. 6 refs.

A new approach is suggested for the prediction of the solar energy received by surfaces of arbitrary tilt and orientation. The method is based on the 'Cosine Hour' integral. This geometric parameter measures the time-equivalent of solar exposure in units of hours of perpendicular insolation. For any surface and day the

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number of Cosine Hours becomes directly proportional to the amount of energy received under ideal weather conditions. For partially cloudy skies the 'Cosine Hour' method yields excellent answers when a 3-modal insolation model is used. Surface orientations can be easily optimized with respect to energy collection by inspection methods when the Cosine Hour Tables (Bossel, 1979) are used. (Author)

A80-33619 Survey of simplified design methodologies for solar heating and cooling systems. P. J. Hughes and P. L. Versteegen (Science Applications, Inc., McLean, Va.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1199-1202. 25 refs. Contract No. DE-8C04-78CS-34261.

This paper reviews the approaches that have been taken in developing simplified design procedures for assessing the performance of solar heating and cooling systems. The term 'simplified' is indicative of a calculational process that involves simple hand computational tools, such as tables, graphs, equations, and a hand-held calculator. Many methods have been proposed in the literature applicable to the analysis of heating and hot-water systems. Few methods have been proposed for the analysis of cooling systems, passive systems, and photovoltaic systems. Furthermore, few of the methods have been tested extensively against experimental data. This paper provides insight to the basic, underlying assumptions of the proposed methods so that the reader better understands the applicability of each to the performance prediction of various systems. (Author)

A80-33620 A simplified solar cooling design method for closed-loop liquid systems. D. K. Anand, R. B. Abarcar, and R. W. Allen (Maryland, University, College Park, Md.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1203-1207. 8 refs. Contract No. EY-76-S-05-4976.

The paper examines a simplified solar cooling design method for closed loop liquid systems. At the present state-of-the-art, solar cooling system performance can only be predicted by a detailed computer simulation. A simulation program (SHASP) has been used in solar cooling systems analysis; however, since not all designers have access to computers that can handle detailed simulation, an alternative is presented in a simplified cooling design method derived from the correlation of detailed simulation results. One such correlation is the cooling fraction chart which can be used to predict solar heating contribution to within 5% of the actual SHASP result. A.T.

A80-33621 * Performance analysis for collector-side reflector systems. P. N. Espy (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1208-1212. 10 refs.

The F-Chart method of solar collector performance evaluation is extended to a flat-plate collector system augmented with planar side reflectors. The modified F-Chart evaluations show that the augmentation of the collector has approximately the effect of increasing the collector area by 60%, and the energy supplied by the collector better matches the load. The installed reflector cost of about 10% of the collector cost is shown to be well justified. V.L.

A80-33622 Cooling system parameter analysis. P. S. Brenner, D. S. Ward, and G. O. G. Lof (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1213-1217. Research supported by the U.S. Department of Energy.

CSU Solar House III operated with a solar cooling system during the summer of 1978. Research was conducted by simulating the solar house and by using analysis results to quantify the piping losses. The

goal is the development of design techniques for system parameters such as piping losses. Preliminary results of the research on cooling system parameters are presented. The indications are that these parameter effects can be characterized and accounted for. Proper design of system parameters is an important part of the overall performance. S.D.

A80-33623 * Thermic diode performance characteristics and design manual. D. E. Bernàrd (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and S. Buckley (MIT, Cambridge, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1218-1222. 5 refs. Contract No. EG-77-S-02-4383.

Thermic diode solar panels are a passive method of space and hot water heating using the thermosyphon principle. Simplified methods of sizing and performing economic analyses of solar heating systems had until now been limited to passive systems. A mathematical model of the thermic diode including its high level of stratification has been constructed allowing its performance characteristics to be studied. Further analysis resulted in a thermic diode design manual based on the f-chart method. (Author)

A80-33624 Optimization of the combined structural components of large-power solar central receiver systems. V. Dunder (Sandia Laboratories, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1224-1228. 5 refs. Research supported by the U.S. Department of Energy.

A80-33625 An optimization procedure for solar thermal electric power plant design. W. M. Bohon and S. L. Levy (Black and Veatch Consulting Engineers, Kansas City, Mo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1229-1232.

The design of a solar thermal electric power plant to produce electricity at the least cost involves a great number of performance/cost evaluations. A sound engineering approach to this optimization task is through suboptimization, e.g., maximize the performance (energy output) of each plant design considered and then select the best design via differential cost estimates (minimize cost of electricity). A procedure is presented for designing a solar thermal electric power plant such that plant performance is maximized. (Author)

A80-33626 DELSOL - A code for central receiver performance and optimization calculations. T. A. Dellin and M. J. Fish (Sandia Laboratories, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1233-1237. 6 refs. Contract No. DE-AC04-76DP-00789.

DELSOL is a quick and accurate computer program for calculating the field performance, field layout and optimal system design for solar central receiver plants. The code consists of a detailed model of the optical performance, a simpler model of the non-optical performance, and algorithms for field layout and finding the best system design. The latter two features are coupled to a cost model of central receiver components and an economic model for calculating energy costs. The code can handle flat, focused and/or canted heliostats and external cylindrical, multi-aperture cavity, and flat plate receivers. The program optimizes the tower height, receiver size, and field layout as a function of power level. (Author)

A80-33627 The cost/performance of large central receiver power systems as a function of heliostat design parameters. M. J. Fish and T. A. Dellin (Sandia Laboratories, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May

28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1238-1242. 8 refs. Contract No. DE-AC04-76DP-00789.

The heliostat field comprises the largest expense as a subsystem of a solar central receiver power plant. Potential cost reductions might be achieved by either total redesigns or subcomponent substitution in existing designs. This paper discusses the value of changing any of several design specifications in the current baseline glass/metal heliostat. Results are quantified in terms of the breakeven cost, i.e., the cost of a new design which will yield the same total system energy cost as the baseline system. Changes in pointing accuracy, surface quality, mirror reflectivity, canting and focusing strategy, and heliostat size are evaluated. (Author)

A80-33628 An investigation of optimum heliostat spacings for the sub-tower region of a solar power plant. M. D. Walzel (Houston, University, Houston, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1243-1247. Contract No. EG-77-C-04-3974.

An investigation of optimum heliostat spacings for the sub-tower region of a solar power plant is presented. This information is obtained from a cellular structure of the heliostat field which has a representative at the center of each cell; finding an optimum solution for the inner cells adjacent to the tower can become a problem, along with mechanical limits when solutions require heliostats to be placed closer than allowed. The annual performance, shading, and blocking losses are compared in the hexagonal close-packed arrays oriented along a north-south and an east-west direction. A.T.

A80-33629 Theoretical consideration on solar concentrations by central receiver systems. T. Sakurai. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1248-1252.

Solar concentrations by central receiver systems have been calculated theoretically assuming that plane heliostat-mirrors, sufficiently small in dimension, cover a circular field without clearance. For the solar radiation incident normal to the heliostat-field, the volume- as well as area-concentration were found to be maximum when the radius of heliostat-field was nearly the same as the height of receiver. The optimum radius showed a slight increase with increasing obliquity of incident radiation. The decrease of concentration with increasing mirror-dimension was estimated by a convenient method. The effect of the geometry of composite mirror on the concentration was discussed also. (Author)

A80-33630 Optical analysis of paraboloidal concentrators with secondary reflectors. A. J. McDanal (E-Systems, Inc., Dallas, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1256-1260.

The paper presents the results of an optical performance analysis of a paraboloidal solar concentrator for a family of secondary reflectors. Solar-thermal-electric power systems are under development which require flux concentration ratios on the order of 2000 or greater to achieve the high temperature for efficient heat engine operation. The optically-perfect parabolic dish concentrators produce high concentration ratios, but require the bulky receiver/heat engine at the focal point of the parabola; the optically perfect paraboloidal concentrator with an optimized secondary reflector yields a concentration ratio of 9200 and has an advantage of the receiver/heat engine located at the vertex of the paraboloid. A.T.

A80-33631 * Optical analysis of Cassegrainian concentrator systems. A. H. Bass, Jr., G. L. Schrenk (Pennsylvania, University, Philadelphia, Pa.), P. T. Y. Poon, and S. N. Higgins (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1261-1265. 6 refs. Research sponsored by the U.S. Department of Energy.

Cone optics procedures have been developed to treat optical systems employing multiple reflectors. The objective of the procedures is to develop efficient techniques to treat multiple reflections of cones when the secondary reflecting surface is curved - in fact, curved differently in different directions. The particular optical system under consideration is the Cassegrainian Concentrator System - a system consisting of a paraboloidal primary reflector and a confocal hyperboloidal secondary reflector. Multiple reflection cone optics methodology as well as preliminary results for the flux distributions and intercept factors based on it are presented in this paper. It is shown that neglecting local curvature effects of the secondary reflector, i.e. even in the differential solid angle within the sun's cone, may overestimate the peak of the flux distribution at the receiver aperture by a factor of two or more. (Author)

A80-33632 A numerical approach to the flux density integral for reflected sunlight. F. W. Lipps (Houston, University, Houston, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1266-1270. Contract No. EG-77-C-04-3974.

A numerical approach to the flux density integral for reflected sunlight is proposed, assuming isotropic Gaussian guidance errors. The flux density integral reduces to several iterated single integrals which are precalculated and stored in a table for interpolation. The LBL solar telescope data are fed into a convolution integral representing the guidance errors and at this point Aureole effects can be switched on or off. A vector of convoluted solar data is input to another integration which gives the table of normalized flux contributions. The tabular values are shown to depend on the position of the flux point with respect to an edge of the heliostat as seen in the image plane. L.M.

A80-33633 A study on mirror fields for tower type solar power plants. G. Francia (Genova, Università, Genoa, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1271-1275.

The paper discusses the use in solar power plants of double curvature mirrors (DCMs), which are capable of rotating about their normal so that the minimum mirror curvature remains on the sun-mirror-receiver plane. DCMs are proposed as a replacement for paraboloid sectors, since the paraboloid changes with the apparent motion of the sun. Attention is given to the movement of DCMs, and the possibility of commanding the rotation of the mirror around its normal by mechanical or electrical means. Also discussed are caustics and image enlargement, and a comparison of DCMs with spherical mirrors is presented. J.P.B.

A80-33634 Analytical and experimental determination of radiation and temperature distributions inside solar receivers. D. Blay and C. Haziza (CNRS, Laboratoire d'Energétique Solaire, Poitiers, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1276-1280. 5 refs.

A80-33635 Conceptual design of a solar-heated-air receiver coupled to a Brayton or Stirling engine. N. I. Hamilton and P. O. Jarvinen (MIT, Lexington, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1281-1285. Research sponsored by the U.S. Department of Energy.

A80-33636 Unfolding concentrator slope errors from reflected-beam measurements. F. Biggs, C. N. Vittitoe, and D. L. King (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1286-1288. Contract No. DE-AC04-76DP-00789.

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A measured flux-density pattern in the reflected beam of a heliostat is analyzed to unfold the distribution of surface slope errors for a heliostat reflecting surface. It is found that two-dimensional effects in this error distribution are within the resolution of the measurements. (Author)

A80-33637 Helios and reconcentrators. C. N. Vittitoe, F. Biggs, L. K. Mathews, and L. O. Seamons (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1289-1293. Contract No. AT(29-1)-789.

Computer predictions for solar energy collection are compared with image data produced by 23 heliostats and with data from a single facet. Two-dimensional surface slope errors and reflectance properties necessary to explain the single-facet results are outlined. V.T.

A80-33638 Design and performance characteristics of compound parabolic concentrators with evacuated and with non-evacuated receivers. M. Collares-Pereira, J. O'Gallagher, A. Rabl, R. Winston (Chicago, University, Chicago, Ill.), R. Cole, W. McIntire, K. Reed, and W. Schertz (Argonne National Laboratory, Argonne, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1295-1299. 12 refs. Contracts No. EY-76-S-02-2446; No. W-31-109-eng-38.

A80-33639 Process steam generation by a faceted, non-imaging solar concentrator. U. Ortobasi, J. A. Atienza, K. G. Soderstrom, A. M. Lopez, L. M. Ozakcay (Center for Energy and Environment Research, Mayaguez, P.R.), and R. Winston (Chicago, University, Chicago, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1300-1303. Research supported by the Bacardi Corp., Center for Energy and Environment Research, and University of Chicago.

A modular non-imaging trough collector for the generation of process steam in a tropical environment has been designed and built. The concentrator design has the desirable features of low cost and light weight. Transportation and installation costs are reduced by its modular aspect. The most innovative feature of this concentrator is that the mirror surface consists of long and narrow planar facets sealed inside low cost glass tubes. The absorber for this collector is also a new design. (Author)

A80-33640 Specular reflectance properties of solar mirrors as a function of incident angle. D. N. Glidden (Albuquerque Academy, Albuquerque, N. Mex.) and R. B. Pettit (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1304-1308. 8 refs. Contract No. DE-AC04-76DP-00789.

The specular reflectance properties of several solar mirror materials have been measured as a function of wavelength, polarization and incident angle. Results for a 3-mm thick, silvered float glass mirror and an aluminized acrylic stretched film are presented. For the silvered glass mirror, measured specular and hemispherical reflectance properties are in excellent agreement with reflectance values calculated from a multiple beam reflectance model. At 65 deg from normal, the average solar reflectance is decreased only about 4% from the value at normal incidence. For the aluminized acrylic mirror, measured specular reflectance values at 15 mrad are in agreement with hemispherical reflectance values, while calculated reflectance values are as much as 2% high for one polarization. The average solar reflectance decreases only 2% at an incident angle of 65 deg from normal, while the width of the specular beam increases slightly with incident angle. (Author)

A80-33641 A computational alignment method for paraboloidal collectors. B. Edwards (Australian National University,

Canberra, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1309-1313. 6 refs.

The proposed alignment method for solar collectors requires no adjustments and relies only on measurements. The method consists in the determination of the calibration constants, i.e., the positions of the zero points and axis direction. The mathematical description of the process is given and implementation details are presented. The accuracy of the system is determined as a function of the system variables. For error ratios of 1.0, the computation for each alignment is estimated at \$0.10. V.L.

A80-33642 Identification of alignment and tracking errors in the open loop, time based heliostat system of the 400 kw Advanced Components Test Facility. H. L. Teague, C. T. Brown, C. J. Swafford, and G. C. Lewis (Georgia Institute of Technology, Atlanta, Ga.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1315-1318.

A80-33643 Collector deflections due to wind gusts and control scheme design. B. Edwards (Australian National University, Canberra, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1319-1323. 7 refs.

The paper considers the relationship between the spectrum of collector deflections due to winds and the composition of the guidance system controlling the collector. It is shown that the interface between these two factors is the required rigidity of the collector, noting that it is important that the collector is not over- or under-designed in this respect. The average sun following error is presented as a function of collector rigidity and guidance and control system type. Further, the required collector rigidity is also presented as a function of average sun following error and guidance and control system type. It is concluded that the contents of the work are applicable to both direct tracking collectors and heliostats. M.E.P.

A80-33644 A simple technique for measuring slope or surface error of a concentrator. J. Sanchez and W. Saylor (General Electric Co., Space Div., Valley Forge, Pa.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1324-1327.

A technique is developed for measuring both sag and slope error of a concentrator. The test method uses a helium-neon laser as a light source, and two sheets of transparent acrylic, which, when suspended vertically and weighted, define parallel planes. The laser is aligned so that its beam is perpendicular to the two planes. This can be checked by seeing that the laser light which is reflected by the two sheets is directed straight back and onto the laser. The concentrator is then placed so that a hypothetical normal to the bottom of the collector is parallel to the direction of the incident laser light. In other words, if the laser is simulating light from the sun, the concentrator is aligned to face the laser as it would normally be aligned to face incident solar radiation. With the positioning of test pieces completed, one can begin measurements and analysis. This method offers two distinct advantages: the procedure is simple and does not require elaborate test equipment, and the method permits one to simultaneously determine both cumulative sag and actual slope error. S.D.

A80-33645 How to measure the optical quality of focusing solar collectors without laser ray tracing. P. Bendt, H. Gaul, and A. Rabl (Solar Energy Research Institute, Golden, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1328-1332. 12 refs.

A novel alternative to the laser ray trace technique is proposed. The new method does not require any equipment beyond what is

used for measuring collector efficiency. The question arises whether instantaneous efficiency measurements can somehow be used to determine $\sigma(\text{optical})$, the rms angular beam spread caused by optical imperfections. It is shown that this can indeed be accomplished by misaligning the collector slightly away from the sun and measuring the efficiency for several values of the misalignment angle. The optical error $\sigma(\text{optical})$ is then extracted by finding the theoretical curve which best fits these misalignment data. Thus, the determination of $\sigma(\text{optical})$ could become part of the standard test procedures for concentrating solar collectors. The theory underlying this method is described, and test results for a parabolic trough collector with cylindrical receiver are presented. The data obtained with this collector point to an acceptable accuracy (within + or -10%) of this method. S.D.

A80-33646 Practical method for including material scattering effects in determining the amount of intercepted sunlight in solar concentrators. R. B. Pettit, C. N. Vittitoe, and F. Biggs (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1333-1337. 10 refs. Contract No. DE-AC04-76DP-00789.

A80-33647 Effects of outdoor exposure on the solar reflectance properties of silvered glass mirrors. J. M. Freese (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1340-1344. 5 refs. Contract No. DE-AC04-76DP-00789.

As solar energy grows in importance, a basic understanding of how environmental factors affect the performance of solar collectors becomes necessary. To this end, the present work studied the specular reflectance properties of silvered glass heliostat mirrors during a 15-month period of exposure to outdoor weather conditions. Initial experiments were designed to obtain a broad, general understanding of the effects of dust accumulation and weather conditions on glass mirror reflectivity. A systematic cleaning procedure was used to determine whether the long-term reflectance losses could be predicted from shorter cleaning cycle results. S.D.

A80-33648 Thermodynamic trade-offs for gas cooled high temperature solar tower receivers. F. D. Heidt and W. Schwarzott (Dornier System GmbH, Friedrichshafen, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1346-1349.

With regard to power generation by means of central solar tower plants, receiver configuration is analyzed, considering the radiative exchange between the isothermal receiver wall area and the aperture area where the solar power enters the receiver. Attention is given to the dependence of receiver efficiency on geometry, operational data, and thermo-optical constants. Also considered are the optimum size of the aperture area and optimized gas temperatures for cavity/Brayton cycle systems. A comparison between external and cavity receivers indicates that, for infrared emittance of 0.60 and cavity ratio of 0.10, flux densities greater than 400 kW/sq m and temperatures lower than 900 deg C should be handled by cavity receivers. J.P.B.

A80-33649 Advanced solar receiver development. P. O. Jarvinen (MIT, Lexington, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1350-1354. Research sponsored by the U.S. Department of Energy.

Ceramic receivers for advanced solar Brayton and advanced solar Stirling thermal power systems are considered which utilize impingement jet cooled silicon carbide ceramic dome heat exchanger modules in conjunction with a cavity receiver geometry to heat a pressurized gaseous heat transfer fluid to temperatures in the range from 1800 to 2400 F. Conceptual designs of single and multiple-dome ceramic cavity receivers are presented and analyzed and a

combined analytical and experimental program to develop a high temperature seal for the ceramic dome module is reported. (Author)

A80-33650 Theoretical study of gas heated in a porous material subjected to a concentrated solar radiation. G. Olalde (CNRS, Laboratoire d'Energétique Solaire, Odeillo, Pyrénées-Orientales, France), J. L. Peube (CNRS, Laboratoire d'Energétique Solaire, Poitiers, France), and M. Daguene (Perpignan, Centre Universitaire, Perpignan, Pyrénées-Orientales, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1355-1358. 6 refs.

The high-temperature heating of gases is considered theoretically and experimentally. A homogeneous solid material and a gas which is transparent to the radiation are studied under steady-state conditions and with constant physical properties, while the radiative fluxes are assumed to be uniform on the front surface of a porous medium. A system of dimensionless equations comprising one order-4 differential equation and one order-2 differential equation, with constant coefficients, is applied to the theoretical analysis of gas circulating both in the direction and in the opposite direction of the heat flow. Profiles of dimensionless solid and gas temperatures as a function of dimensionless distance are determined. Results from experiments using a cylindrical porous material bed of 70 mm O.D. and 75 mm length are presented graphically. J.P.B.

A80-33651 Catalyzed thermal conversion of SO₃ to SO₂+O₂ for solar thermal power. A. D. Baranyi, C. J. Stournaras, M. K. Murthy (Ontario Research Foundation, Mississauga, Canada), and T. A. Chubb (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1359-1361.

As part of the Solchem concept of chemical transfer of solar energy from collectors to a central receiver, a new cordierite ceramic converter-heat exchanger has been developed for the thermal conversion of SO₃ to SO₂+O₂. The ceramic converter-heat exchanger has good mechanical strength at high temperatures, low thermal expansion, low porosity and good resistance to attack by SO₃ and SO₂. Conversion of SO₃ to SO₂+O₂ has been demonstrated in straight pieces of the ceramic converter-heat exchanger with platinum catalyst at temperatures from 800 to 1000 C. Conversion of SO₃ at 1000 C approaches 95% (maximum theoretical efficiency). (Author)

A80-33652 A new solar thermal receiver utilizing small particles. A. J. Hunt (California, University, Berkeley, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1362-1366. 8 refs. Contract No. W-4705-eng-48.

A new type of solar thermal receiver is developed which utilizes the dispersion of very small particles suspended in a gas to absorb the radiant energy from concentrated sunlight. An open Brayton-cycle heat engine utilizing a small particle heat exchange receiver operates by injecting a very small mass of submicron carbon particles into the compressed gas stream before it enters the receiver. The operating temperature of the particle-gas mixture is determined by the vaporization rate of the carbon allotrope used to make the particles. Plant efficiencies in excess of 40% appear feasible without the use of cooling towers or bottoming cycles. Several methods of producing the particles are considered. Carbon is selected because of its optical, chemical and physical properties. The concept has been demonstrated in the laboratory. S.D.

A80-33653 Study and realisation of a high temperature air cooled solar receiver. B. D'Utruy, D. Blay, and F. Ortiz (CNRS, Laboratoire d'Energétique Solaire, Poitiers, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1367-1370.

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An elementary solar panel is developed to warm up air up to 800 C in view of further application of Brayton cycle associated to air turbine. A honey comb cell profile is retained to absorb the radiant energy in small cavities and to warm up the air by forced convection. A theoretical approach is made to evaluate the metal temperature of the panel (40 x 60 cm) under steady state conditions. Theoretical values are compared to experimental data obtained on a test set up with 72 kw quartz lamps. (Author)

A80-33654 Users group for central receiver testing. F. B. Smith (STTF Users Association, Albuquerque, N. Mex.) and A. F. Hildebrandt (Houston, University, Houston, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1372-1376. 13 refs.

The paper considers the solar thermal test facilities Users Association (UA), which acts as the point of contact for users of such facilities, and which solicits and reviews proposals and makes recommendations to DOE regarding their utilization. Solar facilities with which the UA is involved are briefly described, including the Sandia central receiver test facility in Albuquerque, and the Georgia Tech 400-kW thermal central tower facility in Atlanta. The types of high-temperature solar experiments of interest to the UA include steam and hot gases for process heat and chemical transmission, in which high-temperature solar energy is used to split a compound over a catalyst into two or more higher-energy gaseous components. In addition, potential solar chemicals and fuels applications are discussed, such as converting biomass and coal or lignite into usable gases or liquid fuels, as well as the production of hydrogen via a water-splitting reaction, of carbon monoxide via solar coal gasification, and of ammonia and nitrogen fertilizer. J.P.B.

A80-33655 Testing procedures and test results for the EPRI/Boeing gas-cooled receiver tested in the Central Receiver Solar Thermal Test Facility. J. Gintz, R. Zentner (Boeing Engineering and Construction, Seattle, Wash.), B. Marshall, and L. Matthews (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1377-1381. 5 refs.

A80-33656 Testing of the 10-MWe pilot plant solar central receiver. G. C. Coleman (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.) and J. F. Friefeld (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1382-1386.

Insolation testing conducted at the Central Receiver Test Facility (CRTF) in New Mexico to validate the design of the pilot plant receiver panel and controls is discussed. Thermodynamic performance of the receiver is investigated, as well as pilot plant preheater panel performance, panel lateral heat flux gradients, and receiver surface-coating performance and durability. The description of the pilot plant receiver includes panel subassemblies, water manifold, backup structure, and individual tubular panel assemblies, as well as CRTF test receiver panel and flow components. Testing confirmed satisfactory preheater operation, panel expansion heliostat control, and feedwater temperature, pressure, and flow control. Proper functioning of the master control and data computer systems, receiver controller logic and the facility heat rejection system was also demonstrated. In addition, derated steam conditions of 660 degrees F and 1515 psia have been achieved and maintained during normal insolation periods. J.P.B.

A80-33657 One-quarter MWt air cycle receiver test at the Advanced Component Thermal Test Facility at Georgia Institute of Technology. A. Poirier, S. Davis, D. Ross, T. Nussdorfer (Sanders Associates, Inc., Nashua, N.H.), T. Brown, C. Seminario, and H. Teague (Georgia Institute of Technology, Atlanta, Ga.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June

1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1387-1389. Contract No. EG-77-C-03-1555.

A80-33658 Stability of plasma-sprayed coatings tested at White Sands Solar Facility. J. M. Schreyer, C. R. Schmitt (Oak Ridge National Laboratory, Oak Ridge, Tenn.), R. A. Hays, and D. Farwell (U.S. Army, White Sands Missile Range, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1390-1394. Contract No. W-7405-eng-26.

Plasma-sprayed coatings on steel plates were tested at the White Sands Solar Facility at temperatures from 200 C to 1000 C. Analysis of the specimens before and after testing showed erbium dodecaboride (ErB₁₂), yttrium hexaboride (YB₆), titanium diboride (TiB₂), and chromium oxide (Cr₂O₃) to be stable above 600 C. A heat balance on the water-cooled specimens of these coatings showed 73% to 97% heat recovery efficiency. (Author)

A80-33659 Treatment of molybdenite ore with laboratory scale solar furnaces. J. P. Coutures, G. Benezech, R. Renard (CNRS, Laboratoire des Ultra-Réfractaires, Odeillo, Pyrénées-Orientales, France), and S. R. Skaggs (California, University, Los Alamos, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1395-1399. Research supported by the Centre National de la Recherche Scientifique.

A80-33660 Evaluation of hardware and software requirements for the Advanced Components Test Facility real time data collection system - Experiences from two solar experiments. C. E. Seminario and B. C. Skelton (Georgia Institute of Technology, Atlanta, Ga.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1401-1405.

A80-33661 Mini-computer-based energy monitor system. H. F. Schuler, D. F. Rost, and G. Ameduri (General Extrusions, Inc., Youngstown, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1408-1410.

A mini-computer-based energy monitor system is under development for the solar industrial process heat system at General Extrusions, Youngstown, Ohio. The design goals are low cost, reasonable accuracy, control capability, coherent presentation of results, and sufficient hardware and software understanding to allow customization to this application as well as demonstrating the generic capabilities for energy monitor systems for Ohio industries. The major components are from the Heath Company, Benton Harbor, Michigan, because they offer a wide range of components specifically designed to work together and excellent hardware and software documentation. The temperature and flow sensors have not yet been specified. The work is supported by the Ohio Department of Energy. (Author)

A80-33662 A pin programmable controller for research systems. T. N. Bechtel, S. Karaki, G. D. Murphy (Colorado State University, Fort Collins, Colo.), and P. R. Armstrong (Altas Corp., Santa Cruz, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1411-1415. Research supported by the U.S. Department of Energy and Colorado State University.

A pin programmable logic array based controller has been designed and assembled specifically to accommodate the control needs of a solar heating and cooling research and development facility. The controller is suitable for systems covering a wide range of configurations and operating strategies and facilitates control changes with a diode pin programmable logic array. This logic element allows the user to establish the desired relationship between inputs (usually temperatures) and outputs (system components)

according to control criteria by insertion of diode pins into the appropriate location of the logic array board. A prototype has been installed and used in the experimental parallel heat pump, solar air heating and cooling system of CSU Solar House II during the 1978-1979 heating season. Experience has confirmed operation of the control unit according to design specifications. (Author)

A80-33663 The development of an Ambient Temperature Observer/Predictor /ATOP/ for use with solar heating systems. D. K. Hays (Solar Environmental Engineering Co., Fort Collins, Colo.), B. W. Parkinson (Rockwell International Corp., El Segundo, Calif.), and C. B. Winn (Colorado State University, Fort Collins, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1416-1420.

There has been a considerable amount of interest in the use of off-peak storage devices and/or heat pumps with solar heating systems. The control of such devices can lead to significant savings in fuel use if the future values of the ambient temperature are accurately predicted. Both a methodology and hardware for implementation of the methodology have been developed for accurately predicting ambient temperatures for up to 24 hours in advance. This system is referred to as the ATOP system, an acronym for Ambient Temperature Observer/Predictor. The methodology and applications are described in this paper. Also presented are some prediction results which are directly applicable to improved control of off-peak storage devices. (Author)

A80-33664 Optimal and sub-optimal control strategies and sensitivity study for solar liquid collector systems. A. Orbach, R. Fischl, P. R. Herczfeld, and S. Könyk, Jr. (Drexel University, Philadelphia, Pa.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1421-1425. 13 refs. Contract No. E-8-77-5-02-4512.

This paper is concerned with the control of liquid flow in the collector loop for solar heating application. The purpose of the paper is three fold: First a dynamic model which accurately reflects the dynamic behavior of the solar collector is given. Second, an optimal and suboptimal control strategy which maximizes the net usable energy is obtained using this dynamic model. Third, the implementation of the suboptimal policy via a thermostat on/off controller is investigated. Specifically, criteria are given for the selection of the control set points. (Author)

A80-33665 Control systems for interfacing solar agricultural dryers with other energy sources. J. H. Schlag, A. P. Sheppard, W. E. Baird (Georgia Institute of Technology, Atlanta, Ga.), and J. M. Wood (Southern Solar Energy Center, Atlanta, Ga.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1426-1428.

A80-33666 The design and development of programs to optimize the control, monitoring and functional analysis of the U of L solar research center. N. Schmitt, W. T. Jones, and T. M. Murray, Jr. (Louisville, University, Louisville, Ky.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1430-1434. 8 refs.

A80-33667 Measurements of performance and efficiency of solar energy systems. J. M. Suter and P. Kesselring (Zürich, Eidgenössische Technische Hochschule, Würenlingen, Switzerland). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1435-1439. Research supported by the Swiss National Energy Research Foundation.

Measurements on different types of solar energy systems throughout Switzerland have been made in order to detect principal

layout defects, evaluate the actual potential of the technology, and provide recommendations for architects and engineers. In particular, the control device and its interaction with various components are to be examined in detail, and the collectors are considered as an integrated part of the system. Attention is given to a microprocessor controlled, modular data acquisition unit comprised of 16 analog and 6 digital input channels and 15 recorded output quantities, which is used to determine the efficiencies of the collector, space heating boiler, and overall system, as well as storage losses and overall system energy balance. Results indicate that the most important reason for poor overall system efficiency is due to the design of the system itself: there are large storage losses and badly designed hydraulic loops, and the importance of heat storage measurement is often underestimated. J.P.B.

A80-33668 Development of a portable reflectometer for field measurements of the specular reflectance of solar mirrors. J. M. Freese (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1440-1444. Contract No. DE-AC04-76DP-00789.

A80-33669 Performance data from reduced levels of instrumentation in solar heated and/or cooled buildings. C. J. Packard (Alternative Energy Resources, Inc., El Paso, Tex.), R. L. San Martin (U.S. Department of Energy, Washington, D.C.), and D. Fenton (New Mexico State University, Las Cruces, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1445-1449.

A methodology of instrumentation system design is developed which supports multiple levels of hardware complexity and associated cost, while allowing valid performance comparisons to be made between solar buildings employing different levels of instrumentation. The key to the successful design of any instrumentation system is a systems analysis approach. A tool useful in this approach is the energy flow map. A case study of the New Mexico Department of Agriculture Building is presented which illustrates the use of the methodology. S.D.

A80-33671 Monitoring solar heated houses in the European community - Procedures, results and future activities. D. M. Lush (Ove Arup Partnership, London, England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1453-1457. 9 refs. Commission of the European Communities Contracts No. 509-78-2; No. 642-78-7.

The evaluation of solar heating systems in domestic premises is covered, for a wide range of climatic conditions, varying building standards and different occupancy patterns. The strategies for obtaining the necessary information are defined. The theoretical and practical requirements of monitored projects which have already been examined are discussed, together with some alternatives for possible future projects. (Author)

A80-33673 Characteristics of rural energy demand and major barriers and tasks and implementation of potentially viable solar technologies. J. Gururaja (Department of Science and Technology, New Delhi, India) and A. Ramachandran (HABITAT, Nairobi, Kenya). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1466-1470.

A80-33674 Solar energy in Africa: Survey of needs and activities - Potential applications of small solar energy systems. J. L. Sloop, M. H. Watt (PRC Energy Analysis Co., McLean, Va.), and J. J. Gordon (Mitre Corp., Metrek Div., McLean, Va.). In: Sun II;

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Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1471-1474. 10 refs.

A80-33676 **Prospects for solar cooling applications in Nigeria.** B. A. Ajakaiye (Ife, University, Ile-Ife, Nigeria). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1481-1484.

A80-33678 **A solar-powered irrigation system for Bakel, Senegal.** J. Keiser, P. Dustin (Thermo Electron Corp., Waltham, Mass.), J. P. Durand, and L. Pirot (Société d'Etudes Thermiques et d'Energie Solaire, Montargis, Loiret, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1492-1495.

A80-33679 **A free cylinder Stirling engine solar powered water pump.** W. T. Beale (Sunpower, Inc., Athens, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1496-1500. 7 refs.

This paper describes a free cylinder Stirling engine expressly designed for use as a solar water pump. The pumping action takes place as a result of the reciprocating motion of the cylinder of the sealed free piston engine, this cylinder motion being used to directly drive a reciprocating water pump. A 250 watt unit is described, comprised of a free cylinder engine, a faceted focusing collector containing many small mirrors, an equatorial mount, clock drive, tracker and tensioned cable pump. Expected cost of a complete system delivering 250 watts to the water (25 liter-meters/sec) is about \$500 in large scale production. (Author)

A80-33680 **Operational experience of a 3.0 kW solar powered water pump.** C. Macciò, G. Tomei (Ansaldo S.p.A., Genoa, Italy), G. Angelino, M. Gaia, and E. Macchi (Milano, Politecnico, Milan, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1501-1505.

During the Spring of 1978 a solar powered pumping system has been put in operation on the roof of an office building at Ansaldo, for demonstration and experimental purpose. In the paper, the plant design and operation is described, and the obtained results on the performance of the organic Rankine cycle engine, having a single stage turbine as the expander, are presented. (Author)

A80-33681 **Rotary expander for a solar thermo-mechanical conversion system.** R. Chicurel (Universidad Nacional Autónoma de Mexico, Mexico City, Mexico). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1507-1510. 7 refs.

The third and latest version of a rotary steam engine under development at the Engineering Institute of the National Autonomous University of Mexico is described. The working chamber is bounded by four oval-shaped rotors and two side cover plates. The rotors rotate at the same constant speed and in the same direction. Two impulses occur per revolution. The engine's displacement is 208 cu cm and the expansion ratio is 4.15. It will form part of a solar powered Rankine system operating with water as working fluid. The design output is 2 kW of mechanical power. If tests prove satisfactory, a larger engine will be built for a scaled-up system producing 35 kW. (Author)

A80-33682 **A 500 gallons per day hybrid desalination plant using wind/solar energy.** E. Lumsdaine and I. Tag (New Mexico Solar Energy Institute, Las Cruces, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1512-1516.

An analysis of a modular wind/solar distillation plant is presented. The design is based on a constant year-round demand of 500 gallons per day. In arid areas where wind power is available, cost analysis shows that the hybrid system is economically feasible compared with electricity which could only be generated from a conventional source such as a diesel engine. Solar stills are of the basin type while the wind energy conversion system is a horizontal axis type. The selection of the type of wind machine (whether constant speed or variable speed) depends on the meteorological conditions and the frequency of water demand. (Author)

A80-33683 **A regional comparative analysis of residential passive solar systems - Thermal storage walls and direct gain.** F. Roach (California, University, Los Alamos, N. Mex.) and S. Ben-David (New Mexico, University, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1521-1525. 12 refs.

A80-33684 **A simple procedure for assessing thermal comfort in passive solar heated buildings.** W. O. Wray (California, University, Los Alamos, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1530-1534. Research sponsored by the U.S. Department of Energy.

The Fanger thermal comfort equation is linearized and used to develop a procedure for assessing thermal comfort levels in passive solar heated buildings. In order to relate comfort levels in non-uniform environments to uniform conditions, a new thermal index called the 'equivalent uniform temperature' is introduced. (Author)

A80-33685 **Thermopond applicability to climate and structure.** H. R. Hay (Skytherm Processes and Engineering, Los Angeles, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1535-1539. 5 refs. Research supported by the U.S. Department of Energy.

Collection, storage, dissipation and transfer of heat from Thermoponds with movable insulation have newly recognized potentials for solar heating, for replacing air conditioners, and for lessening peak power demand. The state-of-the-art for Skytherm natural heating and cooling of residential and commercial buildings is presented; fire protection and sound control are additional assets. Designs for high seismic, wind, and Thermopond loads are adapted in several illustrated architectural and structural forms. (Author)

A80-33686 **The characterization of the performance of passive solar heating systems.** A. M. Clausing and B. L. Drolen (Illinois, University, Urbana, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1540-1544. 8 refs.

The proposed method of thermal performance evaluation of passive solar heating systems employs three dimensionless performance indicators: efficiency, effectiveness, and comfort index. These indicators are used to quantify the thermal performance characteristics of direct gain and storage wall systems. Typical ranges are presented for key parameters in order to facilitate system design. Explicit analytical solutions are found for three- and four-node models which provide performance bounds for passive solar systems. It is concluded that the method is useful in sizing designs, analyzing the effect of system parameters, such as nighttime insulation, and evaluating the relative performance of various designs. V.L.

A80-33687 **An experimental approach for studying direct solar gain optics of model interiors.** J. F. McClelland, R. Fuchs, and R. N. Kniseley (Iowa State University of Science and Technology, Ames, Iowa). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.

Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2.
Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1620-1624. Research supported by the Consiglio Nazionale delle Ricerche.

A numerical method for the geometric location of the shadows produced by a building on a vertical or horizontal surface is developed. The method also determines the area of the shadows and especially the 'shadow factor', defined as the area of that part of the shadow which intersects a unit rectangle, suitably selected on the surface. In view of its application to several problems (urban planning, correction of thermic load tables), the dependence of the 'shadow factor' upon some parameters is studied. The results for particular cases are presented. (Author)

A80-33688 Physical modeling of buildings. K.-E. Hassan (Centre for Solar Energy Studies, Tripoli, Libya), G. M. Zaki, and A. A. El-Shibani (Alfateh University, Tripoli, Libya). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1551-1555. 11 refs.

The present paper treats the problem of simulating the thermal behavior of a building by a scale model. It takes into consideration insulation on and into the building, and the energy that may be removed by a solar device. The similarity groups that control modeling are deduced from the governing mathematical relations. The effect of each of these groups is studied in some detail. (Author)

A80-33689 Hybrid active-passive designs - Synergy or conflict. J. D. Balcomb, J. C. Hedstrom, and R. D. McFarland (California, University, Los Alamos, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1556-1560. 5 refs. Research sponsored by the U.S. Department of Energy.

Hybrid combinations of active and passive solar heating systems are analyzed using hour-by-hour simulation analysis for a combined space heating and domestic hot water load in Albuquerque and Madison. Various mixes of passive and active solar collection area are studied. The passive system is a Trombe wall design and the active system uses liquid heating collectors. (Author)

A80-33691 Utilization of natural/passive energy systems in a University Office/Teaching Laboratory Building. R. J. Martin (Everett, Zeigel, Tumpes and Hand, Boulder, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1565-1568.

A80-33692 Economic aspects of passive solar remodeling in existing buildings. J. L. Mickelson, Jr. and M. M. Sizemore (Sizemore/CRS, Atlanta, Ga.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1569-1573.

A80-33693 Preliminary winter comparison results of four passive test cells in Omaha, Nebraska. B. Chen, J. Maloney, J. Thorp, K. Pedersen, W. Holmes, C. Sedlacek, R. Sash, and E. Hollingsworth (Nebraska, University, Omaha, Neb.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1583-1587.

Four test cells incorporating various passive solar energy techniques have undergone testing since the end of December 1978. The purpose of this research is to evaluate the suitability of passive solar energy to the midwestern winter climate and to compare the performance of the direct gain with the Trombe wall type of passive system. In order to accomplish these goals, the predicted-computer performance studies are being corroborated by test cells. (Author)

A80-33694 Performance of passive test units during the 1978-79 heating season. T. Wheeling, B. Wadsworth, and L. Palminter (National Center for Appropriate Technology, Butte, Mont.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1589-1593.

Several passive solar test units have been monitored at the National Center for Appropriate Technology since January, 1978. The design, instrumentation, and performance of the direct gain and Trombe wall cells, during the 1978-79 heating season, are discussed. A continuous sequence of hourly measurements, including incident radiation, air temperatures, and thermal storage temperatures has been recorded for the six month period, November 1978 through April 1979. These measurements have been used for the validation of a simple computer simulation model developed at NCAT. (Author)

A80-33695 Performance analysis of a natural convection collector system. J. Cook (Arizona State University, Tempe, Ariz.) and S. Morris. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1594-1598.

A 100% passive heated solar house in the mountains of Arizona, utilizing a full-scale, natural convection collector system with a rock bed storage, has been extensively monitored. An intensive examination of a one-day cycle, as well as a continuous six-day sequence, graphic analyses, plus numerical calculations and evaluation are presented. The results show efficiencies ranging between 30.5% and 43.3% during the demanding period of December 20 to 28. Documentation illustrates the parameters and advantages of such passive solar collector systems with isolated thermal storage. Recommendations and conclusions are made for final adjustments to this system and for the design of future convective systems. (Author)

A80-33696 Measured performance of a passive solar residence in Bozeman, Montana. C. W. Fowlkes (Fowlkes Engineering, Bozeman, Mont.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1600-1604. 5 refs.

This paper summarizes the thermal performance of a passive solar house. Hourly data taken over a three month period during one of the coldest winters on record showed that the solar system was providing 65% of the heating load. The average house temperature was 19 C and the average daily variation was 6.4 C. A low-cost data acquisition system utilizing a Radio Shack TRS-80 computer was developed for this project. (Author)

A80-33697 A new and simple method for estimating the monthly and yearly performance of passive solar systems. R. O. Warrington, R. E. Stotts, R. L. Mussulman, and W. R. Martindale (Montana State University, Bozeman, Mont.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1606-1609. 6 refs. Research supported by the Montana State University.

A80-33698 Monthly average daily insolation on overhang shaded windows. R. E. Jones, Jr. (Colorado, University, Colorado Springs, Colo.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1610-1614. 8 refs.

A method is presented for calculation of the monthly average daily insolation on windows of arbitrary azimuth shaded by overhangs of effectively infinite lateral extent. The method considers beam, diffuse and reflected radiation and is based on an extension to a totally arbitrary orientation of the methods of Liu and Jordan (1961) and of Klein (1977) for estimating the radiation on tilted surfaces. This extension also allows the determination of daily insolation on skylights and windows having orientations away from the equator. (Author)

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A80-33699 A procedure for determining solar heat gain factors for south-facing vertical surfaces on average days. G. L. Powell and J. I. Yellott (Arizona State University, Tempe, Ariz.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1615-1619. 15 refs.

A80-33700 Determination of the shadows area induced on horizontal and vertical surfaces anyway oriented. A. Calarco and M. De Luca (Istituto Universitario Statale di Architettura, Reggio Calabria, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1546-1550. 7 refs. Research supported by the U.S. Department of Energy.

An experimental approach is discussed for measuring the effective solar absorptivity and related optical properties of direct gain interiors. Measurements can be made on a zone or total interior basis using easily constructed models. The study covers characterization requirements, experimental methods, measurement theory, and preliminary experimental results. The data that can be acquired through this approach will be of use in the economical integration of direct gain solar collection with a wide variety of building interiors. (Author)

A80-33703 An application of phase change materials in passive solar systems. S. Faunce, J. Sliwowski, and S. Guceri (Delaware University, Wilmington, Del.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1637-1641. Research supported by the U.S. Department of Energy, Baltimore Gas and Electric Co., and Pennsylvania Power and Light Co.

A modular, hybrid passive solar energy collection and storage unit which is based on energy storage in phase-change materials has been developed for use in a passive solar heating system. The unit, termed the Thermal Wall Panel, is essentially a flat-plate solar collector mounted in the south-facing wall of a structure which uses the phase-change material $\text{Na}_2\text{SO}_4(10\text{H}_2\text{O})$ as an energy storage medium. Results of tests of a 24-sq ft panel during March indicate that the unit can capture and deliver as heat up to 45% of incident solar energy, and supply up to 56% of the heating requirements for a typical 1800 sq ft house in the mid-Atlantic region if coupled with direct solar gain for daytime heating. A computer model developed for the thermal Wall Panel has been found to be in good agreement with experimental measurements. Cost estimates have shown that the system can be installed at an incremental cost of \$6 to \$8 per sq ft and have a simple payback period of seven to nine years. It is recommended that full-scale testing of the system be initiated as a further step in its commercialization. A.L.W.

A80-33704 Analytical and economic evaluation of heat pipe augmented passive solar heating systems. J. M. Corliss and G. H. Stickford (Battelle Memorial Institute, Columbus, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1642-1646. Contract No. DE-SA04-77AL-04222.

A80-33705 Dual desiccant-bed dehumidifier with solar-heated regeneration. F. Moore, J. Cantrell, and G. Willeke (Miami University, Oxford, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1647-1650. 10 refs. Research supported by the Miami University.

A80-33708 Solar-cladding - Insulation plus insolation. A. W. K. MacGregor (Napier College of Commerce and Technology, Edinburgh, Scotland). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1665-1668.

This is an investigation into the possibilities of applying translucent insulation material to the outside surface of existing solid walled buildings, so that the basic heat loss is reduced and, unlike conventional opaque insulation, the solar gain through the wall is increased. Theoretical analysis and experimental work both indicate that the potential energy savings per unit area are of the same order as for solar water heating systems - but with costs at least an order of magnitude less. The main area of application is likely to be in high latitude, maritime regions where overheating is not a problem. (Author)

A80-33709 Hybrid passive for motel guest rooms. R. Wright, L. Dieckmann, R. Selby, and S. Wright (Hawkweed Group, Ltd., Chicago, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1669-1673.

A 19,000 square foot solar-heated motel at Osseo, Wisconsin, contains twenty guest rooms, three shops, banquet facilities, restaurant and lobby. An appropriate integral system was selected for each area of the building based upon occupancy profile. Systems used include mass walls at guest rooms, direct gain at shops and site-built flat plate air type collectors at public spaces. This paper describes the various systems, the design process and construction methods. (Author)

A80-33710 Retrofit sun room thermal performance based on the typical meteorological year weather data. F. C. Westling, E. L. Harley, P. J. Roache, W. C. Marrable, and B. C. Litz (New Mexico University, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1684-1688. 6 refs.

A80-33711 Design and initial performance of the solarium-assisted dormitory at the White Mountain School, Littleton, N.H. A. O. Converse, M. Hall-Martindale (Dartmouth College, Hanover, N.H.), and C. S. White (Banwell, White and Arnold, Architects, Hanover, N.H.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1689-1693. Contract No. EG-77-6-04-4139.

A80-33712 European progress in photovoltaic development. R. J. van Overstraeten (Leuven, Katholieke Universiteit, Louvain, Belgium). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1721-1724.

Photovoltaic industrial production and research and development activities in Europe are reviewed. Consideration is given to materials, cells, and small power systems. System studies are also outlined. V.T.

A80-33713 A 100 kW peak photovoltaic power system for the Natural Bridges National Monument. E. F. Lyon (MIT, Lexington, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1732-1736. Research sponsored by the U.S. Department of Energy.

The implementation of a 100-kW peak photovoltaic power system for the Natural Bridges National Monument in southeastern Utah is considered. The site, PV power system, and its operation are described. V.T.

A80-33714 The Ramón Areces concentration photovoltaic array. G. Sala, G. L. Araújo, A. Luque, J. M. Ruiz, A. Coello, E. Lorenzo, F. Chenlo, J. Sanz, and A. Alonso (Madrid, Universidad Politécnica, Madrid, Spain). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p.

1737-1741. 10 refs. Research supported by the Ramón Areces Foundation.

The project of the 1.8-kW Ramón Areces concentrating photovoltaic array is described, and the results obtained are presented. The objectives of this project are to identify the relevant subjects for research, to determine the real costs of concentrated photovoltaic generators, to evaluate their efficiency and operation modes along the year, and to test the reliability of their active and passive components. The operating characteristics of the array along the year are calculated using measured parameters of the fabricated cells.

S.D.

A80-33715 Autonomous solar-powered beacon for air navigation use. D. Lamant and D. Pero (Instituto Universitario de Tecnología, Caracas, Venezuela). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p.

1746-1748.

Radio-aid equipment for air navigation, used in Venezuela, is described along with its characteristics and locations. The feasibility of installing solar-powered radio-aid beacons to improve the present network is discussed.

V.T.

A80-33716 A 20 kW photovoltaic flat panel power system in El Paso, Texas. B. Blevins, R. Hsiao, A. Masud, H. Zwibel (New Mexico Solar Energy Institute, Las Cruces, N. Mex.), J. Brown (El Paso Electric Co., El Paso, Tex.), J. Morrison (Fouts, Langford, Gomez and Moore, El Paso, Tex.), L. Golucke (Golucke Consulting, El Paso, Tex.), and P. Locke (Photon Power, El Paso, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1749-1753. Contract No. ET-78-C-04-5402.

Two designs for a 20-kW photovoltaic power system utilizing cadmium and silicon modules are described. Consideration is given to photovoltaic modules and system and economic tradeoffs.

V.T.

A80-33717 Photovoltaic module performance and degradation at various MIT/LL test sites. S. E. Forman (MIT, Lexington, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1759-1763. Research sponsored by the U.S. Department of Energy.

The report summarizes the performance of a 25-kW photovoltaic module array. The physical and electrical changes which have occurred due to weathering and soil accumulation since system turn-on are discussed.

V.T.

A80-33718 The photovoltaic effect, its present understanding and remaining mysteries. K. W. Boer (Delaware University; SES, Inc., Newark, Del.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1766-1770. 26 refs. Research supported by the U.S. Department of Energy.

The paper presents an analysis of the photovoltaic effect. Current-voltage characteristics, high-field effects, heterojunction, and junction or interface recombination are discussed. It is noted that several factors need more work and clarification.

V.T.

A80-33719 A fabrication process for Cu₂S-CdS thin film solar cells. W. H. Bloss, W. Arndt, G. Bilger, G. H. Hewig, F. Pfisterer, and H.-W. Schock (Stuttgart, Universität, Stuttgart, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1773-1776. 10 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045; European Economic Community Contract No. 428-78-EsD.

A fabrication process for Cu₂S-CdS thin film solar cells was developed and is described in detail. The Cu₂S-CdS heterojunction is produced using the Clevite process. Sheet glass is used as substrate

and encapsulation. On the back contact, a CdS layer is evaporated, whereas the Cu₂S-layer is produced topotaxially in a dipping process. The front contact is produced using silk screening and etching techniques. On a 7 x 7 sq cm large area substrate glass, encapsulated thin film solar cells with a Cu₂S area of 42 sq cm are produced, which show conversion efficiencies of 7.3%. (Author)

A80-33720 Advances in the development of low-cost, high performance cadmium-sulfide based thin-film solar cells. A. M. Barnett, J. D. Meakin, and A. Rothwarf (Delaware University, Newark, Del.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1777-1781. 13 refs. Contract No. EG-77-C-03-1576.

The paper describes the techniques utilized to analyze losses, and the improved designs and production technologies of thin-film polycrystalline CdS/Cu₂S solar cells, that resulted in systematic increases in energy conversion efficiencies from 7.8 to 8.55 and 9.15%. Analytical and experimental results are presented.

V.T.

A80-33721 Design and performance of silicon solar cells under concentrated sunlight. H. T. Weaver and R. D. Nasby (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1782-1785. 10 refs. Research supported by the U.S. Department of Energy.

The paper examines theoretically two concentrator solar cell designs: a baseline $n(+)-p/$, and a back-surface-field $p(+)-n-n(+)/$ cell. Results of these analyses are compared with experimental data from cells fabricated at several facilities. Agreement between calculations and observations is within 10%; this is somewhat surprising in view of the simplicity of the model of the high-doped regions. Projected maximum efficiencies for both cell designs occur near 25 suns concentration for the assumed 0.02-ohm series resistance. Current fabrication techniques have produced, on a best-effort basis, efficiencies of about 18.5% for both designs.

S.D.

A80-33722 MIS solar cells on crystalline, polycrystal, and thin film silicon. S. L. Hyland, J. K. Kim, A. E. Delahoy (Rutgers University, Piscataway, N.J.), W. A. Anderson, and K. Rajkanan (New York, State University, Buffalo, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1786-1789.

The performance characteristics of MIS solar cells using single crystal, polycrystalline, ribbon and thin film silicon are investigated. Overall cell efficiencies, open-circuit voltages, short-circuit current densities and diffusion lengths were measured for chromium-silicon oxide-silicon cells fabricated on single crystal substrates and the less costly polycrystalline, ribbon, edge-defined film-fed growth and electron-beam deposited silicon. Results reveal cell efficiency to be lower in cells fabricated from the less costly substrates, due to lower short-circuit currents arising from recombination near crystal defects and decreased open-circuit voltage attributed to surface defects. It is concluded that the use of MIS semiconductor solar cells based on silicon, with efficiencies up to 12%, represents progress in attaining photovoltaics costing less than 50 cents/W.

A.L.W.

A80-33723 Photovoltaic concentrator design comparison. M. Edenburn, E. Boes, and B. Shafer (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1793-1796. Research supported by the U.S. Department of Energy.

In the past few years a variety of different designs for photovoltaic concentrators have been proposed. This paper provides a comparison of some of these designs. The comparison is given both in terms of descriptive design features, such as geometric concentration ratio or type of optics used, and in terms of design quality expressed in terms of component efficiencies, array material costs, and S/W. The selection of concentrator array designs for inclusion in

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this comparison was based primarily on the degree of development of the designs and the desire for a representative variety. (Author)

A80-33724 The performance of silicon solar cells under concentrated sunlight. C. E. Backus, B. C. Chambers, T. T. Rule, and R. W. Sanderson (Arizona State University, Tempe, Ariz.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1798-1802. 6 refs. Research supported by the U.S. Department of Energy.

Silicon solar cells especially designed for concentration systems are now available with efficiencies of 18-19% under illumination levels of 30-300 suns at temperatures at 28 C. These efficiencies decrease approximately linearly with temperature. The temperature coefficient decreases slightly at increased concentration levels. (Author)

A80-33725 Analytical evaluation of a solar thermophotovoltaic /TPV/ converter. M. W. Edenburn (Sandia Laboratories; Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1803-1807. Contract No. AT(29-1)-789.

This parametric analysis of a thermophotovoltaic (TPV) converter considers emitter temperature, cell reflectance to radiation with energy below the cell's bandgap energy, and concentration ratio requirements. The concentration ratio is rigorously considered to determine its influence on converter performance. Important conclusions are that an emitter temperature of 2000 K is optimal; a cell reflectance value of 0.98 is required for below-bandgap irradiation; a secondary concentrator must be used with a parabolic-dish primary; and a mirror quality resulting in a 4-mrad reflected-beam dispersion is required for a 24% conversion efficiency. (Author)

A80-33726 * Reduction of intensity variations on a photovoltaic array with compound parabolic concentrators. P. Greenman, J. O'Gallagher, R. Winston (Chicago, University, Chicago, Ill.), and E. Costogoe (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1808-1812. 5 refs. Contract No. JPL-954563.

The reduction of nonuniformities in the intensity distribution of light focused on a photovoltaic array by a compound parabolic concentrator is investigated. The introduction of small distortions into the surfaces of the reflector in order to diffuse the incident collimated light to fill the angular acceptance of the concentrator is calculated by means of ray tracing to decrease the irradiance nonuniformity at the cost of a lowered effective concentration of the concentrator. Measurements of the intensity distribution on a scale test model in terrestrial sunlight with corrugated aluminized mylar reflectors are shown to be in good agreement with the ray tracing results. A two-stage concentrator consisting of a focusing primary and a nonimaging secondary is also shown to result in a fairly uniform intensity distribution except in the case of a 4-deg incidence angle, which may be corrected by the introduction of distortions into one or both concentration stages. A.L.W.

A80-33727 Quasi-static concentrated array with double side illuminated solar cells. A. Luque, J. M. Ruiz, A. Cuevas, J. Eguren, J. Sangrador, G. Sala, J. M. Gómez Agost, and J. del Alamo (Madrid, Universidad Politécnica, Madrid, Spain). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1813-1817. 16 refs.

Double side illuminated (DSI) cells placed in proper quasi-static concentrators allow for double theoretical gain than that of conventional cells. A concentrator prototype is presented which provides double side illumination with a practical gain of 8 and an acceptance (half gain) angle of plus or minus 11 deg. This concentrator also provides cooling for the cells so that they can

operate at 10 C over the ambient under an irradiance of 90 mW/sq cm and wind velocity of 1 m/sec. Three types of DSI cells are being developed. Practical efficiencies of 15.5 percent have been practically demonstrated. (Author)

A80-33728 Development of 1pKW photovoltaic module with concentration. S. Pizzini (Montedison Sistemi S.p.A., Istituto Ricerche, Novara, Italy), M. Giuffrida, P. Zani (Ansaldo S.p.A., Genoa, Italy), G. Scarpi, G. Dionisio (Officine Galileo, Florence, Italy), M. Conti, and A. Modelli (SGS-ATES Componenti Elettronici S.p.A., Milan, Italy). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1818-1821. Research supported by the Consiglio Nazionale delle Ricerche and European Community.

A 1-pKW concentration photovoltaic array with silicon cells, afocal lenses and passive cooling has been designed and developed. The concentrator consists of a mounting frame, whose tracking mode is altazimuthal and ten individual modules. The selected concentration ratio is 50. The afocal lenses provide an optimum flux distribution on the plane of the cell, reduce the incidence of chromatic aberration and tolerate partial shadowing without affecting the illumination profile. The cells have an n/p(+) structure, a Ti-Pd-Ag front metallization pattern, an Al-Cr-Ni-Au back metallization and a silicon nitride AR layer. They display efficiencies in excess of 16%. The tracking system consists of two independent motors for zenithal and azimuthal motion which are driven by two control units: the azimuthal movement has a constant speed basis plus a superimposed increment derived by the sun sensor. The zenithal movement is completely controlled via a suitable operational amplifier and a comparator, by the sun sensor. (Author)

A80-33729 A novel mildly concentrating photovoltaic/thermal total energy system. S. J. Strong (Solar Design Associates, Canton, Mass.), A. J. Manelas (Solelectro-Thermo, Inc., Dracut, Mass.), and F. K. Manasse (New Hampshire, University, Durham, N.H.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 2. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1822-1824.

A mildly concentrating cone collector photovoltaic/thermal energy system concept is discussed. The module design, installation, and performance of the system are considered. V.T.

A80-33730 The DOE photovoltaic concentrator project. D. G. Schueler, E. C. Boes, B. D. Shafer, and J. F. McDowell (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1826-1829. Research supported by the U.S. Department of Energy.

Three major task areas of a photovoltaic concentrator project are described. The technology development activities in each of these areas include design, analysis, prototype and hardware development, evaluation, and production cost analysis. V.T.

A80-33731 Design and analysis of a solar cell concentrating system using a flux redistributor. J. E. Wennstrom (Idaho Power Co., Boise, Idaho) and R. E. Warner (Idaho, University, Moscow, Idaho). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1835-1839. Research supported by the University of Idaho, Washington Water Power Co., and Idaho Power Co.

A concentrating system which focused sunlight on an actively cooled array of silicon solar cells was built and tested. A concentration ratio of 11.7 was provided by a parabolic cylinder with a secondary mirror arrangement near the focal line to redistribute the solar flux. Relationships between optical, electrical, and thermal efficiencies are presented for two mounting positions. Solar cell voltage-current characteristics and the effects of pointing error on

cell output power were examined. Test results show the flux redistributor has an equivalent reflectance of .75, but it provides convection suppression, a 1.0 intercept factor, flux uniformity across the cell surface, and insensitivity to tracking or mirror surface errors. The cells produced .05 W/sq cm with a photovoltaic efficiency of 6.5% and a system efficiency of 4.1% for the conversion of direct beam sunlight to electricity at a cell temperature of 64 C. (Author)

A80-33732 **Effects of encapsulation on the optical and thermal response of solar cells used in concentrated-flux systems.** V. E. Wood, R. P. Kenan, and G. B. Gaines (Battelle Columbus Laboratories, Columbus, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1840-1843. 8 refs. Research supported by the U.S. Department of Energy.

Solar-cell encapsulation for environmental protection affects cells' electrical output and operating temperature. Such effects are particularly significant in concentrator systems requiring high-technology cells and operating above ambient temperature. We have made an initial calculation of effects of encapsulation on optical, thermal, and electrical behavior of low-resistivity solar cells with Fresnel-lens concentrators. Our objectives were to determine flux absorbed, power produced, and steady-state temperature distribution; to determine how these quantities changed on encapsulation; to look for beneficial design modifications. Parameters varied included antireflection-coating thickness, ambient temperature, and heat transfer coefficients. Absorbed heat was assumed dissipated by free convection and radiation. Two representative incident solar spectra were considered. Optical, thermal, and electrical analyses were necessarily carried out in an interdependent way. Encapsulation causes unavoidable power reduction which must be balanced against expected service-life improvements. Steady-state cell temperature increases resulting from encapsulation are small. (Author)

A80-33733 **Status of the photovoltaic systems definition project.** K. L. Biringer, G. J. Jones, D. R. Smith, and H. N. Post (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1846-1850. 14 refs. Research supported by the U.S. Department of Energy.

The paper deals with a photovoltaic systems definition project which is an integral part of the U.S. DOE's National Photovoltaic Conversion Program. Two areas of project responsibility are considered: systems analysis and subsystem technology development. V.T.

A80-33734 **Connection losses in photovoltaic arrays.** A. Luque, E. Lorenzo, and J. M. Ruiz (Madrid, Universidad Politécnica, Madrid, Spain). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1851-1855. Research supported by the Fundacion Ramón Areces.

The shortcircuit current, opencircuit voltage and connection losses of arrays of solar cells, either for normal or concentrated sunlight are analyzed under either series or parallel connection. The parameters of the individual cells are considered as random variables. The main conclusion reached is that the shortcircuit current of the cells connected in series must be carefully monitored in order to avoid any excessive losses. The losses in parallel arrays are small except in some cases in which the cell parameters suffer from an extreme dispersion. (Author)

A80-33735 **Photovoltaic array reliability project.** N. W. Patapoff (Southern California Edison, Rosemead, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1861-1864.

Southern California Edison, a southwestern electric utility, has installed a 2.2 KW (peak) flat plate photovoltaic array at its General

Office in Rosemead, California, a suburb of Los Angeles. The array has given an indication of the reliability and operating characteristics of commercial panels. Results since initial operation in April 1978 have been encouraging. There have been no complete electrical failures, though there has been a significant number of visual degradations. These visual degradations are, for the time being, apparently cosmetic, because no difference was evident between I-V curves taken in June 1978 and April 1979. This project is a first step in the hardware portion of a two-pronged Edison program to examine P/V and its potential to supply energy. (Author)

A80-33736 **Evaluation of combined photovoltaic/thermal collectors.** S. D. Hendrie (MIT, Lexington, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1865-1869. Research supported by the U.S. Department of Energy.

The thermal and electric performance of an air and a liquid-type combined photovoltaic/thermal solar collector has been evaluated, yielding close correlation with theoretical results. Maximum thermal efficiencies of 45.2% and 40% for the liquid and air collectors without electric power production respectively decreased to 40.4% and 32.9% when electrical power was produced. Maximum electrical efficiencies of 6.8% were measured. (Author)

A80-33737 **Optimization of photovoltaic/thermal collector heat pump systems.** M. C. Russell and E. C. Kern, Jr. (MIT, Lexington, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1870-1874. Research supported by the U.S. Department of Energy.

Combined photovoltaic/thermal (PV/T) collectors convert insolation directly to both electrical and thermal energy. These collectors are potentially less costly and have smaller space requirements than equivalent separate collectors operating to satisfy residential heating, cooling, hot water and electric power demands. TRNSYS simulation of PV/T collector-heat pump systems for residences in New York and Fort Worth climates, and analysis of the technical and economic results are discussed. The parallel heat pump configuration with 40 square meters of PV/T collectors was found to be the least-cost system option for the New York residence. (Author)

A80-33738 **What is black chrome.** P. M. Driver (Western Australia, University, Nedlands, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1887-1891. 51 refs.

The paper studies the composition and structure of black chrome coatings and the interrelationship of these parameters together with deposition methods including electrodeposition, chemical vapor, and sputter deposition. Chromium particles and chromium dendrites in a dielectric matrix, and an amorphous structure of chromium and its compounds, are considered. It is concluded that black chromes are still poorly characterized due to their varying structures and limited thin film analysis techniques. A.T.

A80-33739 **Thermal degradation of a black chrome solar selective absorber coating - Short term.** C. M. Lampert (California, University, Berkeley, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1892-1896. 9 refs. Contract No. W-7405-eng-48.

The energy absorption properties and chemical microstructure of CHROM-ONYX were investigated using electron microscopy and X-ray diffraction techniques. Different temperatures for short annealing times were used to evaluate this coating's temperature resistance along with possible degradation mechanisms for stagnation situations. Each sample was characteristically similar, with air acting to mildly accelerate optical degradation at higher temperatures.

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Below 300-400 C black chrome exhibited a structural transformation precipitating Cr₂O₃. Above 500 C this phase grew, while chromium was depleted. For practical purposes black chrome optically degraded between 500-600 C during short exposure times. (Author)

A80-33740 Thermal aging characteristics of electro-deposited black chrome solar coatings. R. B. Pettit and R. R. Sowell (Sandia Laboratories, Albuquerque, N. Mex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1897-1901. 7 refs. Contract No. DE-AC04-76DP-00789.

A80-33741 Improvement of optical reflectance of homogeneous interference film for solar absorber by texture control. J. Ohno, Y. Shindoh, J. Oka, and H. Okada (Nippon Steel Corp., Fundamental Research Laboratories, Kawasaki, Japan). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1902-1906.

A80-33742 Production and properties of selective surfaces coated onto glass tubes by a magnetron sputtering system. G. L. Harding, B. Window, C. Horwitz, A. R. Collins, and D. R. McKenzie (Sidney, University, Sidney, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1912-1916. 11 refs. Research supported by the University of Sidney.

A cylindrical magnetron sputter coater has been constructed for deposition of selective absorbing surfaces onto batches of 1.5 m long glass tubes. A selective surface consisting of reactively sputtered mixed iron chromium and nickel carbides overlaid on sputtered copper on glass has been used to evaluate the properties of the coater. Absorptances, emittances and ageing properties of selective surfaces produced by the coater are discussed. (Author)

A80-33743 Selective electrodeposited chromium black coatings - Optical properties, selectivity model. J. Lafait, S. Berthier, and J.-M. Behaghel (Paris VI, Université, Paris, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1922-1925. 6 refs.

A80-33744 Photoacoustic determination of absorptance and emittance of solar selective coatings. S. I. Yun (Busan National University, Busan, South Korea). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1926-1930. 24 refs.

A new approach to the study of radiation characteristics of solar selective coatings is reported. When chopped light impinges on a solid in an enclosed cell, an acoustic signal is produced and detected by a sensitive microphone. This photoacoustic effect is the basis of the new approach. This paper reports the design and performance characteristics of a photoacoustic spectrometer suitable for recording absorptance and emittance spectra of the solar selective coatings. The dependence of photoacoustic signal on various experimental parameters is explored and some of its usefulness and limitations of the photoacoustic spectrometry in determining absorptance and emittance of the prepared sample has been made. For comparison, both absorptance spectra obtained by photoacoustic technique and conventional Gier-Dunkle reflectometer are reported. A calibration procedure for the photoacoustically determined absorptance and emittance is also discussed. (Author)

A80-33745 Radiative selectivity and the oxidation of stainless steels. V. C. Sharma (Benin, University, Benin City, Nigeria) and M. G. Hutchins (University College, Cardiff, Wales). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1940-1944. 14 refs. Research supported by the Science Research Council.

A comparison of spectrally selective surfaces formed by both chemical and thermal oxidation of 300 series stainless steels has been made. The optical properties, solar absorptance and thermal emittance, have been measured and the compositions and growth of the surface oxides have been studied using Auger electron spectroscopy. A dark blue, chemically-oxidized surface was found to have the most favorable combination of radiative properties, though further development to produce higher solar absorptance is needed for both chemically and thermally produced surfaces. (Author)

A80-33746 Absorptance and emittance measurements of AlPbS and Zn dust selective surfaces. B. K. Gupta, F. K. Tewari, R. Thangaraj, S. S. Mathur, and O. P. Agnihotri (Indian Institute of Technology, New Delhi, India). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1945-1949. 7 refs.

Measurements of the visible absorptance and infrared emittance of the low-cost potential solar energy absorbers Al-PbS and coated zinc dust are presented. Selective absorption surfaces were obtained by the spraying of solutions of PbS in various concentrations of lead acetate and thiourea in water onto Al-coated surfaces and the electroless deposition of CuO, CuS and CuS + PbS coatings onto zinc dust to form a selective black paint which is applied onto metal sheets. PbS coatings produced in a solution with a 1:3 ratio of lead acetate to thiourea are found to exhibit the best absorptivity (0.93), with an emissivity of 0.21. The coated metal dust surfaces are observed also to have high absorptivities (around 0.95) but with relatively higher emissivities (0.42-0.51), which are attributed to the uncontrollable amount of black coating deposited on the metal particles. A.L.W.

A80-33747 Ion implanted materials as selective absorbers for photothermal solar energy conversion. G. Chassagne, A. Delmas, and M. Treilleux (Lyons I, Université, Villeurbanne, Rhône, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1950-1954.

Composite materials are produced by implantation at room temperature of alkali metal ions, K(plus), Li(plus), Na(plus), in magnesium oxide single crystals. Thermal treatment precipitates metal aggregates in implantation zone. These precipitates are observed by electron microscopy. The optical properties of these composite materials, principally MgO:Na, are studied with consideration given to their applicability as selective solar energy absorbers. (Author)

A80-33748 Nickel pigmented anodic aluminium oxide for selective absorption of solar energy. C. G. Granqvist (Chalmers Tekniska Hogskola, Goteborg, Sweden), O. Hunderi (Norges Tekniske Hogskole, Trondheim, Norway), and A. Andersson (Granges Aluminium, Finspang, Sweden). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1955-1959. 29 refs.

A80-33749 Studies of directly absorbing fluids for mid-temperature solar thermal applications. A. R. Burke, D. E. Etter, C. J. Wiedenheft, and L. J. Wittenberg (Monsanto Research Corp., Miamisburg, Ohio). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 1960-1964. 7 refs. Contract No. DE-AC04-76DP-00053.

Thermal, photochemical, and optical absorptivity studies at elevated temperatures were initiated on various heat transfer fluids containing chromophoric materials. The solar absorption efficiency of the fluids and chromophores were calculated at ambient and elevated temperatures. Density, viscosity, and heat capacity measurements for specific solutions were also determined. Eight chromophoric solutions have been identified, thus far, for further study as candidates for directly absorbing fluids for use up to 100 C. (Author)

A80-33751 Comparison of costs for solar derived electrical sources with diesel generators in remote locations. F. K. Manasse (New Hampshire, University, Durham, N.H.) and R. L. Borofsky (AETA Corp., Dover, N.H.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2102-2106. 11 refs.

This paper looks specifically at three alternative sources for generating power in remote regions of the world. These include diesel electric, photovoltaic and solar thermal electric devices. Fuel cost, and more specifically, transportation costs of that fuel, dramatically change which device will be most cost effective under specific conditions. In areas where fuel is readily available, diesel appears to be the best alternative financially. Even today, however, solar thermal generators appear to make sense in a number of realistic scenarios, especially those involving LDCs. Photovoltaics do not seem to be competitive at this time, but technical advances may in fact change this in the future. These comparisons are all represented graphically and numerically in the body of this paper. (Author)

A80-33752 The economics of solar hot water heating in multifamily units. H. B. Zien (Zien Mechanical Contractors, Milwaukee, Wis.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2107-2110.

A80-33754 Analysis of solar energy conversion processes - Systems economic impact of thermochemical storage efficiencies. J. J. Iannucci and J. D. Fish (Sandia Laboratories, Livermore, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2116-2120. 13 refs. Contract No. DE-AC04-76DP-00789.

Chemical storage is the only mode now under consideration for solar thermal electric plants which might satisfy the concept of inexpensive, easily transportable, long duration, ambient temperature storage. The predicted thermal-to-chemical-to-thermal efficiencies for the most prominent of the candidate reactions, however, have been disappointingly low. These low efficiencies are shown to be natural outgrowths from fundamental thermodynamic and engineering principles. Close analogies are drawn between the efficiency of thermal to electric conversion and the efficiency of chemical energy storage processes. (Author)

A80-33755 Cost and performance evaluation of passive solar systems. R. Gorman, K. L. Heitner, K. H. Mehta, A. B. Molander, P. S. Moritz, and C. J. Thomas (TRW Energy Systems Group, McLean, Va.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2132-2136.

The paper deals with a computer program developed for rapid design of optimum passive solar systems with thermal storage walls. The program performs the combined functions of selecting the optimum glazing-reflector-insulation-storage configuration in each climate, correctly sizing the thermal storage wall configuration, and calculating the economics and fuel savings for the optimal installations. V.T.

A80-33757 The effect of an auxiliary load management strategy on solar system performance. T. Newell, S. Swanson, and R. Boehm (Utah, University, Salt Lake City, Utah). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2143-2147. 7 refs. Research supported by the Utah Power and Light Co.

Electric utilities typically have peaking problems caused by seasonal and time-of-day variations in demand. This report presents

the results of an analysis performed to determine whether solar systems could be used for electric utility load management. A straight-forward strategy was devised that consisted of adding heat energy to the solar system heat storage during off-peak (night time) hours, bringing the sensible heat storage up to a controlled temperature level. This strategy was then investigated by means of a detailed computer simulation of system performance, using Salt Lake City weather data. The elevated storage temperature due to the load management led to a reduction in the solar system performance, which was compensated by a shift of the utility load to off-peak times. The tradeoff looks quite favorable as a large shift to off-peak energy usage is accompanied by only a small reduction in solar system performance. (Author)

A80-33758 A benefit-cost analysis of the impact upon an existing utility of a solar electric experimental facility. D. A. Murry (Stone and Webster Management Consultants, Inc., Washington, D.C.) and R. Zumwalt (C.H. Guernsey and Co., Oklahoma City, Okla.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2148-2151.

The paper deals with a project designed to assess the potential benefits and costs for the New Mexico Electric Service Company (NMESC) resulting from the interconnection of various solar electric plant systems. Eight solar electric configurations, each with and without storage, are considered at two separate sites. The impact of a solar R&D facility on the NMESC will depend on the specific type, size and location of plant selected, and on the treatment of the incremental benefits/costs as to whether or not such effects are passed onto rate payers or stockholders. S.D.

A80-33759 Prediction of global solar electricity market, in connection with geographical distribution of decentralized and centralized electrical demand up to year 2025. M. J. Claverie and A. P. Dupas (CNRS, Paris, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2152-2156. 15 refs.

The potential production of solar power plants in the year 2025 is calculated, assuming moderate growth of energy demand and rather fast economic development. Population distribution and the fraction of energy consumption used for the generation of electricity in each world region are taken into account in predicting the future demands for centralized as well as decentralized electrical energy. Future solar power plant production is discussed, considering latitude and the expected costs of power plant investment and fuel. It is concluded that there will be a market of 1000 GW from solar power plants in 2025, producing 2500 Twh/year, that is, 5% of global electricity demand, supplying 17-28% of the earth's population. J.P.B.

A80-33761 Application of circumsolar measurements to concentrating collectors. D. F. Grether, D. Evans, A. Hunt, and M. Wahlig (California, University, Berkeley, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2193-2197. Contract No. W-7405-eng-48.

A systematic measurement program is being carried out to assess the effects of circumsolar radiation (the solar aureole) on the performance of solar conversion systems using concentrating collectors. Four instrument systems have been constructed and are providing detailed intensity vs. angle profiles of the solar and circumsolar (out to 3 deg from the center of the sun) as well as other solar measurements. The instruments are briefly described. Results are presented of the average effect of the circumsolar radiation on the solar energy available to an idealized point focusing system. Results are also presented for an analysis of two specific Central Receiver designs. (Author)

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A80-33763 The simulation of partially and fully tracking flat plate collectors in northern latitudes. J. R. Simonson (City University, London, England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2214-2218. Research supported by Hall Thermostat.

A computer programme was written to calculate the incident energy available on the surface of a flat plate collector, using hourly measured radiation data for horizontal surfaces at Kew. An optimum annual incidence of 1004 kWh/sq m was calculated for a collector of 31 deg slope, pointing due south with normal ground reflectance. In partial tracking the collector followed the sun's azimuth angle, the slope being fixed. Increases were achieved with partial and full tracking, the small additional increase with full tracking being due to the relatively large amounts of diffuse radiation. (Author)

A80-33764 The measurement of solar irradiance on a tilted surface. B. Justin (Pilkington Brothers, Ltd., Lathom, Lanc., England), D. B. Pye, and J. L. J. Rosenfeld (Shell Research, Ltd., Chester, Middx., England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2219-2221.

The measurement of solar irradiance on a tilted plane has been compared using two methods. The irradiance was calculated from the measured total and diffuse irradiance in the horizontal plane assuming an isotropic sky and compared with that measured in the tilted plane. Differences were observed which depended on how the tilted solarimeter was mounted. It is concluded that provided errors of about 5% can be tolerated, the irradiance on a tilted surface may be estimated from measurements with horizontally placed instruments, assuming sky isotropy. If a tilted instrument is used, it is important to ensure adequate radiation shielding and ventilation around the back of the instrument. (Author)

A80-33766 Markov chains to solar energy storage calculations. R. O. Fernández (R. Fernández y Asociados, Buenos Aires, Argentina) and M. V. García (Comisión Nacional de Investigaciones Espaciales, San Miguel, Argentina). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2227-2231.

The statistic theory of Markov chains has been used to make probabilistic predictions of sequences of variable length of cloudy days starting in a typical day. The calculations were made in Buenos Aires and La Plata, for thirty years of observations of cloudiness based on data of bright sunshine distributed in four intervals. The probabilities of various sequences of different length, and the corresponding storage capacities for different thermic loads have been determined. (Author)

A80-33782 General formulation of the current-voltage characteristic of a p-n heterojunction solar cell. S. J. Fonash (Pennsylvania State University, University Park, Pa.). *Journal of Applied Physics*, vol. 51, Apr. 1980, p. 2115-2118. 12 refs.

A derived current-voltage (I-V) characteristic for p-n heterojunction solar cells of the form window/absorber is obtained. The development lends itself to a simple, diagrammatical interpretation of the step-by-step collection of the photocurrent flowing out of the base of the absorber. The resulting general I-V characteristic under illumination is in a form useful for the design of these devices and for the interpretation of their performance. (Author)

A80-33785 Reverse current-voltage characteristics of indium tin oxide/silicon solar cells under illumination. P. Smith, R. Singh, and J. DuBow (Colorado State University, Fort Collins, Colo.). *Journal of Applied Physics*, vol. 51, Apr. 1980, p. 2164-2166. 10 refs. Contract No. XS-9-8232-1.

Recently, Rodriguez and co-workers (1979) reported anomalous photocurrent in reverse-biased tin oxide/silicon solar cells. The

present authors have observed no anomalous photocurrent in indium tin oxide/silicon semiconductor-insulator-semiconductor (SIS) solar cells. In this paper, a possible explanation of why the authors of the above referred paper have observed anomalous photocurrent in tin oxide/silicon solar cells whereas no such effect has been observed in the indium tin oxide/silicon SIS solar cells of the present authors has been offered. (Author)

A80-33786 Sputtered indium-tin oxide/cadmium telluride junctions and cadmium telluride surfaces. F. G. Courreges, A. L. Fahrenbruch, and R. H. Bube (Stanford University, Stanford, Calif.). *Journal of Applied Physics*, vol. 51, Apr. 1980, p. 2175-2183. 23 refs. Research supported by the U.S. Department of Energy.

The properties of indium-tin oxide (ITO)/CdTe junction solar cells prepared by RF sputtering of ITO on P-doped CdTe single-crystal substrates have been investigated through measurements of the electrical and photovoltaic properties of ITO/CdTe and In/CdTe junctions, and of electron beam induced currents in ITO/CdTe junctions. In addition, surface properties of CdTe related to the sputtering process were investigated as a function of sputter etching and thermal oxidation using the techniques of surface photovoltage and photoluminescence. ITO/CdTe cells prepared by this sputtering method consist of an n(+)-ITO/n-CdTe/p-CdTe buried homojunction with about a 1-micron-thick n-type CdTe layer formed by heating of the surface of the CdTe during sputtering. Solar efficiencies up to 8% have been observed with an open-circuit voltage of 0.82 V and a short-circuit current density of 14.5 mA/sq cm. The chief degradation mechanism involves a decrease in open-circuit voltage with a transformation of the buried homojunction structure to an actual ITO/CdTe heterojunction. (Author)

A80-33805 Wide-angle lenses and image collapsing subreflectors for nontracking solar collectors. C. J. Sletten, F. S. Holt, and S. B. Herskovitz (Solar Energy Technology, Inc., Bedford, Mass.). *Applied Optics*, vol. 19, May 1, 1980, p. 1439-1453. 7 refs. Contract No. DE-FG04-77CS-34163.

This paper presents new optical methods for the design of nontracking solar energy concentrators with acceptance angles of 60 deg in the elevation (altitude) plane and plus or minus 50 deg in azimuth sectors. A two-point corrected cylindrical stepped prism lens (SPL) with 30.48-cm aperture height and F/D approximately equal to 1, which focuses well over the acceptance interval, has been designed and constructed. Image collapsing subreflector (ICS) surfaces are synthesized that reflect the incident illumination refracted by the lens onto a small fixed absorbing area or shelf 7.6 cm wide resulting in near maximum theoretical concentration ratios for these broad acceptance angles. Nearly 100% of the incident optical rays intercept the absorber shelf. The wide-angle and image collapsing optical properties were confirmed by laser and solar experiments. Rooftop thermal tests on a 30.5 x 30.5-cm collector section using selectively absorbing tubes with water as circulant were conducted that indicate aperture efficiencies of 60% could be expected on large area collectors based on this design. (Author)

A80-33852 n-type molybdenum-diselenide-based liquid-junction solar cells - A nonaqueous electrolyte system employing the chlorine/chloride couple. L. F. Schneemeyer, M. S. Wrighton (MIT, Cambridge, Mass.), A. Stacy, and M. J. Sienko (Cornell University, Ithaca, N.Y.). *Applied Physics Letters*, vol. 36, Apr. 15, 1980, p. 701-703. 10 refs. Research supported by the Massachusetts Institute of Technology, U.S. Navy, and U. S. Air Force.

The paper demonstrates that single-crystal, n-type MoSe₂ can be used as a stable photoanode in an electrochemical cell using a nonaqueous solution of Cl₂/Cl⁻ as the redox active material. The MoSe₂ is qualitatively better than MoS₂ which has a larger band gap, and both materials are stable in a nonaqueous solution, while both photocorrode in aqueous Cl⁻ solutions. The stable Cl₂/Cl⁻ system show that a transparent, reversible, non-O₂-sensitive redox couple can be useful in n-type semiconductor-based liquid-junction cells using a direct band gap material with optimum solar response. A.T.

A80-33854 # Improved model of $\text{In}_2\text{O}_3/\text{SnO}_2\text{-SiO}_2/\text{x/n-Si}$ solar cells (Uluchshennaiia model' solnechnykh preobrazovatelei na osnove struktury $\text{In}_2\text{O}_3/\text{SnO}_2\text{-SiO}_2/\text{x/n-Si}$). A. I. Malik, V. B. Baraniuk, and V. A. Manasson (Akademiia Nauk Ukrainiskoi SSR, Institut Prikladnykh Problem Mekhaniki i Matematiki, Chernovtsy, Ukrainian SSR). *Geliotekhnika*, no. 1, 1980, p. 3, 4. In Russian.

A80-33855 # Analysis of heat losses and ways to improve the efficiency of solar-array thermoelectric generators (Analiz teplovykh poter' i nekotorye puti povysheniia effektivnosti panel'nykh solnechnykh termoelektrogeneratorov /STEG/). I. I. Kokhova, Iu. N. Malevskii, and A. I. Tsvetkov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika*, no. 1, 1980, p. 5-11, 9 refs. In Russian.

Ways to improve the efficiency of solar thermoelectric generators by reducing heat losses are discussed. Different heat transfer conditions are examined: single and double layer glass coatings, selective coatings on the collector, ordinary and vacuum-type heat insulation, and air and water cooling. B.J.

A80-33856 # Calculation of the angular error of a solar cylindrical concentrator made from sheet material (Raschet uglovoi pogreshnosti solnechnogo tsilindricheskogo konsentratora iz listovogo materiala). M. A. Markman, L. M. Simanovskii, and O. P. Zakharova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). *Geliotekhnika*, no. 1, 1980, p. 15-18. In Russian.

A80-33857 # Geometric and kinematic characteristics of solar-tower heliostats (Geometricheskie i kinematicheskie kharakteristiki geliostatov SES bashennogo tipa). R. R. Aparisi, D. I. Teplakov, and B. G. Khantsis (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika*, no. 1, 1980, p. 19-25, 5 refs. In Russian.

Equations for the geometric and kinematic characteristics of solar-tower heliostats are obtained and used for the direct calculation (based on the method of angular coordinate determination) of the positions of typical heliostats. Velocities of the azimuth and zenith rotations of heliostats are determined. B.J.

A80-33858 # The electronic aberrogram recorder (Elektronnyi registrator aberrogramm). R. A. Zakhidov (Akademiia Nauk Uzbekskoi SSR, Tsentral'noe Proektno-Konstruktorskoe Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). *Geliotekhnika*, no. 1, 1980, p. 26-29. In Russian.

The electronic aberrogram recorder (EAR) is an optoelectronic device designed for monitoring the operation of solar concentrators. The device is used to record the point of incidence of light beams reflected by the concentrator; this is accomplished by the transformation of incidence-point coordinates into voltages, that can be viewed on an oscillograph or plotted. Particular attention is given to an EAR system which uses a photodiode array as the photosensitive surface. B.J.

A80-33859 # Investigation of light-absorbing coatings obtained by the combined condensation of metal and dielectric vapors (Issledovanie svetopogloshchaiushchikh pokrytii, poluchennykh sovmestnoi kondensatsiei parov metalla i dielektrika). U. Kh. Gaziev, Sh. A. Faiziev, V. V. Li, and V. S. Trukhov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika*, no. 1, 1980, p. 30-32, 6 refs. In Russian.

The paper examines metal/dielectric light-absorbing coatings (for use on solar collectors) prepared by thermal vapor deposition in high vacuum. Results on spectral reflectance were obtained for the following materials (in the dielectric to metal concentration ratio range from 3:1 to 1:3): $\text{SiO}_2\text{-Ni}$, $\text{CeO}_2\text{-Ni}$, and $\text{SiO}_2\text{-Cr}$. The study showed that the light-absorbing properties of the coatings are stable to temperatures of 400 C. B.J.

A80-33860 # Test results on solar turbogenerators (Nekotorye rezul'taty ispytaniia solnechnogo turbogeneratora). A. K. Alimov, L. M. Drabkin, G. Ia. Umarov, and P. U. Khatamov (Vsesoiuznyi Zaochnyi Institut Inzhenerov Zheleznodorozhnogo Transporta, Moscow, USSR; Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika*, no. 1, 1980, p. 36-38. In Russian.

The dynamic characteristics of a full-scale solar turbogenerator were obtained for a direct solar radiation power of 650 W/sq m, a maximum collector-wall temperature of 423 C, and an air flowrate of 0.03 kg/sec. Specifically, attention was given to the dependence of the number of rotations on the temperature of the working fluid, and to transient temperatures in the generator. B.J.

A80-33861 # The use of solar energy storage for heating and cooling applications (K ispol'zovaniiu akkumuliatorov solnechnoi energii dlia teplo- i khladosnabzheniia). A. Davletov, A. A. Petrova, and F. A. Guseinova (Akademiia Nauk Turkmeniskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Geliotekhnika*, no. 1, 1980, p. 39-43. In Russian.

The paper examines the development of solar heat storage systems for the heating and cooling of houses in desert regions (the Turkmenian SSR is considered as an example). The choice of heat storage materials is considered (the advantages of paraffin are emphasized), and the thermodynamic properties of the materials are examined. B.J.

A80-33862 # Choice of cycle parameters for solar Freon air conditioning equipment of ejector type (Vybor raschetnykh parametrov tsikla geliiozhektornoii Freonovoi kholodil'noi mashiny /GEFKhM/). S. Z. Zhadan and N. A. Shchetinina (Odesskii Tekhnologicheskii Institut Kholodil'noi Promyshlennosti, Odessa, Ukrainian SSR). *Geliotekhnika*, no. 1, 1980, p. 44-47. In Russian.

A method for calculating the cycle parameters of a solar air conditioning system of ejector type is described; calculations are made for solar radiation conditions typical of Odessa in July. A combined analysis of the efficiencies of the solar and cooling parts of the system is used to determine the optimal temperature of the working fluid. B.J.

A80-33863 # Development of a combined solar heating/heat pump system for conditions typical of the Crimea (Razrabotka kombinirovannoi sistemy solnechnogo teplosnabzheniia s teplovym nasosom v usloviakh Kryma). S. I. Smirnov and A. S. Troshin (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika*, no. 1, 1980, p. 75-80, 9 refs. In Russian.

The feasibility of developing solar-assisted heat pump systems for Crimean conditions is examined. Particular consideration is given to a solar heating system with flat-plate collectors and a compression-type heat pump; a diagram of the system is provided and the basic parameters are examined. B.J.

A80-33864 Dynamic modelling and verification of a flat-plate solar collector. A. J. de Ron (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). *Solar Energy*, vol. 24, no. 2, 1980, p. 117-128, 14 refs.

In the modelling of flat-plate solar collectors the dynamic effects have often been neglected. But because the solar collector is inherently exposed to variable weather conditions, its dynamics may be important to the design and control. It is demonstrated that it is not necessary to ignore the dependence of the various temperatures on the location in the direction of flow (which is often done to avoid complications) provided the model is developed in the frequency domain. The linearised model has been verified in the frequency domain by means of a least squares estimator. The verification was performed with a part of a full-size collector, as has been applied in some solar houses, and an artificial sun. It is concluded from the results of the verification that the developed model describes the collector dynamics quite satisfactorily. The differences between the

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theoretical and estimated heat resistances was about 10 per cent. The verification and estimation procedure proved to be a useful tool for comparing various collectors because the collector has to be fitted with only two temperature sensors. It is shown that the simple models discussed in the literature give responses which are not representative of the collector's dynamics. For well-designed collectors a simplified model is derived. Finally, some desirable sampling rates are given. (Author)

A80-33867 Optimization of stationary nonimaging reflectors for tubular evacuated receivers aligned north-south. W. R. McIntire (Argonne National Laboratory, Argonne, Ill.). *Solar Energy*, vol. 24, no. 2, 1980, p. 169-175. 7 refs. Contract No. W-31-109-eng-38.

Design optimization of solar collectors for tubular evacuated receivers aligned north-south is discussed, with attention given to the choice of acceptance angles and truncation parameters. Considerations involved in this choice include the effects of reflection losses, reflector-receiver alignment errors, variation of selective surface absorptance with angle of incidence on the receiver, and losses through the gap between the receiver and the reflector. Wide-acceptance-angle reflectors are found to enhance the performance of tubular evacuated receivers, and the performance of collectors using these reflectors is not a sensitive function of acceptance angle in the range near 60 deg. The reflectors' wide acceptance angles and ideal nonimaging optics allow manufacturing tolerances without requiring that the concentrator be designed for undersize receivers. L.M.

A80-33869 Thermosyphon circulation in solar collectors. G. L. Morrison (New South Wales, University, Kensington, Australia) and D. B. J. Ranatunga (National Engineering Research and Development Centre, Solar Energy Div., Colombo, Sri Lanka). *Solar Energy*, vol. 24, no. 2, 1980, p. 191-198. 13 refs.

Theoretical predictions of flow rate in thermosyphon solar collectors are compared with experimental measurements obtained using a laser Doppler anemometer. Modifications to the usual method of analysis are proposed to improve the accuracy of the predictions, and the results are compared with flow rate predictions and measurements in other investigations. (Author)

A80-33871 Optimization of flat-plate collector-flat mirror systems. D. C. Larson (Drexel University, Philadelphia, Pa.). *Solar Energy*, vol. 24, no. 2, 1980, p. 203-207. 9 refs. Research supported by the U.S. Department of Energy.

Solar collection capabilities of a flat-plate collector with a flat specular mirror are analyzed in order to determine the optimal geometries and tilting strategies of the collector and mirror for a variety of solar energy applications. Maximum enhancement factors and associated tilt angles for year-round collection are graphically determined as a function of the mirror length relative to the panel length (L), and it is found that for mirror lengths ranging from one to two times the panel length the panel should be tilted $\phi + 15$ deg (where ϕ is the latitude angle) from the horizontal and the front mirror tilt from the horizontal should increase from $55 - \phi$ for $L = 1$ to $65 - \phi$ for $L = 2$. L.M.

A80-33872 Fluid circulation control in conventional and heat pipe planar solar collectors. H. F. W. de Vries, W. Kamminga, and J. C. Francken (Groningen, Rijksuniversiteit, Groningen, Netherlands). *Solar Energy*, vol. 24, no. 2, 1980, p. 209-213.

The efficiencies of a planar heat pipe solar collector and a conventional flat plate solar collector are compared with respect to the transient behavior during periods in which the absorber temperature becomes lower than the storage temperature. A simple mathematical model is used and equations for the oscillating insolation of the sinusoidal and square wave types are obtained in order to investigate the impact of the pump on/off switch and the diode resistance on the collector efficiencies for different oscillating periods. It is found that the performance of the heat pipe collector used without fluid circulation control is as good as that of a conventional collector used with control; hence, the control unit can

be omitted in the heat pipe collector. However, then a manual or automatic cut-off is required during the night. L.M.

A80-34561 A water-trickle type solar collector with a massive concrete slab for heat storage and radiation /TMU solar system I/. N. Ito, K. Matsuda (Tokyo Metropolitan University, Tokyo, Japan), A. Ishii (Kyushu Institute of Design, Kyushu, Japan), and H. Osawa (Ministry of Construction, Building Research Institute, Japan). (*Solar Energy*, vol. 4, no. 2, 1978, p. 5-10.) *Energy Developments in Japan*, vol. 2, Jan. 1980, p. 253-263. Translation.

Experimental results are reported for a simple open type solar collector - a water trickle type collector - used in combination with a massive concrete slab for energy storage. This relatively low cost system was installed on a typical Japanese house in Yokohama City and measurements were made of the interior temperature. The system showed considerable promise for application in Japan. (Author)

A80-34598 Solar collectors for low and intermediate temperature applications. F. Kreith, A. Rabl (Solar Energy Research Institute, Golden, Colo.), G. O. G. Lof (Colorado State University, Fort Collins, Colo.), and R. Winston (Chicago, University, Chicago, Ill.). *Progress in Energy and Combustion Science*, vol. 6, no. 1, 1980, p. 1-34. 53 refs.

To provide a rational basis for deciding which type of low or intermediate temperature solar collector is best suited for a particular application, various flat-plate and nonfocusing solar concentrators are compared in terms of their most important general characteristics, viz. concentration, acceptance angle, sensitivity to mirror errors, size of reflector area, and thermal efficiency. This summary of low and intermediate temperature solar collectors first outlines the principles of flat-plate collectors, then discusses the performance of liquid and air flat-plate collectors from experimental and analytical standpoints, and finally presents the theory and design of low concentration type of nonimaging collectors. S.D.

A80-34637 Photovoltaic materials. E. A. Perez-Albuerne and Y.-S. Tyan (Eastman Kodak Co., Rochester, N.Y.). *Science*, vol. 208, May 23, 1980, p. 902-907. 38 refs.

The materials requirements of typical solid-state photovoltaic cells for the various solar cell configurations under investigation are reviewed. The operating principles of photovoltaic cells are discussed, with particular attention given to the loss mechanisms which limit the efficiency of charge generation and separation. The development and photovoltaic properties of single-crystal and polycrystalline silicon cells, gallium arsenide cells, thin film cadmium sulfide/copper sulfide cells and amorphous silicon cells are then surveyed, and other promising semiconductor materials are indicated. It is concluded that while systems characterized by ease of fabrication, high efficiency or long-term stability have been developed, further advances in materials properties and automated, large-volume, cost-effective manufacturing processes must be made in order to attain the properties necessary for large-scale application simultaneously in a single substrate. A.L.W.

A80-34778 Selection of materials and development of processes for the fabrication of solar reflector panels. M. R. Boyaner and H. K. Lauer (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: *New horizons - Materials and processes for the eighties; Proceedings of the Eleventh National Conference*, Boston, Mass., November 13-15, 1979. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 424-431.

The MDAC central receiver solar thermal power system is based on the concept of multiple solar energy reflectors (solar reflector panels) directing the sun's energy on a receiver unit, where the concentrated heat from the sun is used to convert water into steam. This paper presents the trade studies and tests performed to select the core material, the back face sheet, and the adhesives and sealants used to bond and seal the reflector panels. The processes for adhesive application and panel assembly are discussed. The selected heliostat reflector panel design is a sandwich panel consisting of a styrofoam

core bonded to a second surface mirror on one side, and a sheet of galvanized steel on the other side. The periphery of the panel is sealed by bonding on a galvanized steel edge member incorporating the use of a dual seal system. (Author)

A80-34779 Solar materials R & D overview emphasizing solar thermal power systems. B. L. Butler (Solar Energy Research Institute, Golden, Colo.). In: *New horizons - Materials and processes for the eighties*; Proceedings of the Eleventh National Conference, Boston, Mass., November 13-15, 1979. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 432-436. 5 refs.

A80-34780* Silicon material task - Low cost solar array project JPL/DOE. R. Lutwack (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *New horizons - Materials and processes for the eighties*; Proceedings of the Eleventh National Conference, Boston, Mass., November 13-15, 1979. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 437-440.

The paper describes the silicon material task of the low-cost solar array project, which has the objective of establishing a silicon production capability equivalent to 500 mW per year at a price less than 10 dollars/kg (1975 dollars) in 1986. The task program is divided into four phases: technical feasibility, scale-up studies (the present phase), experimental process system development units, and implementation of large-scale production plants, and it involves the development of processes for two groups of materials, that is, semiconductor grade and solar cell grade. In addition, the effects of impurities on solar cell performance are being investigated. Attention is given to problem areas of the task program, such as environmental protection, material compatibility between the reacting chemicals and materials of construction of the equipment, and waste disposal. J.P.B.

A80-34781 Low-cost, high-performance solar selective paint coatings. W. D. McKelvey and P. B. Zimmer (Honeywell, Inc., Avionics Div., Minneapolis, Minn.). In: *New horizons - Materials and processes for the eighties*; Proceedings of the Eleventh National Conference, Boston, Mass., November 13-15, 1979. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 453-462. Research supported by the U.S. Department of Energy.

The development of low-cost, high-performance solar selective paint coatings for flat-plate collectors is described. Some of the coatings hold the promise of on-site application by unskilled personnel. The selective paints were made by optimizing coating thickness, pigment volume concentration and pigment particle size. Coatings were shown to be optically efficient with solar absorptance of 0.90 and infrared emittance of 0.10. Material cost for typical thickness-sensitive selective paint coatings was estimated at 1 cent/sq. ft. Thickness insensitive paints using binary pigment combinations were also developed providing values of solar absorptance equal to 0.90 and infrared emittance equal to 0.30. Coatings of this type are independent of either thickness or substrate surface and offer considerably wider versatility for commercial and residential applications than thickness sensitive coatings. (Author)

A80-34782* Glass fiber reinforced concrete for terrestrial photovoltaic arrays. H. Maxwell (California Institute of Technology, Jet Propulsion Laboratory, Applied Mechanics Section, Pasadena, Calif.). In: *New horizons - Materials and processes for the eighties*; Proceedings of the Eleventh National Conference, Boston, Mass., November 13-15, 1979. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 463-470.

The use of glass-fiber-reinforced concrete (GRC) as a low-cost structural substrate for terrestrial solar cell arrays is discussed. The properties and fabrication of glass-reinforced concrete structures are considered, and a preliminary design for a laminated solar cell assembly built on a GRC substrate is presented. A total cost for such a photovoltaic module, composed of a Korad acrylic plastic film

front cover, an aluminum foil back cover, an ethylene/vinyl acetate potant/adhesive and a cotton fabric electrical isolator in addition to the GRC substrate, of \$9.42/sq m is projected, which is less than the \$11.00/sq m cost goal set by the Department of Energy. Preliminary evaluations are concluded to have shown the design capabilities and cost effectiveness of GRC; however, its potential for automated mass production has yet to be evaluated. A.L.W.

A80-34841 Solar energy utilization. T. Michels (Londe, Parker, Michels, Inc., St. Louis, Mo.). New York, Van Nostrand Reinhold Co., 1979. 265 p. 285 refs. \$18.50.

The book is presented in five chapters: energy conservation, the sun with the earth, solar energy collectors, solar energy storage, and sizing. Energy conservation is discussed with general comments and relative to specific concepts for the residential sector, walls, windows, infiltration, ceilings and attics, floors, and ventilation. Chapters 2 to 4 present the necessary background solar information so that one can understand what has been done and, generally, why. This information is required to establish an informed judgment. Chapter 5 is designed to ensure that basic, preliminary design decisions are made that facilitate design development. S.D.

A80-34847* Solar cell array design handbook - The principles and technology of photovoltaic energy conversion. H. S. Rauschenbach (TRW Defense and Space Systems Group, Redondo Beach, Calif.). Research supported by NASA; Contract No. JPL-953913. New York, Van Nostrand Reinhold Co., 1980. 564 p. 433 refs. \$42.50.

Photovoltaic solar cell array design and technology for ground-based and space applications are discussed from the user's point of view. Solar array systems are described, with attention given to array concepts, historical development, applications and performance, and the analysis of array characteristics, circuits, components, performance and reliability is examined. Aspects of solar cell array design considered include the design process, photovoltaic system and detailed array design, and the design of array thermal, radiation shielding and electromagnetic components. Attention is then given to the characteristics and design of the separate components of solar arrays, including the solar cells, optical elements and mechanical elements, and the fabrication, testing, environmental conditions and effects and material properties of arrays and their components are discussed. A.L.W.

A80-34999* # Large space structures - Fantasies and facts. M. F. Card and W. J. Boyer (NASA, Langley Research Center, Hampton, Va.). In: *Structures, Structural Dynamics, and Materials Conference*, 21st, Seattle, Wash., May 12-14, 1980, Technical Papers. Part 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 101-114. 37 refs. (AIAA 80-0674)

A review of large space structures activities from 1973 to 1979 is presented. Long-range studies of space colonies, gigantic solar power stations and projected earth applications revived interest in space activities. Studies suggest opportunities for advanced antenna and platform applications. Matching low-thrust propulsion to large flexible vehicles will be a key technology. Current structures technology investigations include deployable and erectable structures and assembly techniques. Based on orbited structures experience, deployment reliability is a critical issue for deployable structures. For erectable structures, concepts for earth-fabricated and space-fabricated members have been demonstrated. (Author)

A80-35335 Thin-film solar cells - A unified analysis of their potential. A. M. Barnett (Delaware University, Newark, Del.) and A. Rothwarf (Drexel University, Philadelphia, Pa.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 615-630. 43 refs.

The development and deployment of low-cost thin-film solar cells for the direct conversion of sunlight to electricity can be accelerated by the utilization of loss minimization and cost minimization methodologies. The solar cell is separated into its five

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constituent layers to provide a common basis for the development of these methodologies. Photovoltaic theory, materials science, and loss analysis are combined to develop the loss minimization methodology which can be used to systematically improve and optimize performance of any solar-cell material system. The techniques of the chemical process industry have been applied to achieve cost minimization. The loss- and cost-minimization methodologies have been combined into a generalized procedure for the accelerated development of all low-cost thin-film photovoltaic material systems. (Author)

A80-35336 Characteristics of MOS solar cells built on *n*-type/ *InP* substrates. K. P. Pande (Rutgers University, Piscataway, N.J.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 631-634. 20 refs.

An examination is made of the electrical and photovoltaic characteristics of Au-*n*-type *InP* Schottky-barrier solar cells with and without a thin anodic oxide layer at the interface. Cells built on anodized surface (MOS type) exhibit a reduction of dark current by three orders of magnitude and an increase in the barrier height about (0.80 eV) by 0.30 eV, over conventional Schottky-barrier devices. Current transport in both type of cells is limited by thermionic emission of carriers and an increase in *n* factor from 1.02 to 1.16 is observed for MOS cells. Under illumination, MOS cells show an increase of open-circuit voltage to 0.46 V without any reduction in the short-circuit current which is obtained as 17.20 mA/sq cm. The efficiency has been found to go up from 3.45 to 6 percent for MOS cells which show an excellent spectral response, almost flat over a large portion of the visible spectrum. (Author)

A80-35337 The preparation and properties of thin polycrystalline GaAs solar cells with grain boundary edge passivation. K. P. Pande (Rutgers University, Piscataway, N.J.), D. H. Reep, S. K. Shastri, A. S. Weiner, J. M. Borrego, and S. K. Ghandhi (Rensselaer Polytechnic Institute, Troy, N.Y.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 635-640. 11 refs. Research supported by the Solar Energy Research Institute.

A80-35338 Deposition and characterization of gallium arsenide films for solar cells applications. S. S. Chu, T. L. Chu, and Y. T. Lee (Southern Methodist University, Dallas, Tex.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 640-645. 14 refs. Research supported by the Solar Energy Research Institute; Contract No. EG-77-C-01-4042.

Gallium arsenide films have been deposited on tungsten-coated graphite substrates by the reaction of gallium, hydrogen chloride, and arsine in a hydrogen flow. It has been found that the presence of hydrogen chloride in the gallium monochloride-arsenic mixture is essential in obtaining large-area gallium arsenide films with sufficiently good microstructure suitable for photovoltaic devices. Schottky-barrier and MOS structures have been prepared from *n*-GaAs/*n*(+)-GaAs films on tungsten/graphite substrates, and their electrical properties investigated. Under AM1 conditions, MOS structures of area 9 sq cm have conversion efficiencies of up to 4.4 percent (without antireflection (AR) coating, would be about 6.7 percent with proper coating), and the conversion efficiencies can be increased to 5 percent (without AR coating, would be about 7.5 percent with proper coating) by using a thin gallium arsenide-phosphide film at the surface of gallium arsenide. (Author)

A80-35339 The design and fabrication of thin-film CdS/Cu₂S cells of 9.15-percent conversion efficiency. J. A. Bragagnolo, A. M. Barnett, J. E. Phillips, R. B. Hall, J. D. Meakin (Delaware University, Newark, Del.), and A. Rothwarf (Drexel University, Philadelphia, Pa.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 645-651. 25 refs.

A80-35340 The thermal expansion shear separation /TESS/ technique for producing thin self-supporting silicon films for low-cost solar cells. K. R. Sarma and M. J. Rice, Jr. (Motorola, Inc., Solar Energy Research and Development Dept., Phoenix, Ariz.).

IEEE Transactions on Electron Devices, vol. ED-27, Apr. 1980, p. 651-656. 11 refs. Contract No. ET-78-C-03-2207.

A new technique - Thermal Expansion Shear Separation (TESS) is described for producing thin self-supporting polycrystalline silicon ribbons using temporary molybdenum substrates. The TESS substrates and separated silicon ribbons were characterized to determine the shear separation mechanism, limits to substrate recyclability, and the quality of the silicon ribbon for efficient solar-cell fabrication. Solar cells fabricated on the silicon ribbons separated from molybdenum substrates have exhibited AM1 conversion efficiencies of up to 11.8 percent after ribbon-to-ribbon (RTR) grain enhancement. By recycling the Mo substrate its cost contribution can be as low as \$0.0074/peak watt of electricity produced. (Author)

A80-35341 Optimization of oxide-semiconductor/base-semiconductor solar cells. R. Singh (Colorado State University, Fort Collins, Colo.), K. Rajkanan (General Instrument Corp., Hicksville, N.Y.), D. E. Brodie, and J. H. Morgan (Waterloo University, Waterloo, Ontario, Canada). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 656-662. 53 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada.

In order to get the maximum output from an oxide-semiconductor/base-semiconductor solar cell, one has to incorporate an ultrathin insulating layer so that the resulting configuration is a semiconductor-insulator-semiconductor (SIS) diode. The performance of such SIS diodes is equivalent to a metal-insulator-semiconductor (MIS) solar cell. The key parameters in the optimization are the thickness of the insulating layer and the work function of the oxide semiconductor. Using the existing knowledge of the parameters for a number of oxide semiconductors one would conclude that ITO, ZnO, and SnO₂ are good oxides for the fabrication of SIS solar cells. Some properties of highly conducting and highly transparent ZnO films which have been fabricated are presented. These results suggest that these ZnO films should be useful for fabricating low-cost SIS solar cells. (Author)

A80-35342 Design considerations for a-Si solar cells. V. L. Dalal (Delaware University, Newark, Del.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 662-670. 21 refs. Contract No. ET-79-03-23034.

The design considerations which can be used to develop high-efficiency devices from a-Si are studied. The design analysis takes full advantage of the flexibility in bandgap and other material properties offered by a-Si. Several structures, such as light-trapped cells, graded layer cells, and tandem junction a-Si/a-Si cells are analyzed in detail for collection efficiency, and fill factors. It is shown that using these innovative structures, realistic conversion efficiencies exceeding 10 percent can be realized in a-Si in spite of the very low diffusion lengths about 0.1 micron. Technological considerations for achieving such structures are also discussed. (Author)

A80-35343 Impurity gettering of polycrystalline solar cells fabricated from refined metallurgical-grade silicon. T. Saitoh, T. Warabisako, E. Kuroda, H. Itoh, S. Matsubara, and T. Tokuyama (Hitachi, Ltd., Central Research Laboratory, Kokubunji, Tokyo, Japan). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 671-676. 19 refs. Research supported by the Ministry of International Trade and Industry.

A80-35345 Grain boundary effects on the electrical behavior of Al-poly-Si Schottky-barrier solar cells. C.-M. M. Wu, E. S. Yang, W. Hwang, and H. C. Card (Columbia University, New York, N.Y.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 687-692. 14 refs. NSF Grant No. ENG-78-19426; Contract No. ET-78-R-03-1876.

Schottky-barrier diodes using aluminum on p-type polycrystalline silicon have been fabricated. The contrast of the orientation of neighboring grains is observed after chemical etching of the surface. Comparing the surface morphology of the substrate with the electronic behavior of the Schottky diode, the influence of grain

boundaries is identified. The experimental data indicate that recombination centers and traps are introduced, resulting in an increase in recombination current and a reduction of the effective mobility. The conduction mechanisms for the two types of diodes are clearly distinguishable both in the dark and under illumination. (Author)

A80-35346 Theory of grain-boundary and intragrain recombination currents in polysilicon p-n-junction solar cells. J. G. Fossum and F. A. Lindholm (Florida, University, Gainesville, Fla.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 692-700. 17 refs. Contract No. EG-77-C-01-4042.

The physics controlling recombination in polysilicon p-n-junction solar cells is described. Analytic models characterizing this recombination, whose parameters can be related directly to experiment, are developed. The analysis reveals that, in general, the description of intragrain and grain-boundary recombination in a polysilicon solar cell requires the solution of a nonlinear three-dimensional boundary-value problem. Cases of practical interest for which this problem is tractable are discussed. The analysis predicts an $\exp(qV/2kT)$ dependence (the reciprocal slope factor is exactly two) for carrier recombination at a grain boundary within the junction space-charge region of a nonilluminated, forward-biased cell. This result, and others of the analysis, are consistent with preliminary experimental data. (Author)

A80-35348 MIS and SIS solar cells. J. Shewchun, D. Burk, and M. B. Spitzer (Brown University, Providence, R.I.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 705-716. 32 refs.

This review paper shows that MIS (metal-insulator-semiconductor) and SIS (semiconductor-insulator-semiconductor) solar cells are basically one and the same type of device, even though they are usually regarded as being separate and are reported as such. Experimental results on the two most common systems, Al-Si(x)-pSi and ITO-SiO(x)-pSi (ITO designates indium-tin-oxide) are presented to support a model where tunnel current through the insulator or interface is the transport mechanism between the metal or oxide semiconductor (acting as a collecting grid) and the base converting semiconductor. However, the I-V characteristics of the devices are dominated by diffusion current flow in the bulk of the base converting substrate and display the usual Shockley diode equation behavior, in the absence of additional defect current mechanisms. (Author)

A80-35349 A comparison of majority- and minority-carrier silicon MIS solar cells. K. K. Ng (Bell Telephone Laboratories, Inc., Murray Hill, N.J.) and H. C. Card (Columbia University, New York, N.Y.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 716-724. 54 refs. Grant No: DAAG-79-C-0079; Contract No. ET-78-R-03-1876.

The photovoltaic properties of majority-carrier and minority-carrier MIS solar cells are investigated as a function of the thickness of the insulating layer. The performance of majority-carrier (Au-SiO₂-nSi) and minority-carrier (Al-SiO₂-pSi) structures is compared for SiO₂ layers prepared under identical oxidation conditions. The short-circuit current densities are found to be suppressed by tunneling through the SiO₂ layers for a thickness of 17 Å or less, whereas fill factors begin to decrease at even smaller thicknesses. For the majority-carrier cells the effective AM1 conversion efficiency reaches an optimum value of 9-10% as compared to 11-12% for minority-carrier cells. V.L.

A80-35350 Spray-deposited ITO-silicon SIS heterojunction solar cells. A. Ashok, S. J. Fonash (Pennsylvania State University, University Park, Pa.), and P. P. Sharma (Fairchild Camera and Instrument Corp., San Jose, Calif.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 725-730. 20 refs.

A systematic study of semiconductor-insulator-semiconductor (SIS) solar cells has been undertaken on n-type silicon using spray-deposited indium-tin-oxide (ITO) for the window layer of the heterostructure. The optical and electrical characteristics of the ITO layer as well as the thickness of the I layer have been optimized. The

dark I-V characteristics have also been evaluated to identify the mechanisms of barrier formation and current flow. (Author)

A80-35351 Detailed modeling of inversion-layer solar cells. C. E. Norman (Universidad Nacional del Centro del Perú, Huancayo, Peru) and R. E. Thomas (Carleton University, Ottawa, Canada). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 731-737. 22 refs. Research supported by the National Research Council of Canada.

Numerical modeling of inversion-layer (IL) solar cells is described. The steady-state continuity equations are solved for both electrons and holes. A novel integrated recombination technique is applied to accurately find the one-dimensional current flow. Two-dimensional resistive and grid geometry effects are modeled to predict the output current-voltage curve for the cell. Modeled results are in excellent agreement with those measured for a real cell. The model is used to investigate the operation of IL cells and to determine how their performance can be improved through process changes. Practical AM1 efficiencies up to 17 percent are predicted and a theoretical maximum efficiency of 21 percent is calculated. Many of the modeling techniques and results can be applied to other solar-cell structures. (Author)

A80-35352 High-efficiency silicon minMIS solar cells Design and experimental results. R. B. Godfrey (Tideland Energy Pty, Ltd., Sydney, Australia) and M. A. Green (New South Wales, University, Kensington, Australia). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 737-745. 36 refs. Research supported by the Australian Department of National Development.

Grating minority-carrier Metal-Insulator-Semiconductor (min-MIS) solar cells have been fabricated on a range of Czochralski (CZ) and float-zone (FZ) substrates. The most efficient cells result when the semiconductor surface between the grating lines is inverted. To characterize the measured short-circuit current of grating cells, the concept of an effective minority-carrier collection distance is introduced. Record open-circuit voltages of 655 mV (AM0, 25 C) for 0.1-ohm cm FZ substrates have been achieved. AM1 active area efficiencies of 17.6 percent for polished substrates and 17.4 percent for texture substrates have been measured. (Author)

A80-35353 Upper limit of thermophotovoltaic solar-energy conversion. P. Würfel and W. Ruppel (Karlsruhe, Universität, Karlsruhe, West Germany). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 745-750. 5 refs.

The efficiency of the conversion of solar energy into electrical energy by solar cells is improved if the incident solar radiation is first absorbed by an intermediate absorber. The reemitted radiation is directed onto the solar cell. This mode of operation is known as thermophotovoltaic energy conversion. A black-body intermediate absorber is advantageous for small-bandgap solar cells. An even higher improvement is, however, achieved by a selective intermediate absorber with an absorption edge at the energy of the bandgap of the solar cell. Furthermore, if only a narrow spectral interval of radiation near the absorption edge is transmitted through a filter from the intermediate absorber to the solar cell, a maximum efficiency of 65 percent is obtained for a solar cell and absorber with a bandgap of 0.8 eV. (Author)

A80-35354 * Updating the limit efficiency of silicon solar cells. M. Wolf (Pennsylvania, University, Philadelphia, Pa.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 751-760. 23 refs. Contract No. JPL-KM-68903.

The limit efficiency of a silicon solar cell is investigated using an analytical approach. The analytical model is based on the solution of a transport equation for minority carriers derived from the Shockley equations. On the basis of the computations, a 'narrow-region' design approach is suggested for both the front and the back regions of the solar cell. The design relies on low effective surface-recombination velocities, a textured front surface, and an optical internally reflecting back surface. With this approach, the limit efficiency is near 25%, and the optimum cell is 50 to 150 microns thick. V.L.

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A80-35355 A study of the conversion efficiency limit of p(+)-i-n(+)-silicon solar cells in concentrated sunlight. T. I. Chappell (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 760-766. 30 refs.

The conversion efficiency limit of p(+)-i-n(+)-silicon solar cells in concentrated sunlight is explored with numerical simulations of an idealized p(+)-i-n(+)-cell having field-induced junctions. Conversion efficiencies greater than 30 percent are calculated for this cell operating in sunlight concentrated 1000 times. The relative importance of bulk and surface recombination in limiting the cell conversion efficiency is illustrated for operation in 1 to 1000 suns. For surface recombination velocities below 100 cm/s, it is shown that bulk recombination losses limit the cell performance rather than recombination losses occurring in the p(+) or n(+) regions. The results show that Auger recombination in the bulk region will limit ultimately the cell conversion efficiency. (Author)

A80-35356 Unified model of fundamental limitations on the performance of silicon solar cells. D. Redfield (RCA Laboratories, Princeton, N.J.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 766-771. 17 refs. Research supported by RCA; Contract No. DE-AC01-79ET-23108.

Previous attempts to explain the substantial discrepancy between observed and predicted efficiencies in silicon solar cells are shown to have treated inadequately two important features of typical devices: (1) in the diffused region the electric-field distribution is much wider than generally believed and the field values away from the junction are generally higher; (2) Auger processes in heavily doped regions have a more pervasive impact than has been recognized. By incorporating a suitable modification of the junction model and a consistent treatment of Auger effects into the analysis, a unified model is developed for the principal limitations on the performance of Si solar cells. This model accounts for limits to I_{sc} and V_{oc} arising in either the front or base region. The present analysis reinterprets the violet-cell observations of the effect of the diffusion profile and presents an alternative to the bandgap-narrowing model of the heavy-doping effect on V_{oc} . A new method is developed for evaluating the junction saturation current in heavily doped regions of such solar cells and transistor emitters. (Author)

A80-35358 A one-dimensional theory of high base resistivity tandem-junction solar cells in low injection. C. Goradia. *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 777-785. 13 refs.

A one-dimensional theoretical model of the Tandem-Junction Solar Cell with high base resistivity and under low-level injection is derived. The model provides a theoretical basis for a previously published conceptual model and allows for the calculation of the spectral response and other performance parameters, namely, I_{sc} , V_{oc} , $P(m)$, FF, and η , under variation of one or more of the geometrical and material parameters and 1-MeV electron fluence. Sample calculation results of computer simulation of this model are presented. (Author)

A80-35359 Physics underlying the performance of back-surface-field solar cells. J. G. Fossum (Florida, University, Gainesville, Fla.), R. D. Nasby (Sandia Laboratories, Albuquerque, N. Mex.), and S. C. Pao (Burroughs Corp., San Diego, Calif.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 785-791. 17 refs. Research supported by the U.S. Department of Energy.

A description of the physics of back-surface-field (BSF) solar cells is presented, in which several key approximations, valid for effective BSF cells, have been used to express the results of the analysis in ways that make them useful in understanding the performance of high-efficiency BSF cells. A silicon p(+)-n-n(+)-BSF solar cell, developed in conjunction with the theoretical treatment, provides experimental support for the theory. Measured current-voltage characteristics, together with the analysis, are used to describe the important physical mechanisms that control the performance of the BSF solar cell. For example, the analysis enables

the determinations of the carrier lifetimes in the base region and of the effective surface recombination velocity at the low-high junction. (Author)

A80-35360 A study of the factors which control the efficiency of ion-implanted silicon solar cells. E. C. Douglas and R. V. D'Aiello (RCA David Sarnoff Research Center, Princeton, N.J.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 792-802. 18 refs. Research supported by RCA; Contract No. JPL-954868.

The objective of this work was to determine experimentally the ion-implantation parameters and furnace annealing conditions required to produce high-efficiency solar cells. A comprehensive experimental study was conducted in which the optimum ion-implantation parameters were found by a systematic variation of the implant parameters followed by detailed studies of solar-cell devices. Two furnace heat-treatment techniques were found which effectively anneal the implanted layers and at the same time preserve or improve the diffusion length in the bulk silicon. Detailed characteristics of both the junction and bulk properties of solar cells fabricated over the spectrum of implant parameters are discussed. Optimized implant parameters and annealing conditions were found which allow for the fabrication of 14-15-percent (AM1) efficient solar cells. (Author)

A80-35361 Tailored emitter, low-resistivity, ion-implanted silicon solar cells. J. A. Minnucci, A. R. Kirkpatrick, and K. W. Matthei (Spire Corp., Bedford, Mass.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 802-806. 8 refs. Contract No. NAS3-20823.

Open-circuit voltages as high as 0.645 V (AM0, 25 C) have been obtained by a new process developed for low-resistivity silicon. The process utilizes high-dose phosphorus implantation followed by furnace annealing and simultaneous oxide growth. The effect of the thermally grown oxide is a reduction of surface recombination velocity; the oxide also acts as a moderately efficient antireflection (AR) coating. Boron-doped, float-zone silicon with resistivities from 0.1 to 1.0 (Ω cm) has been processed according to this sequence; results show that the highest open-circuit voltage is obtained with 0.1 (Ω cm) starting material. The effects of Auger recombination and bandgap narrowing caused by high doping concentrations in the n(+) junction region have been investigated by implanting phosphorus over a wide range of dose levels. The effects of emitter-phosphorus concentrations tailored to optimize electric fields in the emitter have also been investigated. (Author)

A80-35362 Pulsed laser techniques for solar cell processing. R. T. Young, R. F. Wood, J. Narayan, C. W. White, and W. H. Christie (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 807-815. 23 refs. Contract No. W-7405-eng-26.

Q-switched lasers can serve as energy sources to replace conventional high-temperature furnaces in p-n junction formation in solar cells. They have been used to anneal ion-implantation damage, to produce laser-assisted dopant diffusion, and to regrow doped amorphous layers deposited on single-crystal Si substrates. It has been demonstrated that all these methods are suitable candidates for the processing of high-efficiency Si solar cells. Because they provide ultra-rapid heating and cooling of the near-surface region, these laser techniques can be used for p-n junction formation in thin-film polycrystalline material to prevent enhanced dopant diffusion along grain boundaries and for compound semiconductors, such as GaAs, to avoid the need for surface encapsulation during the annealing of ion implantation damage. Defects in the near-surface region such as the 'dead layer' produced by conventional high-temperature diffusion can be completely removed by laser irradiation. (Author)

A80-35363 Laser processing in the preparation of silicon solar cells. J. C. Muller, E. Fogarassy, D. Salles, R. Stuck, and P. M. Siffert (CNRS, Centre de Recherches Nucléaires de Strasbourg, Strasbourg, France). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 815-821. 31 refs.

Besides cheaper techniques of growing the starting silicon, the reduction of manufacturing costs of terrestrial solar cells needs new automated approaches for the preparation of the junction. The possibilities given by laser processing are considered for three different structures: diffused junctions, ion implanted and alloyed diodes prepared from layers of dopants just deposited on surface.

(Author)

A80-35364 Material and device considerations for cascade solar cells. S. M. Bedair, S. B. Phatak (Research Triangle Institute, Research Triangle Park, N. C.), and J. R. Hauser (North Carolina State University, Raleigh, N.C.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 822-831. 25 refs. Research supported by the U.S. Department of Energy and U.S. Air Force.

The cascade solar cell using two or more junctions has the potential for significantly increasing the efficiency of solar cells beyond that of single-junction cells. Theoretical calculations give AM0, one sun efficiencies of 30 percent or slightly higher. Before these efficiencies can be achieved, many material and device problems must be solved. This paper discusses these major material and device problems as related to the cascade solar cell concept. Also presented are some experimental results on materials and devices which are presently being explored for use in the cascade solar cell.

(Author)

A80-35365 Cascade solar-cell design for high-temperature operation. M. F. Lamorte and D. H. Abbott (Research Triangle Institute, Research Triangle Park, N.C.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 831-840. 16 refs. Research supported by the U.S. Department of Energy and Sandia Laboratories.

The cascade solar-cell optimization design procedure developed using computer modeling to obtain a cell design that results in maximum conversion efficiency under a given set of operating conditions has been extended. Earlier work reported optimized designs for operation at 300 K, AM0, and AM1.5. In this work, optimized designs are determined for a two-junction, monolithic, cascade solar cell for operation at eight temperatures in the range from 300 to 475 K, AM1.0, and one million cm/sec surface-recombination velocity. The device performance characteristics for each of the eight optimized designs are studied over the 300 to 600 K operating-temperature range.

(Author)

A80-35366 A new technology to fabricate high-efficiency silicon concentrator solar cells. M. Finetti, P. Ostojic, S. Solmi, and G. Soncini (CNR, Laboratorio LAMEL, Bologna, Italy). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 841-843. 9 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A new procedure to fabricate silicon concentrator solar cells based on phosphorus diffusion into the semiconductor through a thin polysilicon film is described. The polysilicon reduces the high-diffusivity tail of the conventional phosphorus-doping profile and avoids interdiffusion phenomena at the metal-semiconductor interface during sintering, thus allowing Al to be used as front grid contact. Outdoor testing of 2 x 2-sq cm solar cells computer-designed to operate at 50 suns showed conversion efficiencies higher than 17%.

(Author)

A80-35367 'Band readjustment' effect with applications to solar cells. S.-C. Lee and G. L. Pearson (Stanford University, Stanford, Calif.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 844-850. 16 refs. NSF Grants No. DMR-76-84373; No. DMR-79-01661.

Double-layer Au-(n)AlGaAs-(n)GaAs Schottky-barrier devices were examined. The interaction of the closely spaced Au-AlGaAs Schottky barrier and the AlGaAs-GaAs heterojunction was found to produce a novel phenomenon termed 'band readjustment.' This effect is applied to the design of high-efficiency solar cells. Three criteria are presented by which the open-circuit voltage and the short-circuit current of the solar cells can be improved separately. Current transport through the potential barrier, located within the heterojunction depletion region, is also discussed.

(Author)

A80-35368 Barrier height enhancement in heterojunction Schottky-barrier solar cells. H.-T. Yang, Y.-D. Shen, D. Edwall, D. L. Miller, and J. S. Harris, Jr. (Rockwell International Corp., Electronics Research Center, Thousand Oaks, Calif.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 851-856. 11 refs. Research supported by the U. S. Department of Energy.

A80-35369 * Deep-level defects, recombination mechanisms, and their correlation to the performance of low-energy proton-irradiated AlGaAs-GaAs solar cells. S. S. Li, W.-L. Wang, P.-W. Lai (Florida University, Gainesville, Fla.), R. Y. Loo, G. S. Kamath, and R. C. Knechtli (Hughes Research Laboratories, Malibu, Calif.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 857-864. 19 refs. Grant No. NSG-1425.

A80-35370 # Laser scanning of solar cells for the display of cell operating characteristics and detection of cell defects. D. E. Sawyer (Chevron Research Co., Richmond, Calif.) and H. K. Kessler (National Bureau of Standards, Electron Devices Div., Washington, D.C.). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 864-872. 9 refs. Contract No. EA-77-A-6010.

A new optical scanning technique was developed to map solar-cell operation over the cell area and reveal several types of cell defects. The technique, which makes use of the distributed nature of the cell, an intrinsic property shared by all cells, allows one to detect potentially harmful cracks with a sensitivity greater than any other optical technique reported previously, and it permits one, for the first time, to locate regions of poor metallization. It has also been used to determine efficacy of cell design and to study cell degradation processes. The new scanning technique employs forward biasing of the cell during scanning. Biasing may be achieved through the use of a steady-state light source, or for cells made using conventional semiconductor materials, e.g., silicon and gallium arsenide, the use of an external current source. The scanning technique is nondamaging; it requires no electrical contacts to the cell other than those already present, and it can be used on encapsulated or unencapsulated cells in almost any laboratory or test environment.

(Author)

A80-35372 Upper limit for the conversion of solar energy. W. Ruppel and P. Würfel (Karlsruhe, Universität, Karlsruhe, West Germany). *IEEE Transactions on Electron Devices*, vol. ED-27, Apr. 1980, p. 877-882. 8 refs.

A semiconductor in the solar radiation field acts as a thermal electronic engine. It converts absorbed radiation heat into chemical energy of the excited electron-hole gas. In flow equilibrium, a homogeneous semiconductor gives off this chemical energy by radiative recombination to the surroundings. If provision is made, as by a p-n junction, to divert the excited electrons and holes, before they recombine, from their point of generation, their chemical energy may be converted into electrical energy. The ratio of this chemical energy current, which constitutes an upper limit for the obtainable electrical energy current, to the absorbed heat current is computed as a function of the value of the bandgap of the semiconductor. Under the assumption that the absorptivity of the electron-hole system of the semiconductor is unity for photon energies larger than the bandgap and zero for smaller photon energies, the conversion efficiency for unfocused sunlight has a maximum of 30 percent for a bandgap of 1.3 eV.

(Author)

A80-35385 Effect of titanium, copper and iron on silicon solar cells. A. Rohatgi, J. R. Davis, R. H. Hopkins, P. Rai-Choudhury, P. G. McMullin (Westinghouse Research and Development Center, Pittsburgh, Pa.), and J. R. McCormick (Hemlock Semiconductor Corp., Hemlock, Mich.). *Solid-State Electronics*, vol. 23, May 1980, p. 415-419, 421, 422. 19 refs. Research sponsored by the U.S. Department of Energy.

The effect of Ti, Cu, and Fe on silicon solar cells has been investigated. Ti severely degrades cell performance above a concentration of 10 to the 11th per cu cm. A higher Ti level results in a 63% loss in cell performance and more than an order of magnitude

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reduction in carrier lifetime; Ti produces two deep levels in Si at $E_v + 0.30$ eV and $E_c - 0.27$ eV. Copper, at concentrations below 10 to the 16th per cu cm, has negligible effect on cell performance and carrier lifetime. Fe begins to damage the cell performance above a concentration of 2×10 to the 14th per cu cm; at the concentration of 1.7×10 to the 15th per cu cm it causes a 46% loss in cell efficiency and about an order of magnitude reduction in lifetime.

A.T.

A80-35467 Improvement of polycrystalline silicon solar cells with grain-boundary hydrogenation techniques. C. H. Seager, D. S. Ginley (Sandia Laboratories, Albuquerque, N. Mex.), and J. D. Zook (Honeywell Corporate Technology Center, Bloomington, Minn.). *Applied Physics Letters*, vol. 36, May 15, 1980, p. 831-833. 12 refs. Contract No. DE-AC04-76DP-00789.

Electron-beam-induced-current and dark-current-voltage measurements have been made on p/n photovoltaic cells fabricated from polycrystalline silicon. These data have demonstrated that grain-boundary hydrogenation greatly reduces grain-boundary minority carrier recombination and improves diode current-voltage characteristics. (Author)

A80-35474 Properties of photoelectrochemical cells with a chemically sprayed photoanode. C.-H. J. Liu and J. H. Wang (New York, State University, Buffalo, N.Y.). *Applied Physics Letters*, vol. 36, May 15, 1980, p. 852, 853. 7 refs: NSF Grant No. PCM-77-5502.

Chemically sprayed CdSe thin films were used as photoanodes in photoelectrochemical solar cells. The power characteristics of the cell ITO/CdSe/Na₂S-NaOH/Pt was measured. The energy conversion efficiency of this cell was 7.8% at 640 nm and 5.2% under 50-mW/sq cm white light. (Author)

A80-35480 Photovoltaic Material and Device Measurements Workshop, Arlington, Va., June 11-13, 1979, Proceedings. Part 1. Workshop sponsored by the U.S. Department of Energy and Solar Energy Research Institute. Edited by D. E. Sawyer (National Bureau of Standards, Electron Devices Div., Washington, D.C.). *Solar Cells*, vol. 1, Feb. 1980. 123 p.

A collection of papers on solar cells is presented regarding their science, technology, applications and economics. Attention is given to polycrystalline materials and the associated thin-film solar-cells. Topics of interest include perspective on photovoltaic material and device measurements, new techniques for the study and control of grain boundary effects, grain size and its influence on efficiency in polycrystalline GaAs solar cells, scanning light spot analysis of faulty solar cells, and effective diffusion length in polycrystalline semiconductor thin films. S.D.

A80-35482 Electron-beam-induced current characterization of polycrystalline silicon solar cells. J. I. Hanoka (Mobil Tyco Solar Energy Corp., Waltham, Mass.). *Photovoltaic Material and Device Measurements Workshop, Arlington, Va., June 11-13, 1979.* *Solar Cells*, vol. 1, Feb. 1980, p. 123-139. 15 refs.

The use of the electron-beam-induced current mode of the scanning electron microscope for recombination studies in polycrystalline silicon solar cells is reviewed. The potential and some limits of the technique are discussed. Quantitative studies and representative results for edge-defined film-fed growth (EFG) ribbon solar cells and other kinds of silicon solar cells are presented and compared. Questions concerning recombination by impurities and defects such as dislocations, grain boundaries and SiC particles and the interactive effects of all these are discussed at some length. (Author)

A80-35486 The Zn(x)/Cd(1-x)/S/Cu₂S heterojunction - Review and recent measurements. L. C. Burton (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Photovoltaic Material and Device Measurements Workshop, Arlington, Va., June 11-13, 1979.* *Solar Cells*, vol. 1, Feb. 1980, p. 159-174. 36 refs.

Development of the Zn(x)Cd(1-x)S/Cu₂S thin-film solar cell is reviewed. Several possible mechanisms that could account for differences between solar cells made from Zn(x)Cd(1-x)S and CdS

are described. It is found that there is an accumulation of zinc under the Zn(x)Cd(1-x)S/Cu₂S interface for junctions formed by ion exchange. It is proposed that this zinc-rich region is inhomogeneous when the Cu₂S is formed in aqueous solution, resulting in current blocking behavior over a fraction of the cell area. The open-circuit voltage of these cells is controlled by the nonblocking regions of lower barrier height. Composition measurements of the Zn(x)Cd(1-x)S/Cu₂S interfacial region are related to a modified model which can account for some of the properties of the junction that are not well understood. S.D.

A80-35488 Etching of CdS films. F. A. Shirland (Westinghouse Research and Development Center, Pittsburgh, Pa.). *Photovoltaic Material and Device Measurements Workshop, Arlington, Va., June 11-13, 1979.* *Solar Cells*, vol. 1, Feb. 1980, p. 183-197. 13 refs. Research supported by the Westinghouse Electric Corp.; Contract No. EG-77-C-03-1577.

In the processing of front-wall CdS thin film solar cells the films are given a strong HCl etch prior to formation of the Cu₂S layer. This results in substantially higher cell outputs. Preliminary data are reported of a study of how HCl attacks CdS films and how the attack is affected by changes in the etching parameters, particularly time, temperature and acid concentration. Etched CdS films and replicas of etched CdS film surfaces were examined by scanning electron microscopy (SEM) and selected SEM photographs are presented to illustrate the effects. It is shown that etching textures the front surface of the CdS films and forms deep pits into the films. Pitting is the factor which varies most widely on differently processed films and which seems to correlate with the output level achievable from cells made from such films. The underlying substrate seems to be the factor having most influence on the etch pits. (Author)

A80-35490 Photoconductivity as a probe of polycrystalline films. R. H. Bube (Stanford University, Stanford, Calif.). *Solar Cells*, vol. 1, Feb. 1980, p. 209-212. 9 refs. Abridged.

The paper shows how photoconductivity measurements can provide information about the properties of polycrystalline films through a variety of direct and indirect effects. The temperature dependence of the photoconductivity decay, or its associated phenomenon of thermally stimulated conductivity, may be used to obtain information and to evaluate parameters of imperfections. Measurements that allow separation of density and mobility effects are discussed. A model proposed by Petritz (1956) provides a useful framework within which to consider barrier modulation effects with photoexcitation. The discussion is illustrated by two specific examples involving polycrystalline films of CdS and PbS. S.D.

A80-35491 Electron diffusion lengths in the CdS/Cu_x/S cell from spectral response measurements. C. Moses (New York, State University, Canton, N.Y.) and D. Wasserman (Cornell University, Ithaca, N.Y.). *Solar Cells*, vol. 1, Feb. 1980, p. 218-221. 5 refs. Abridged.

A80-35492 The design and utilization of a microprocessor-controlled absolute spectral response system. L. M. Kilgren, N. C. Wyeth, and W. E. Devaney (Delaware, University, Newark, Del.). *Photovoltaic Material and Device Measurements Workshop, Arlington, Va., June 11-13, 1979.* *Solar Cells*, vol. 1, Feb. 1980, p. 225-231. 5 refs.

A fully automated spectral response system for solar cells has been developed and utilized in the study of CdS/Cu₂S and Zn₃P₂ solar cells. Four types of measurements were carried out: (1) spectral response under bias light conditions to study the effects of light intensity and spectral content on cell response; (2) spectral response on thick absorbing layers to determine their diffusion length and absorption coefficient; (3) spectral response beyond the intrinsic absorption region to determine the internal photoemission barrier height; (4) the response at a given wavelength as a function of the voltage bias and light bias on the cell to determine the voltage dependence of the light-generated current and its effect upon the fill factor of the cell. (Author)

AB0-35493 Electron-beam-induced current and scanning light spot techniques for investigating the response of polycrystalline solar cells. N. Inoue, S. M. Goodnick, and C. W. Wilmsen (Colorado State University, Fort Collins, Colo.). *Solar Cells*, vol. 1, Feb. 1980, p. 233-236. Abridged.

AB0-35500 * # Preliminary study of a solar selective coating system using black cobalt oxide for high temperature solar collectors. G. McDonald (NASA, Lewis Research Center, Cleveland, Ohio). *American Vacuum Society, International Conference on Metallurgical Coatings, San Diego, Calif., Apr. 21-25, 1980, Paper*. 14 p. 8 refs.

Black cobalt oxide coatings were deposited on thin layers of silver or gold which had been deposited on oxidized stainless steel substrates. The reflectance properties of these coatings were measured at various thicknesses of cobalt oxide for integrated values of the solar and infrared spectrum. The values of absorptance and emittance were calculated from the measured reflectance values before and after exposure in air at 650 C for 1000 hours. Also, these cobalt oxide/noble metal/oxide diffusion barrier coatings have absorptances greater than 0.90 and emittances of approximately 0.20 even after about 1000 hours at 650 C. (Author)

AB0-35838 Heat losses of a static low-concentration solar collector. F. Grasso, G. Guerriera, F. Musumeci, and A. Triglia (Catania, Università; Centro Siciliano di Fisica Nucleare e Struttura della Materia, Catania, Italy). *Nuovo Cimento C, Serie 1*, vol. 2C, Sept.-Oct. 1979, p. 537-542. 11 refs.

A static low-concentration collector has been designed and manufactured. The collector geometry reduces the thermal convection, and the selective coating of the absorber reduces radiative losses. The total heat losses have been measured as a function of temperature difference between absorber and ambient up to 150 C. A typical loss figure is 160 W/sq m for a temperature difference of 80 C. (Author)

AB0-36052 An assessment of solar hot water heating in the Washington, D.C. area - Implications for local utilities. M. W. Stuart (George Washington University, Washington, D.C.). *Energy* (UK), vol. 5, Apr. 1980, p. 331-342. 19 refs.

A survey of residential solar hot water heating in the Washington, D.C. area is presented with estimates of the total solar energy contribution per year. These estimates are examined in relation to a local utility's peak-load curves to determine the impact of a substantial increase in solar domestic hot water use over the next 20 yr in the area of utility management. The results indicate that a 10% market penetration of solar water heaters would have no detrimental effect on the utility's peak-load profile and could save several million dollars in new plant construction costs. (Author)

AB0-36121 A circuit for measurement of the fill factor of solar cells. G. Popkirov (B'lgarska Akademiia na Naukite, Tsentralna Laboratoriia po Sl'ncheva Energiia i Novi Energiini Iztochnitsi, Sofia, Bulgaria). *Journal of Physics E - Scientific Instruments*, vol. 13, May 1980, p. 496.

A simple, accurate electronic circuit for the direct measurement of the fill factor of solid-state solar cells is presented. The circuit provides for solar cell operation in the short circuit, open circuit and applied voltage modes, and fill factor is determined from the ratio of the product of the maximum applied current and voltage to the product of the short-circuit current and open-circuit voltage. Depending on component precision, accuracies of 1% or better can be obtained. (Author)

AB0-36242 Observation of an active photoinductive component in high intensity solar cells. F. C. Jain (Connecticut University, Storrs, Conn.). *Journal of Applied Physics*, vol. 51, May 1980, p. 2685-2692. 25 refs.

Observations of a photoinductive reactance in Si and GaAs p-n junction diodes under photon flux densities above a certain threshold

value are discussed. Results of experimental measurements of the capacitance and inductance of a n(+)-p Si diode, a p(+)-n Si diode, two n(+)-n-pp(+) Si diodes and a p(+)-n GaAs diode as a function of photon flux density expressed in terms of diode short circuit current are presented for virtually dc open-circuited solar cell conditions, and a crossover to inductive behavior at threshold photon flux densities from 2.75 to 21 times as intense as solar radiation at air mass 2, depending on diode structure and wavelength of incident light, is demonstrated. Theoretical considerations are presented which show that an explicit inductive component originates in the conductivity-modulated section of the base region when the photogenerated minority carrier concentration becomes comparable to that of the majority carriers. Theoretical computations of reactance characteristics on the basis of this model are then shown to be in agreement with experimental results. (Author)

AB0-36245 An analytical model of a backwall MIS Schottky barrier solar cell. B. L. Krauter and R. J. Soukup (Nebraska University, Lincoln, Neb.). *Journal of Applied Physics*, vol. 51, May 1980, p. 2914-2919. 25 refs.

The paper analyzes various factors which determine the performance of a backwall MIS Schottky barrier solar cell, including the short-circuit current density, the MIS Schottky barrier junction behavior, and resistive losses. The study concentrates on the Al-Al₂O₃-GaAs-metal structure. It is shown that the maximum current occurs when the GaAs thickness is in the 500 Å to 1.2 microns range, depending on the minority carrier diffusion and surface recombination velocity. An optimum open circuit voltage is achieved for an Al₂O₃ thickness of 15 Å. Conversion efficiencies as high as 6% are predicted for this structure despite rather poor electrical properties of the GaAs films. (Author)

AB0-36587 Processes degrading the electrophysical characteristics of photoconverters in long-term operation. G. S. Daletskii, I. V. Karpenko, M. M. Koltun, V. A. Karpukhin, Iu. N. Ksendzatskaia, V. M. Kuznetsov, S. V. Riabikov, and R. N. Tykvenko (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 7-12.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 1-5. 8 refs. Translation.

Causes of the degradation of the photoelectric characteristics of silicon and thin-film photoconverters during long-term operation are considered. Laboratory tests in high-vacuum conditions under a simulator have shown that a transparent bonding compound based on low molecular weight silicone rubber has greater resistance to the ultraviolet radiation of the sun and to nuclear particle irradiation than epoxy cements, and maintains its elasticity at temperatures down to -180 C. The stability of cells in which polycrystalline films of n-type cadmium sulfide and telluride form the base region of the solar cells was investigated; the potential barrier is formed at Cu₂Te-CdTe and Cu₂S-CdS heterojunctions, where a p-type layer of copper chalcogenide is produced by a chemical substitution reaction (Cu₂S) or by discrete deposition in vacuum (Cu₂Te). It is concluded that silicon single-crystal solar cells using the system of optical coatings developed and thin-film solar cells based on A2B6 compounds may be used for space and ground applications. (Author)

AB0-36588 Investigation into the influence of high solar-excitation level on optimal parameters of P-Al(x)/Ga(1-x)/As-P-GaAs-n-GaAs heterophotocells. S. A. Azimov, M. M. Mirzabaev, K. Rasulov, A. Iskanderov, and M. Tursunov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 13-16.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 6-9. 6 refs. Translation.

The behavior of solar cells using n-GaAs-P-GaAs-P-Al(x)Ga(1-x)As systems with an intermediate diffused layer is studied for high solar-radiation conditions. It has been shown by Alferov (1977, 1978) and Agavev et al. (1978) that heterophotocconvertors (HPC) based on GaAs-AlGaAs with an intermediate radiation conversion and an intermediate conversion layer, and graded heterostructures with forbidden gap widths that expand toward the irradiated surface can operate at high illumination and

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temperature levels. This study made it possible to determine the method by which the basic HPC energy parameters depend on illumination, temperature and structural characteristics of the contacts. The operating efficiency of the HPC at elevated illumination levels depends on the spreading resistance of the upper layer; if this is reduced through selection of an optimal contact structure, the output power and efficiency of the cells will be increased. A.T.

A80-36591 Investigation into operating characteristics of solar batteries using Cu/2-x/S-CdS ceramic photoconverters. A. I. Marchenko, I. I. Stepko, G. A. Fedorus, and G. I. Sheremetova (Akademiia Nauk Ukrain'skoi RSR, Institut Napivprovidnikiv, Kiev, Ukrainian SSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 34-37.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 27-30. 7 refs. Translation.

The development of Cu(2-x)-CdS heterogeneous photoconverters with parameters which appear promising for solar batteries is presented. Typical specimens of ceramic solar cells (SC) using CdS for solar radiation power of 75 mW/sq cm and AM1 conditions were used, with the solar batteries (SB) having 10, 20, 40, and 80 individual photoconverters, each with an area of 3 sq cm. The devices were installed on a flat micarta board with various types of leads, making it possible to change the interconnection of individual modules. Investigation of the operating characteristics of the SB under laboratory and natural conditions demonstrated the possibility of their utilization as independent power sources; it was also established that additional improvement is required in the construction of the SB and its protection against the environment, since the use of varnish as the protective coating is inadequate because it is affected by moisture. A.T.

A80-36592 Evaluating the performance of reflecting concentrating systems. R. A. Zakhidov (Akademiia Nauk Uzbekskoi SSR, Tsentral'noe Proektno-Konstruktorskoe i Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 38-42.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 31-36. Translation.

Methods for evaluating the performance of mirror elements of reflecting concentrators are described. A system for the inspection of reflecting surfaces combining several methods of determining the geometric-optic characteristics of the reflectors was developed; the system consists of devices for local and integral inspection of geometric accuracy and reflectance of the surfaces. The contact (profilometry) and contactless (optical) methods are local; the calorimeter, thermoelectric, and photoelectric methods are integral. The profilometer inspection-measurement setup includes a coordinate stand and a micrometer measurement head with an interchangeable dial-type indicator; the optical unit includes a coordinate illuminator with a laser; the unit for investigating the shape of reflecting-surface elements by moiré method uses the 'mechanical' interference of a reference grating and a grating pattern reflected from the mirror surface. Finally, the integral-inspection devices and installations, and the unit for determining the reflectance of concentrating surfaces are discussed, noting possibilities for future automation. A.T.

A80-36593 Obtaining film materials with solar furnaces. I. N. Frantsevich, V. S. Dverniakov, I. E. Kasich-Pilipenko, V. L. Tikush, G. V. Rusakov, L. A. Gaevskaia, L. R. Shaginian, and R. S. Biriukova (Akademiia Nauk Ukrain'skoi SSR, Institut Problem Materialovedeniia, Kiev, Ukrainian SSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 43-47.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 37-40. 8 refs. Translation.

It is shown that it is possible to produce films of various materials by means of solar energy. A single-crystal type KE silicon was used as a substrate, and coatings of silicon monoxide, silicon, and aluminum were applied. The electron diffraction studies showed that silicon monoxide applied to single-crystal silicon has an amorphous structure, aluminum films deposited on these substrates have a polycrystalline textured structure, and silicon layers on the same substrate are polycrystalline with inclusions of single crystal

blocks. It is concluded that solar energy films in a wide range of thicknesses can be produced and used as dielectrics, semiconductors, and metals. A.T.

A80-36594 Electrolytic coatings of 'black chromium' type for solar collectors. G. Ia. Umarov, U. Kh. Gaziev, Sh. A. Faiziev, V. V. Li, and V. S. Trukhov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 50-55.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 44-48. 11 refs. Translation.

Results are reported for investigations of a 'black chromium' type electrolytic coating. The 'black chromium' deposits obtained on copper and nickel substrates have good optical characteristics: a solar-radiation absorptance of 0.9-0.93 and an emissivity of 0.1. (Author)

A80-36596 Technical-economic validation for selection of solar resources as energy sources. R. B. Salieva (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 74-77.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 67-70. 5 refs. Translation.

The paper presents calculations for technical-economic validation of the choice of solar resources as energy sources using mathematical-economic models for calculation stages. The economic justification of the energy base for construction of solar-power and wind-power systems is especially important for areas with scarcity of water and energy; this applies to the deserts and arid steppes of Central Asia and Kazakhstan. The basic energy technical-economic considerations are the reduction of the variants compared to an identical energy effect, and the evaluation of the one-time and annual expenditures for the variants are compared. The solar and wind plants for which the total output over the period of utilization would make it possible to meet the total demand for the facilities serviced with the required insurance standards is considered; this is followed by the calculation for regulation of output of the solar and wind plants. A.T.

A80-36597 Development and investigation of solar thermoelectric generator using a tubular module. Ch. Agabaev, G. A. Gukhman, N. V. Kolomoets, M. A. Markman, N. G. Milevskaia, and N. Rozyev (Akademiia Nauk Turkmen'skoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 82, 83.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 77-79. Translation.

A technical-economic comparison was made for the effectiveness of using solar desalination plants (SDP) and water lines in a pressure water-supply system. It is shown that in a desert-pasture water supply, solar desalination plants are more economical than water lines. Thus, utilization of SDP in the area of operation of the Erbent, Turkmenia water line produced a 55% reduction in capital investment for construction of a water-supply system. A.T.

A80-36598 Evaluating certain ways of storing solar energy. A. V. Sheklein. (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 92-96.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 87-91. 9 refs. Translation.

An evaluation of large-scale utilization solar energy storage methods is presented. The photosynthesis method can be embodied in growing of algae with subsequent production of gas, liquid, or solid fuel by pyrolysis or hydrogasification; the photoelectric method with generation of electric power is promising for large-scale energy systems; and the thermal method may be used in the production of electric power by means of thermodynamic cycles and power generation by thermoelements. The photochemical reaction methods, including fission, synthesis, or isomerization can be used for storage, although it has a drawback of the relatively low quantum yield of many reactions and low storage capacity. It is concluded that photochemical storage of radiant energy, especially when using photolysis of water and production of a nearly ideal fuel, hydrogen, is fully competitive with other types of energy accumulation. A.T.

A80-36821 Energy balance of solar thermoelectric generator. V. A. Baum, C. Agabaev, and N. Ovezsakhov (Akademiiia Nauk Turkmensoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad,

The paper develops a computational method for determining the maximum efficiency of a solar thermoelectric generator. It is shown that the efficiency of a solar thermoelectric system with natural cooling and without radiation concentration is less than 1%. B.J.

A80-36822 Multielement silicon photoelectric converters for investigating the optical and energy characteristics of solar and radiant energy concentrators. A. Ia. Gliberman, I. I. Kovalev, V. I. Krasilovskii, and L. M. Medvedeva (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, no. 3, 1979, p. 7-10.) *Applied Solar Energy*, vol. 15, no. 3, 1979, p. 5-8. 5 refs. Translation.

A80-36824 Thin-film and ceramic solar converters based on cadmium sulfide and selenide. V. N. Komashenko, A. I. Marchenko, and G. A. Fedorus (Akademiiia Nauk Ukrainsoi SSR, Institut Poluprovodnikov, Kiev, Ukrainian SSR). (*Geliotekhnika*, no. 3, 1979, p. 15-21.) *Applied Solar Energy*, vol. 15, no. 3, 1979, p. 13-19. 12 refs. Translation.

A80-36825 Calculation principles for heliostat fields of solar power plants. R. A. Zakhidov (Akademiiia Nauk Uzbeksoi SSR, Tsentral'noe Proektno-Konstruktorskoe i Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). (*Geliotekhnika*, no. 3, 1979, p. 22-27.) *Applied Solar Energy*, vol. 15, no. 3, 1979, p. 20-25. 14 refs. Translation.

The paper attempts to develop a general computational model for solar-tower concentrating systems. The model takes into account a number of factors, including the solar radiation characteristics, the arrangement of heliostats, the shape of mirrors, collector configurations, etc. Formulas are obtained for calculating insolation for collectors and heliostats of arbitrary configuration. B.J.

A80-36826 Heating characteristics of concentrator/receiver system employing a selective absorbing surface. O. I. Kudrin and A. Abdurakhmanov. (*Geliotekhnika*, no. 3, 1979, p. 28-33.) *Applied Solar Energy*, vol. 15, no. 3, 1979, p. 26-31. 5 refs. Translation.

A80-36829 Thermodynamic analysis of solar-energy thermal-power converters operating together with photoelectric converters. B. A. Bazarov and B. D. Tairov (Akademiiia Nauk Turkmensoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). (*Geliotekhnika*, no. 4, 1979, p. 10-13.) *Applied Solar Energy*, vol. 15, no. 4, 1979, p. 8-11. Translation.

The paper examines the operation of a solar energy system combining solar cells and a thermomechanical converter based on a Freon turbine with power output up to 10 kW. The basic thermodynamic and design parameters of such a system are investigated and compared to that of other Freon and water-vapor systems. B.J.

A80-36830 High-voltage multijunction solar-energy photoelectric converter. V. G. Doroshenko, M. B. Zaks, V. A. Kalash'ian, V. N. Lozovskii, Iu. V. Skokov, and O. I. Solodukha. (*Geliotekhnika*, no. 4, 1979, p. 14-18.) *Applied Solar Energy*, vol. 15, no. 4, 1979, p. 12-15. Translation.

The paper examines the photoelectric properties of single-crystal silicon high-voltage solar cells with bulk arrangement of p-n junctions, obtained through gradient zone recrystallization. The temperature dependence of the basic properties of such cells was studied in the 100-400-K range, and volt-ampere characteristics at high illumination intensities were examined. B.J.

A80-36832 Evaluating the mass of current conductors and required voltage level for large orbiting solar batteries. A. Kh. Cherkasskii (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, no. 4, 1979, p. 25-29.) *Applied Solar Energy*, vol. 15, no. 4, 1979, p. 21-25. Translation.

Estimates are obtained in a dimensionless form for the necessary mass of conductors for a large satellite solar array. In addition,

necessary voltage levels at array output terminals are estimated as a function of area. B.J.

A80-36833 Development and application of high-power lightpipes. V. S. Dverniakov, V. V. Pasichnyi, I. E. Kasich-Pilipenko, T. V. Eremina, D. K. Sattarov, M. I. Murav'eva, and I. E. Galant (Akademiiia Nauk Ukrainsoi SSR, Institut Problem Materialovedeniia, Kiev, Ukrainian SSR). (*Geliotekhnika*, no. 4, 1979, p. 36-39.) *Applied Solar Energy*, vol. 15, no. 4, 1979, p. 32-35. 6 refs. Translation.

The paper examines the possibility of using optical waveguides to transmit high-flux solar radiation in solar-furnace type systems. The waveguides will be used to deliver concentrated solar radiation for such manufacturing processes as zone melting, welding, and heat treatment. Design parameters and materials selection for such waveguides are considered. B.J.

A80-36834 Selective radiation absorption as a means of improving efficiency of a high-temperature solar power plant. O. I. Kudrin, A. Abdurakhmanov, and I. A. Aggeeva. (*Geliotekhnika*, no. 4, 1979, p. 40-48.) *Applied Solar Energy*, vol. 15, no. 4, 1979, p. 36-43. Translation.

The use of selectively absorbing surfaces to increase the efficiency of high-temperature solar energy systems is examined. Particular attention is given to the application of selective absorption to: (1) a high-temperature Stirling-engine system and (2) a solar thermal rocket engine. B.J.

A80-36898 Screen printed thin film CdS/CdTe solar cell. N. Nakayama, H. Matsumoto, A. Nakano, S. Ikegami (Matsushita Electric Industrial Co., Ltd., Wireless Research Laboratory, Osaka, Japan), H. Uda, and T. Yamashita (Matsushita Electric Industrial Co., Ltd., Materials Research Laboratory, Moriguchi, Osaka, Japan). *Japanese Journal of Applied Physics*, vol. 19, Apr. 1980, p. 703-712. 14 refs. Research supported by the Agency of Industrial Science and Technology.

A screen-printed thin-film solar cell with a CdS/CdTe junction is considered. Microstructures of the cell near the boundary of CdS and CdTe films are discussed along with the photovoltaic properties of the cell. In the most efficient cell, the peak of electron voltaic effect exists within 1 micron of the CdTe side from the CdS/CdTe metallurgical boundary. A 1-watt solar cell module consisting of 25 elements with a module efficiency of 2.9% is described. V.T.

A80-36933 * Forward- and reverse-bias tunneling effects in n⁺/p silicon solar cells. G. F. J. Garlick (Southern California, University, Los Angeles, Calif.) and A. H. Kachare (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Applied Physics Letters*, vol. 36, June 1, 1980, p. 911-913. 16 refs. Research sponsored by the U.S. Department of Energy.

Excess currents due to field-assisted tunneling in both forward and reverse bias directions have been observed in n⁺-p silicon solar cells. These currents arise from the effect of conducting paths produced in the depletion layer by n⁺ diffusion and cell processing. Forward-bias data indicate a small potential barrier with height of 0.04 eV at the n⁺ end of conducting paths. Under reverse bias, excess tunneling currents involve a potential barrier at the p end of the conducting paths, the longer paths being associated with smaller barrier heights and dominating at the lower temperatures. Low-reverse-bias data give energy levels of 0.11 eV for lower temperatures (253-293 K) and 0.35 eV for higher temperatures (293-380 K). A model is suggested to explain the results. (Author)

A80-36937 Charge collection and spectral response of amorphous-silicon solar cells. R. O. Bell (Mobil Tyco Solar Energy Corp., Waltham, Mass.). *Applied Physics Letters*, vol. 36, June 1, 1980, p. 936-938. Contract No. DE-AC03-79ET-20460.

Current generation in hydrogenated amorphous silicon, a-Si(H), was found to be predominately from the space-charge region. The mobility-lifetime products were the order of 5 x 10 to the -10th sq cm/V for both holes and electrons. It was necessary to consider

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trapping and recombination of the optically generated carriers in the space charge region to interpret solar cell and spectral response data.

(Author)

A80-37012 **Medium and high temperature solar processes.** J. F. Kreider (Jan F. Kreider and Associates, Boulder, Colo.). New York, Academic Press, Inc., 1979. 358 p. 148 refs. \$38.

The subject matter of this book is concerned with those solar-thermal processes that operate above 100 C. A broad division between medium- and high-temperature processes is made at 300-400 C, corresponding to practical operating temperatures achieved by single- and compound-curvature solar concentrators. An attempt is made to present an analytical framework for comparing the many features of thermal, solar, and nonsolar systems in an unbiased manner so that technically and economically optimal systems for performing a given task may be designed. Seven problem areas are discussed: solar systems economics and environmental impacts of solar systems; principles of solar radiation and optics; selected topics if the maximum temperature increase on discharge is to be kept below 5-10 C to avoid electrolyte loss via evaporation/condensation processes. Conversely, use of only one or two layers leads to an unacceptably high penalty in the energy density.

(Author)

A80-37190 **Characterization of commercial black chrome coatings.** D. M. Fell, L. L. Tongson, S. V. Krishnaswamy, R. Messier, and I. S. T. Tsong (Pennsylvania State University, University Park, Pa.). (*American Vacuum Society, National Symposium, 26th, New York, N.Y., Oct. 1-5, 1979.*) *Journal of Vacuum Science and Technology*, vol. 17, Jan.-Feb. 1980, p. 358-361. 21 refs.

A comparative study of the optical properties and chemical composition of three commercially prepared black chrome solar absorber coatings has been made. In all these samples, the visible and IR spectra were nearly the same and showed no peaks corresponding to hydrated chromium oxides. The chemical composition was obtained by AES and sputter-induced photon spectrometry (SIPS). The hydrogen profiles by SIPS indicated the presence of H (or OH) at varying levels in these coatings. Although the AES and SIPS analyses showed significant compositional profile differences among samples, their optical properties were quite comparable.

(Author)

A80-37191 **Preparation of thin films for solar energy utilization.** D. M. Mattox (Sandia Laboratories, Albuquerque, N. Mex.). (*American Vacuum Society, National Symposium, 26th, New York, N.Y., Oct. 1-5, 1979.*) *Journal of Vacuum Science and Technology*, vol. 17, Jan.-Feb. 1980, p. 370-373. 36 refs.

Thin film deposition techniques have made and are making a contribution to solar energy utilization. Commercial applications of thin films include photothermal selective absorbers formed by electroplating, chemical conversion, and vacuum processing; solar reflectors formed by vacuum processes; heat reflectors formed by vacuum processes and spray pyrolysis; and antireflection coating formed by vacuum processes and chemical leaching and the metallization of photovoltaic cells. CdS/Cu₂S photovoltaics formed by vacuum processes and spray pyrolysis are also close to commercial utilization. Principal problems in thin films applications include economics of fabrication and environmental stability of the thin film materials. For many applications the best and most economical film deposition technology is not yet defined. One of the problems with thin film evaluation is the lack of acceptable testing procedures particularly as related to lifetime. Research is continuing in the application of sophisticated thin films to photovoltaic conversion and other applications. This paper reviews the status of thin film in solar energy utilization.

(Author)

A80-37192 **Importance of the interface in noncrystalline/poly and amorphous/ conductor-insulator-semiconductor (CIS) solar cells.** R. Singh (Waterloo, University, Waterloo, Ontario, Canada) and K. Rajkanan (New York, State University, Buffalo, N.Y.). (*American Vacuum Society, National Symposium, 26th, New York, N.Y., Oct. 1-5, 1979.*) *Journal of Vacuum Science and Technology*, vol. 17,

Jan.-Feb. 1980, p. 376-379. 27 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada.

Recently a new class of photovoltaic device, classified as a conductor-insulator-semiconductor (CIS) solar cell, has been developed. On the top layer of these devices there may be a transparent metal film, oxide-semiconductor, or a combination of these leading to a wide variety of metal-insulator-semiconductor (MIS) and semiconductor-insulator-semiconductor (SIS) solar cells. Due to improved understanding of the interface between the top layer and the single crystal base semiconductor, efficiencies above 17% have been realized. However, CIS-type solar cells made on nonrecrystallized poly and amorphous semiconductors usually have low efficiency. It is shown that the native grown oxide may not be capable of forming a good interface and deposited dielectrics are required for noncrystalline CIS solar cells. The criteria for selecting the insulating layer are presented.

(Author)

A80-37195 **Evidence for grain boundary passivation by oxidation in polycrystalline GaAs solar cells.** L. L. Kazmerski and P. J. Ireland (Solar Energy Research Institute, Boulder, Colo.). (*American Vacuum Society, National Symposium, 26th, New York, N.Y., Oct. 1-5, 1979.*) *Journal of Vacuum Science and Technology*, vol. 17, Jan.-Feb. 1980, p. 525-528. 14 refs.

The chemistry and composition of grain boundaries in polycrystalline GaAs grown by liquid phase epitaxy (LPE) and molecular beam epitaxy (MBE) are examined using complementary Auger electron spectroscopy (AES), secondary ion mass spectrometry (SIMS) and X-ray photoelectron spectroscopy (XPS). The effects of an unintentional residual-oxygen partial pressure during LPE growth are investigated in terms of grain boundary passivation. Depth-compositional data verify the grain boundary localization of oxides using an in situ, UHV fracturing technique. Indications of distributions of these oxides over the grain boundary are presented. The performances of Au Schottky barrier solar cells fabricated from the polycrystalline LPE and MBE GaAs are compared and differences are explained in terms of grain boundary activity.

(Author)

A80-37297 **An array of directable mirrors as a photovoltaic solar concentrator.** W. B. Ittner, III (IBM Corp., Federal Systems Div., Gaithersburg, Md.). *Solar Energy*, vol. 24, no. 3, 1980, p. 221-234.

Calculations of the optics of heliostats for use in large thermal power towers have been carried out in considerable detail, chiefly by Vant-Hull et al. This paper describes a simplified method for calculating the images generated by a special type of concentrator, i.e. an array of independently steered mirrors on a single frame, intended to direct the solar image onto a flat photovoltaic solar cell target. The case of interest is one in which the field of illumination on the target is as uniform as possible, and the emphasis is thus on small 'rim angle' geometries (a configuration which also minimizes mirror interference effects). Calculations are presented for constructing the individual mirror target images in terms of three angles: (1) the angle between the photovoltaic target normal and the reflecting mirror (called here the mirror position angle), (2) the angle between the target center and the sun as measured from the center of the reflecting mirror, and (3) the angle at which the plane defined by the center of the sun, the mirror center and the target center intersects the plane of the target. The overall system efficiency for various mirror configurations, characterized by such parameters as the maximum mirror angle (i.e. 'rim angle'), target-mirror plane separation, and mirror aiming accuracy is discussed in terms of the specifications desirable in an optical concentrator designed specifically to illuminate uniformly a photovoltaic solar cell target.

(Author)

A80-37299 **Selenium and tellurium selective absorber coatings produced by an oblique vacuum deposition technique.** M. J. Peterson and F. H. Cocks (Duke University, Durham, N.C.). *Solar Energy*, vol. 24, no. 3, 1980, p. 249-253. 20 refs. Research supported by the Selenium-Tellurium Development Association.

Selective absorber surfaces with a/e ratios greater than 33:1 have been produced by the angled vapor deposition of Te thin films onto specular metal substrates. Such Te films have a remarkable surface texture structure which results in highly absorptive behavior for incident sunlight. The emissivity of the surface is determined by the specular substrate when the Te film is thin, thus producing the extremely high a/e ratio observed. The present work appears to yield substantially higher a/e ratios than those previously studied. Se, which also shows a distinctly different surface texture effect, was not found to yield a/e ratios greater than 2:1. (Author)

A80-37300 Design and cost analysis for an ammonia-based solar thermochemical cavity absorber. O. M. Williams (Australian National University, Canberra, Australia). *Solar Energy*, vol. 24, no. 3, 1980, p. 255-263. 12 refs.

A design and cost analysis is introduced for a solar thermochemical cavity absorber operated at the focus of a tracking paraboloidal concentrator and based on the ammonia dissociation reaction. The absorber design consists of a catalyst-filled nickel alloy tube wound into a spiral forming the inner cavity wall and shaped to match the incident power density profile to the reactor heat requirements. The reactor tube is welded to a coaxial counterflow heat exchanger. The relationships among the power density profile, the reaction thermodynamics and kinetics, and the heat transfer characteristics are examined in detail and it is shown that an installed cost goal of typically 10 U.S. dollars per square meter of solar collector area can be achieved through use of high activity ammonia dissociation catalyst. The optimum absorber size for a given paraboloidal dish area is calculated for a system pressure of 20 MPa and it is shown that a cost effective absorber suitable for 100,000-hr operation would operate at 90% efficiency at 750 C wall temperature. (Author)

A80-37301 Maximally concentrating collectors for solar energy applications. E. J. Guay (Wisconsin, University, Madison, Wis.). *Solar Energy*, vol. 24, no. 3, 1980, p. 265-270.

The performance characteristics of a solar energy collector can be described by a function relating the concentration to the direction of incident radiation. A strict bound on the integral of this function is established. This is used to define a realistic class of collectors with maximal concentration which can serve as a basis for design and optimality studies. (Author)

A80-37302 Use of solar energy to reduce carbon dioxide. L. R. Martin (Aerospace Corp., Los Angeles, Calif.). *Solar Energy*, vol. 24, no. 3, 1980, p. 271-277. 27 refs. Contract No. E(04-3)-1101.

Several thermodynamically possible ways are outlined in which solar energy could be used to decompose carbon dioxide into carbon or carbon monoxide and oxygen, thereby providing a new source of carbon-based fuels which do not contribute to the environmental problems of mining operations, sulfur pollution, and carbon dioxide buildup in the atmosphere. It is shown that these methods are analogous to cyclic thermochemical processes for the decomposition of water into hydrogen. While these cycles have not yet been proven practical in the laboratory, it is suggested that the thermodynamics are sufficiently favorable that experimental study is recommended. Finally, since the approach has much in common with the hydrogen economy, some of the basic aspects of the hydrogen proposal are reviewed. M.E.P.

A80-37305 Solar coal gasification. D. W. Gregg, W. R. Aiman, H. H. Otsuki, and C. B. Thorsness (California, University, Livermore, Calif.). *Solar Energy*, vol. 24, no. 3, 1980, p. 313-321. 18 refs. Contract No. W-7405-eng-48.

A preliminary evaluation of the technical and economic feasibility of solar coal gasification has been performed. The analysis indicates that the medium-Btu product gas from a solar coal-gasification plant would not only be less expensive than that from a Lurgi coal-gasification plant but also would need considerably less coal to produce the same amount of gas. A number of possible designs for solar coal-gasification reactors are presented. These

designs allow solar energy to be chemically stored while at the same time coal is converted to a clean-burning medium-Btu gas. (Author)

A80-37306 Absorption enhancement in solar collectors by multiple reflections. J. J. O'Gallagher, R. Winston (Chicago, University, Chicago, Ill.), A. Rabl (Chicago, University, Chicago, Ill.; Solar Energy Research Institute, Golden, Colo.), and W. McIntire (Argonne National Laboratory, Argonne, Ill.). *Solar Energy*, vol. 24, no. 3, 1980, p. 323-326. 5 refs. Contracts No. ER-78-5-02-4657; No. W-31-109-eng-38.

This technical note examines the problem of effective absorption enhancement from the standpoint of the second law of thermodynamics. A limit is derived for the enhancement factor, and it is shown that the limit can indeed be reached in cases of practical interest if the receiver is coupled to an involute reflector with concentration less than unity. A simple formula is obtained for the enhancement factor which agrees well with ray-trace results. An analysis is presented which can be visualized conceptually in terms of any of the typical trough configurations which have been proposed for evacuated glass tubular absorbers, such as the flat diffuse reflector, specular V-trough, specular cylinder and specular involute, as shown schematically. The results are readily generalized to the case where the incidence angles are restricted and the maximum concentration is greater than unity. S.D.

A80-37937 Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volumes 1-4. Symposium-Workshop sponsored by the National Science Foundation. Edited by T. N. Veziroglu (Miami, University, Coral Gables, Fla.). New York, Pergamon Press, Inc., 1980. Vol. 1, 619 p.; vol. 2, 556 p.; vol. 3, 570 p.; vol. 4, 604 p. Price of four volumes, \$300.

The symposium concentrated on solar energy collection, storage, and applications. The major topics included: solar radiation, flat plate collectors, concentrating collectors, collector technology and research, thermal storage, heating and cooling systems, biological and chemical conversion, direct electrical conversion, and solar power plants. Other subjects were distillation and desalination using solar energy, agricultural and industrial applications of solar energy systems, combination of solar and wind energies, national and international solar energy programs, and solar energy economics and policies. V.L.

A80-37940 Solar energy at ground surface. N. H. Helwa (National Research Centre, Solar Energy Laboratory, Cairo, Egypt). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978*. Volume 1. New York, Pergamon Press, Inc., 1980, p. 41-55. 8 refs.

Information is presented on weather conditions and the rates of incident solar radiation on different oriented surfaces at various months of the year required for the planning of a solar project. The total solar radiation incident on a horizontal surface, the ambient air temperature, the relative humidity, the wind speed, and the direct solar radiation incident on a plane normal to the solar beam were recorded by meteorological stations in Egypt; some of these measurements were mapped, including the hourly variations of direct solar radiation, monthly average of solar radiation, and the calculated amount of the total solar radiation at Giza. The uses of solar energy including heating of water, sea water desalination, and drying of crops are also discussed. A.T.

A80-37943 The flat plate solar collector - Its steady-state and transient state behaviour. E. Hahne, N. Fisch, and A. Arafa (Stuttgart, Universität, Stuttgart, West Germany). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978*. Volume 1.

New York, Pergamon Press, Inc., 1980, p. 159-186. 6 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045-A.

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The efficiency and effectiveness of the flat plate collectors were calculated in their steady-state and transient state behavior. The studied parameters were grouped into collector, operation, and meteorological parameters. The effects of these parameters and their relation to other factors were obtained by their individual variation in computer programs; the numerical results were compared to experimental data. The agreement was satisfactory with deviations of less than 10% as an average for efficiency and less than 2 K for transient outlet temperatures of more than 30 C. A.T.

A80-37944 Flat-plate solar collectors - Influence of design material and configuration on performance. S.-E. Ransmark (Lund Institute of Technology, Lund, Sweden). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 187-214.

A study was made of the effect of various materials, designs, and mass flow rates on the efficiency of a flat-plate solar collector. It showed that a mass flow rate higher than 0.05 kg/s/sq m will give a minimal efficiency increase; that with a metal absorber the efficiency will be approximately the same for risers of 5, 10, and 20 mm in diameter as long as the number of risers per meter is the same; and that with 10 or more risers per meter the efficiency will be approximately the same for absorbers of copper, aluminum, and steel. In addition, it was found that an absorber of plastic has to be water cooled, and that parallel risers or tubes in serpentine provide the same efficiency if the total tube length is the same, and if the mass flow is 0.05 kg/s/sq m or larger. It was concluded that small dimensions will reduce the heat capacity, which will shorten the collector start-up time and increase efficiency, at least in areas with varying cloudiness. A.T.

A80-37945 My new types of flat plate solar collectors. R. Jankovic. In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 215-238. 6 refs.

The paper presents new types of flat plate solar collector, and the collection efficiency factors for flat plate solar collector with rectangular tubes between two plates. The absorber of a semielliptic flat plate collector is described along with the absorber of a trapezoidal collector; details are given of construction of a flat plate collector with and without a glass cover. Collection efficiency factors are calculated for flat plate collectors with rectangular tubes, and the main parameters are depicted for the flat plate collector with a rectangular channel. Finally, an equation is derived for the fin efficiency factor which may be used to estimate the efficiency factor of the flat plate solar collector with rectangular channels. A.T.

A80-37946 Measurements on a flat thermal solar energy collector with a cellular structure after Francia. A. Bahr, H. Piwecki, and L. Rigolini (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerche, Ispra, Italy). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 239-257.

A thermal flat plate solar energy collector with a cellular structure after Francia has been tested in outdoor conditions. The results have been compared with measurements done at the same collector but with the cellular structure removed. Besides these measurements have been performed to determine separately the influence of the cellular structure on the internal heat transfer in the collector by radiation and by natural convection. The method applied - comparison of cover glass temperature in the selected working conditions - furthermore allows the determination of the influence of the absorption of solar radiation by the cover glass and the cellular structure on the effective power. (Author)

A80-37947 Flat plate boosters for elevating temperatures. I. A. Sakr and A. I. Hegazi (National Research Centre, Solar Energy

Laboratory, Cairo, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 274-297. 5 refs.

A stationary concentrating solar flat-plate booster (SFPB) with a flat absorber suited for moderate temperature applications is presented. It has the features of a trapezoidal enclosure, with two reflecting sides, flat absorbing passage at the bottom and a glass cover at the top. Mathematical expressions are deduced for the geometrical parameter, 'L, W, H' of the SFPB with apex angles between 5.0 and $\pi/2$. Concentration gain and effective transmission factors are deduced for different SFPBs concerning the effect of beam deviation, apex angles and surface reflectivity. The year-round performance of different SFPBs is computed for the Egyptian solar conditions. It is shown that concentration ratios up to 4 times that associated with temperatures up to 180 C and effective transmission factors higher than 70% can be obtained with this class of solar boosters, depending on its apex angle and surface quality. (Author)

A80-37948 A black liquid flat plate collector for economical applications. R. S. Daryan and P. K. C. Pillai (Indian Institute of Technology, New Delhi, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 298-307. 8 refs.

A black liquid flat plate solar energy collector for economical applications has been designed and tested. A rectangular pattern of thin transparent glass tubing is used as the collector fluid container, in which a highly absorbent 'black' liquid flows and directly absorbs the solar energy. The liquid is the hottest substance in the collector and does not require any metal in the design. The structure is enclosed in a thermally insulated box with a two-glass cover. The collector efficiency with different black liquids, in which black ingredient and working fluid are used in different proportion, was calculated and a comparison with other conventional type flat plate collectors was made. (Author)

A80-37949 Passive solar wall collectors. A. Faist and J. B. Gay (Lausanne, Ecole Polytechnique Fédérale, Lausanne, Switzerland). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 308-323.

A study of front covers to be used in passive solar wall systems for building insulation is presented. Nineteen covers were investigated, including glass, translucent plastics and metal plates. The measurements were made under natural conditions on small concrete elements of about 0.5 sq m front surface. A mathematical model was developed and adapted to each case; by fitting the different measured curves, all the physical characteristics of the different covers were obtained. The measurements for 19 covers were presented; the results of a mathematical simulation based on meteorological data near Lausanne of two periods during the 1976-1977 winter were presented for four covers. A.T.

A80-37950 * A two-dimensional finite-difference solution for the transient thermal behavior of a tubular solar collector. F. L. Lansing (California Institute of Technology, Jet Propulsion Laboratory, DSN Engineering Section, Pasadena, Calif.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 328-350. Contract No. NAS7-100.

A numerical procedure was established using the finite-difference technique in the determination of the time-varying temperature distribution of a tubular solar collector under changing solar radiancy and ambient temperature. Three types of spatial discretization processes were considered and compared for their accuracy of computations and for selection of the shortest computer time and cost. The stability criteria of this technique were analyzed in detail to give the critical time increment to ensure stable

computations. The results of the numerical analysis were in good agreement with the analytical solution previously reported. The numerical method proved to be a powerful tool in the investigation of the collector sensitivity to two different flow patterns and several flow control mechanisms. (Author)

A80-37951 **Optical and thermal performances of a half-circular, cylindrical concentrator.** K. Bordoloi, T. Murray, F. Bynum, and E. Chaves (Louisville, University, Louisville, Ky.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 351-377. 10 refs.

An investigation of the optical and thermal performances of a non-tracking, half-circular cylindrical concentrator is presented. The study of the optical and thermal properties has resulted in the selection of a class of receivers for the non-tracking mode in which the concentrator can be used. The receiver is designed to have placement and size to take into account the changing orientation of the incident solar radiation as the declination changes throughout the year; the main type of receivers considered are circular and triangular. The study focused on: (1) the geometrical consideration of the concentrator and the receiver for the optimum absorption of sunlight, (2) the study of optical parameters such as the concentration ratio and the average number of reflections, and (3) the analysis of the collector in terms of the heat transfer coefficient, heat loss coefficient, useful energy gain, and the efficiency of the collector. The results suggest that the concentrator performs satisfactorily even under non-tracking mode when compared with a flat-plate collector; the cost effectiveness of such a concentrator is favorable, if used for space heating and cooling. A.T.

A80-37952 **Modeling a V-trough collector in terms of zero, single or multiple thermal capacitance nodes.** K. Bordoloi, C. Hoang, and F. Bynum (Louisville, University, Louisville, Ky.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 378-391. 15 refs.

Previously a mathematical model for the thermal performance was developed for a V-trough collector. Essentially, it was an application to this configuration of an H-B-W zero capacitance node model. In this present paper this analysis is extended to take into account the effects of thermal capacitance. The collector involved is formed of a linear array of V-troughs, is non-concentrating in nature and it heats a stream of air going through the channels above the blackened heat-absorbing plate and below a transparent cover. Direct comparison is made of the results of calculations between the zero capacitance node model and the present version which includes the capacitance effects. In each case identical sets of time-changing inputs are used. The method of study is by the digital simulation of the collector's overall performance. (Author)

A80-37953 * **High-efficiency solar concentrator.** F. L. Lansing and J. Dorman (California Institute of Technology, Jet Propulsion Laboratory, DSN Engineering Section, Pasadena, Calif.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 392-403. Contract No. NAS7-100.

A new type of solar concentrator is presented using liquid lenses and simple translational tracking mechanism. The concentrator achieves a 100:1 nominal concentration ratio and is compared in performance with a flat-plate collector having two sheets of glazing and non-selective coating. The results of the thermal analysis show that higher temperatures can be obtained with the concentrator than is possible with the non-concentrator flat-plate type. Furthermore, the thermal efficiency far exceeds that of the comparative flat-plate type for all operating conditions. (Author)

A80-37955 **Thermo-fluid analysis of a cylindrical solar heat absorber.** M. F. Khalil (Alexandria, University, Alexandria, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 412-430. 7 refs.

In this paper, a theoretical analysis for the fluid flow through a cylindrical solar heat absorber is considered, taking into consideration the heat loss to the surroundings due to convection and radiation. The variation of fluid density and viscosity with temperature, is also considered. The continuity, momentum and energy equations in cylindrical co-ordinates, are reduced in such a way to describe the flow and temperature fields along the absorber. These equations are solved numerically using the Runge-Kutta method. The effect of radiative and convective heat losses from the absorber is demonstrated. The effect of fluid thermal conductivity and absorber thermal capacity are considered on the fluid temperature rise, pressure drop for fluid flow along the absorber, and finally on the absorber efficiency. (Author)

A80-37956 **An experimental investigation of comparative performance of a header-type compound parabolic concentrator and a flat-plate collector.** K. K. Rao and S. B. Ahmed (Indian Institute of Technology, Madras, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 431-445.

The comparative performance of a header-type compound parabolic concentrator and a flat-plate collector has been experimentally investigated. Two configurations of the collectors, one in which the absorber tubes were all oriented in the east-west direction, and another in which the absorber tubes of the FPC were oriented north-south, three different flow rates and three angles of tilt were considered. The hourly efficiency and useful thermal energy gain have been obtained as a function of the hour of day, and efficiency vs Delta T/I curves have been drawn. The results show that in configuration I, the CPC was more efficient than the FPC for about two to three hours around noon when kept at an angle equal to latitude or declination. The mean daily efficiency was about the same for both collectors. When kept horizontal the CPC was quite inefficient. In configuration II, the CPC was more efficient than the FPC for about two hours around noon when kept at the declination angle; when kept at an angle equal to the latitude the FPC had the better overall performance. (Author)

A80-37957 **Interferometric investigations of convection in slat, flat plate and vee-corrugated solar collectors.** B. A. Meyer, K. R. Randall, M. M. El-Wakil, and J. W. Mitchell (Wisconsin, University, Madison, Wis.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1. New York, Pergamon Press, Inc., 1980, p. 446-462. 14 refs. Contract No. E(11-1)-2941.

An interferometric study is presented which determined the local and average values of the Nusselt number in moderate and small aspect ratio flat-plate enclosures. The investigation was made of collector tilt angles from 45 to 90 deg, aspect ratios from .25 to 36 and slat angles from 45 to 90 deg. The results show that aspect ratios between .5 and 10 are undesirable because of a convective loss; collector geometries with slat angles less than 90 deg are effective in reducing convective losses. Heat transfer rates in an enclosure bounded by a heated vee-corrugated surface on the bottom and a cooled flat surface on the top were also examined for vee aspect ratios of .75, 1, and 2 and tilt angles of 0, 45, and 60 deg. It is concluded that the average heat transfer for this geometry is considerably higher than for the flat-plate collector operating under similar conditions. A.T.

A80-37958 **Study of a multi-pass radiation fluid-heater exposed to non-uniform radiation.** N. M. Rafat, M. M. Elkotb, and M. F. El-Refaie (Cairo, University, Giza, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-

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Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1.
New York, Pergamon Press, Inc., 1980, p. 463-489. 5
refs.

The steady state performance of a multipass radiation fluid heater is investigated when the distribution of the incident thermal radiation is non-uniform in cross direction. This condition may occur in a multipass solar collector combined with a parabolic reflection trough; the analysis presented is valid for any general form of radiant energy distribution. Mathematical expressions are derived for the fluid and wall temperature distributions along the serpentine; these expressions are given in terms of a number of convenient dimensionless groups. The performance of the heater is evaluated, and a new effectiveness index is used, together with conventional efficiency, to describe the performance. When the heater passes are exposed to different radiation densities, the sequence of flow through the different passes will be of importance; the effect of the flow arrangement on the performance is studied and the optimum flow pattern is determined. A.T.

A80-37959 Simulations of solar captation systems - Methodology and applications to distillation, gas and water heating. F. Rocaries, G. Olalde, P. Granier, B. N'Doye, and M. Dagueuet (Perpignan, Université, Perpignan, France). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1.
New York, Pergamon Press, Inc., 1980, p. 490-511. 5
refs.

The authors study heat transfer phenomena with numerical methods. Because of the experimental difficulties, it is useful of course to simulate the behavior of solar systems. Simulation is available for high temperatures systems (gas reheaters in focusing devices); for solar stills; flat plate collectors, etc. Simulation enables an accurate prevision of the behavior, and a systematical study of all the parameters effects. This last study points out the major parameters, to simplify the model. The present study regards: solar stills, various flat collectors, high temperatures gas re-heaters. The authors give appropriate organigrams and graphical results. (Author)

A80-37960 Low cost spiral shaped solar collector. P. K. C. Pillai and R. C. Agarwal (Indian Institute of Technology, New Delhi, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1.
New York, Pergamon Press, Inc., 1980, p. 512-521.

The details of the design and development of an inexpensive solar collector system are given in this paper. A spiral-shaped plastic tube coated with a black paint constitutes the solar absorber in the above collector. The above structure is enclosed in a wooden box with 4 in. thick glass wool insulation at the bottom and also provided with a glass cover at the top. Water is used as a working fluid. For high temperature applications with higher efficiencies, plastic tubing is replaced by a metallic tubing. Studies on the characteristics of this solar collector with and without selective absorptive coatings are also being made. (Author)

A80-37961 Optimum inclination of linear reflectors. B. A. Khalefa and A. S. Hegazy (Minufiya University, Shibin el Kom, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1.
New York, Pergamon Press, Inc., 1980, p. 529-535.

This paper presents a computer model for determining the optimum angle of inclination of a linear reflector for a specified site and a certain time period. This optimum angle of inclination is selected on the basis of maximum solar radiation energy reflected from the concentrator and received by its target during the testing time period. This proposed model was applied to some sites in Egypt for certain time periods of the month and year. (Author)

A80-37962 Phase change collector wall versus water collector wall. L. Bourdeau and A. Jaffrin (CNRS, Laboratoire d'Ecothermique Solaire, Nice, France). In: Solar energy: International

progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1.
New York, Pergamon Press, Inc., 1980, p. 549-564.

Two experimental cells have been constructed to study under true weather conditions the thermal behavior of collector - storage walls containing a phase changing material or plain water. Recorded temperatures show that the latent heat wall collects solar energy with a much larger efficiency (up to 100%) and stores twice more heat than the water wall of same volume, while acting as a very good temperature filter. (Author)

A80-37963 On the evaluation of the feasibility of solar collectors for electrical power generation applications. A. Gokhman and N. Ozboya (Miami, University, Coral Gables, Fla.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 1.
New York, Pergamon Press, Inc., 1980, p. 565-576.

In this paper certain technical parameters have been proposed for economical evaluation of solar collectors for electric power generation applications. In the analysis only high temperature concentrating collectors have been considered. These parameters could be useful for government agencies and power companies in order to compare various solar collector subsystems quickly and correctly. (Author)

A80-37964 Performance of a storage unit coupled to a flat plate solar collector. S. B. Ahmed and V. Sriramulu (Indian Institute of Technology, Madras, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.
New York, Pergamon Press, Inc., 1980, p. 593-603. 6 refs.

A storage unit is an indispensable component of a solar power generating unit. A thermal storage unit coupled to a system of flat plate collectors is described. In a thermal storage unit stabilization effects are always present; the processes occurring in such a system have been simulated on a digital computer to determine the performance characteristics of the unit for a given load pattern. The analysis considers a selectively coated surface employing water as the working medium. The temperature distribution in the storage unit undergoes a change when the water flow rate is altered. The storage volume does not affect the performance significantly in the range of volumes investigated. (Author)

A80-37969 Solar heating systems with air collectors and rock bed storage. W. L. Dutre, L. Cypers, J. Berghmans, and A. Deboscher (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.
New York, Pergamon Press, Inc., 1980, p. 697-730.

A domestic air heating system based on air collectors and rock bed storage is studied in this paper. For the system being considered a dynamic model has been developed, including the regulation criteria and the dynamic behaviour of the building. Making use of the climatological data for temperature and solar radiation as half-hour averages for the Belgian climatological reference year, the year round performance of the system has been calculated over a wide range of the most important design parameters, such as collector area, thermal capacity of the storage system, the total heat demand and its distribution. Results of these calculations are reported in this paper and the relative influence of system component size as well as the importance of each of the possible operation modes under the climatic conditions being considered are discussed. (Author)

A80-37970 Influence of heat exchanger effectiveness on the performance of thermosyphon double loop water heating system. A. F. Orlando, L. Goldstein, Jr., and D. Magnoli (Centro de Tecnologia Promon, Rio de Janeiro, Brazil). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978.
New York, Pergamon Press, Inc., 1980, p. 731-744. 5 refs.

The development and testing of a double loop thermosyphon solar heater is described. It is reported that the absorbers in the collector are non selective and of the roll-bond aluminum type. Further, it is shown that for the required consumption hot water temperature range (40-60 C), single glazing collectors are more efficient than double glazing collectors. In addition, the design of the heat exchanger is found to be critical to the technical and economic performance of the water heater. The influence of the heat exchanger is analyzed in terms of the coefficient of performance COP. It is concluded that the system is found to be more efficient for larger ratios between the heat exchanger surface and collector.

M.E.P.

A80-37971 Hot water production by means of a solar thermosyphon loop. W. L. Dutré, L. Cypers, J. Berghmans, and A. Debosscher (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p.

745-766. Research supported by the Belgian National Research and Development Programme on Solar Energy Applications.

The results of a study of hot water production using a solar thermosyphon loop are reported. A dynamic model has been developed describing the behaviour of the loop consisting of a number of solar collectors and a water tank placed above the collectors. The loop is segmented and for each segment the time-dependent mass conservation, momentum and energy equations are satisfied. The solution of these equations is obtained numerically and is compared to temperature distributions determined experimentally. It is found that good agreement can be obtained between theoretical predictions and experiment. Using the temperature and solar radiation data for a typical Belgian year, the dynamic model allows one to calculate the energy produced by the thermosyphon system as a function of system parameters: collector size, storage tank size, daily consumption rate, etc. Energy savings with respect to an all-electric heater are reported as a function of the system parameters. (Author)

A80-37972 Effectiveness of packed-bed solar air heaters. S. C. Gupta (Allahabad, University, Allahabad, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p.

767-777. 8 refs.

The fabrication and performance testing of a single glass cover solar air heater with a packed-bed absorber made of iron shavings as well as one of iron wires and scraps of aluminum are reported. A test procedure recommended by the National Bureau of Standards has been followed during experimentation. The comparative efficiencies of both heaters are evaluated with and without the use of a metallic tray of absorbers. In addition, the effect of mass flow rate, aspect ratio, length of absorber, air temperatures and solar insolation are also studied. Finally, it is found that the collection efficiencies of these absorbers are as high as 70 to 75% at outlet air temperatures of 50 to 53 C. M.E.P.

A80-37973 Performance comparison of different types of solar water heaters under Egyptian conditions. S. W. Youssef and I. A. Sakr (National Research Centre, Solar Energy Laboratory, Cairo, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p. 778-792.

The design details of four different types of solar water collectors, suitable for providing enough hot water for domestic demand are reported. It is shown that the collectors are designed in a way that they can be easily manufactured with local materials and technology and can operate optimally under the climatic conditions of Egypt. Attention is given to performance tests of these different types under identical conditions. Further, a study is carried out to determine which available materials can be used most economically

in the production of solar water heaters. Finally, the results obtained are analyzed to select the most suitable type for operating under the local conditions described. M.E.P.

A80-37974 Solar water heaters. D. Buxey (Dr. Beck and Co. /India/, Ltd., Bombay, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p. 793-801.

The salient features of world developments and new developments in the field of solar heaters are briefly summarized. Attention is given to the importance of adapting the heater to varying needs which vary not only due to locale but also habits. The first major industrial installation in a hotel in Matheran, near Bombay, is described noting the the absorption and storing in same and separate units, and the dual circulation system. Further, the various factors affecting design, such as heat removal, orientation and transmittance of glass covers, are examined, and trends in the improvement of design are discussed. Finally, auxiliary heating and the design of a solar switch are also considered. M.E.P.

A80-37975 Latent heat diode wall. L. Bourdeau and A. Jaffrin (Nice, Observatoire, Nice, France). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p. 802-826.

A composite wall with separate collector side and storage volume operating as a thermal diode is proposed. The storage uses a latent heat material called chialiolithe. Laboratory experiments performed on the storage side show that it is possible to define satisfactory conditions both for the collector side and for the heat restitution: relatively low temperature in collector, little external losses, storage equivalent to 75 cm of concrete in the form of 5 cm of chialiolithe, excellent temperature control on the internal side. (Author)

A80-37976 Comparison between two absorption cooling systems of the 'open' type under different climate conditions. M. Bolzan and R. Lazzarin (Padova, Università, Padua, Italy). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p.

827-854. 12 refs.

Two open-type solar cooling systems are described and compared: (1) the dehumidification-humidification (DH) system and (2) Baum's system which consists only of evaporator and absorber, and with the generator in the open air. The DH systems are shown to be more efficient in the three climates in which tests were conducted (hot dry, hot humid, and Mediterranean). Some advantages of Baum's cycle are noted. B.J.

A80-37977 Analysis of ammonia-water intermittent solar refrigerator operating with a flat plate collector. A. Venkatesh and M. C. Gupta (Indian Institute of Technology, Madras, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p.

870-885.

The paper is concerned with the thermodynamic analysis of an ammonia-water intermittent solar refrigerator which uses a simple flat plate collector for generating ammonia vapors from the ammonia-water solution. A digital computer is used to simulate the processes which constitute the cycle. The following parameters are evaluated and discussed: heat absorbed during generation, amount of vapors generated and amount of ammonia condensed, minimum evaporator temperature, effective refrigeration, and coefficient of performance. The solar refrigerator has no moving parts and hence it is easy to maintain. In addition, it has no pumps, fans or any gadgets that require electricity. S.D.

A80-37978 * A thermodynamic analysis of a solar-powered jet refrigeration system. F. L. Lansing and V. W. Chai (California

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Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 886-897. 5 refs. Contract No. NAS7-100.

The article describes and analyzes a method of using solar energy to drive a jet refrigeration system. A new technique is presented in the form of a performance nomogram combining the energy and momentum equations to determine the performance characteristics. A numerical example, using water as the working fluid, is given to illustrate the nomogram procedure. The resulting coefficient of performance was found comparable with other refrigeration systems such as the solar-absorption system or the solar-Rankine turbocompressor system. (Author)

A80-37979 **Development of a solar desiccant dehumidifier.** Z. Lavan, D. Gidaspow, M. Onischak, S. Chaturvedi, B. Mathiprakasham, and S. Perkari (Illinois Institute of Technology, Chicago, Ill.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 898-931. 9 refs. Contract No. EG-77-C-03-1589.

A preliminary design of a cross-cooled two-ton silica gel dehumidifier is presented. The system consists of two identical fixed bed units; one dehumidifies while the other is being regenerated. The cross cooling is achieved with room or ambient air flowing through rectangular channels; the process stream flows in perpendicular channels which are lined with paper-like sheets consisting of micron-size silica gel particles held in a Teflon web. The silica gel was tested in an isothermal channel and found to perform satisfactorily. Detailed calculations have shown that the low regeneration temperatures of the silica gel result in sufficient dehumidification for air conditioning applications. The low regeneration temperature permits the use of flat plate solar collectors. B.J.

A80-37980 **Liquid desiccant solar heat pump for developing nations.** H. Robison (South Carolina University, Conway, S.C.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 932-938. 11 refs.

A redesign of the U.S.C. liquid sorbent solar air collector to include a heating cycle, while being more economical to construct and operate, is described. It is reported that the triethylene glycol desiccant has been replaced by a calcium chloride solution. Concentration of the desiccant by direct solar radiation absorbed by the colored liquid is shown to allow collector operation at low temperature and high efficiency. Attention is given to the fact that the easily constructed open-channel trickle collector system is not used for transfer of sensible heat, but rather is used for mass transfer of water absorbate from the absorbent solution to the natural ambient air stream. It is stressed that the hardware necessary to build the system is readily available worldwide. Finally, a detailed description of the cooling and heating modes is given. M.E.P.

A80-37981 **A review of the historical developments of the use of passive solar systems.** C. L. Robbins (Florida Agricultural and Mechanical University, Tallahassee, Fla.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 939-959. 34 refs.

The historical development of passive solar systems from 3000 BC in Mesopotamia to the present is reviewed. Attention is given to the systems design, performance characteristics, and energy conservation criteria of convective self-flow thermal systems and passive (natural) lighting systems. B.J.

A80-37982 **Natural lighting in buildings - A passive solar system.** C. L. Robbins (Florida Agricultural and Mechanical University, Tallahassee, Fla.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo,*

Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p. 960-982. 35 refs.

This paper reviews the issue of using natural lighting in buildings. In general, there are four basic reasons why natural lighting systems are required by building codes in many parts of the world. These reasons are: (1) to facilitate the performance of visual tasks and ensure visual comfort; (2) to provide visual communication channels between people and their outdoor environment; (3) to provide psychological impact to lighting schemes; and (4) to conserve lighting energy, during daylight hours, and help reduce the total energy requirements in buildings. The realization that there is a need to conserve energy in the United States has brought about a renewed interest in the use of natural lighting systems to provide light within buildings during daylight hours. This interest has caused the development of new techniques to study daylight as well as new natural lighting systems called Planned Supplemental Lighting Systems. (Author)

A80-37983 **Solar collector related research and development in the United States for heating and cooling of buildings.** R. K. Collier (California University, Los Alamos, N. Mex.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 991-1028. 19 refs. Research sponsored by the U.S. Department of Energy.

This paper describes some of the research funded by the Research and Development Branch of the Heating and Cooling Division of Solar Energy of the United States Energy Research and Development Administration. Specifically, this paper deals with collector and collector materials research reported on during FY-1977. The R&D Branch has funded research in open and closed cycle liquid heating flat plate collectors, air heating flat plate collectors, heat pipe collectors, concentrating collectors, collector heat transfer studies, honeycomb glazings, evacuated tube collectors, ponds both salt gradient and viscosity stabilized, materials exposure testing, collector testing standards, absorber surface coatings, and corrosion studies. A short description of the nature of the research is provided as well as a presentation of the significant results. (Author)

A80-37985 * **A quinone-assisted photoformation of energy-rich chemical bonds.** S. W. Fox, T. Adachi, and W. Stillwell (Miami University, Coral Gables, Fla.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 1056-1074. 18 refs. Grant No. NGR-10-007-008.

In a study of biochemical means of solar energy conversion, ADP and inorganic phosphates were converted to ATP by white light in the nonaqueous solvent dimethylformamide in the presence of tetrachloro-p-quinone or ubiquinone. Conversion of ADP to ATP has been accomplished in aqueous suspension by the use of cell-like structures aggregated from poly(aspartic acid, glutamic acid, tyrosine). This is believed to occur through the formation of dopa-quinone in the peptide structure during illumination. The way in which the quantitative yield of ATP has been influenced by pH and by added substances, such as FeCl₂, was studied. B.J.

A80-37990 **Physics and economics of photovoltaic solar energy conversion.** Y. Marfaing (CNRS, Laboratoire de Physique des Solides, Bellevue, Hauts-de-Seine, France). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3.* New York, Pergamon Press, Inc., 1980, p. 1132-1153. 13 refs.

This paper presents principles of the photovoltaic effect. From this description are derived the basic properties required for the semiconducting materials to be used in photovoltaic solar converters. Then, the structure and the performances of various photovoltaic devices produced by industry or studied in the laboratory are presented. Finally, some considerations are given about the cost of

electric energy supplied by photovoltaic generators for the present time and to be expected in the future. (Author)

A80-37991 Realization of p-n junction solar cells by an ion implantation doping procedure. J. C. Muller, M. Hage-Ali, and P. Siffert (CNRS, Centre de Recherches Nucléaires de Strasbourg, Strasbourg, France). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1154-1166. 13 refs.

The possibility of using a low cost ion implantation procedure for the preparation of junction solar cells has been investigated. The method employs a dc glow discharge ion source and a short post acceleration structure, without any mass separation. Preparation of the cells in a continuous way is possible at competitive speeds since the ion beam current density reaches 1 mA/sq cm. The properties of silicon cells, obtained by discharge bombardment in BF₃ or PF₅ atmosphere followed by recrystallization of the damaged layer either by thermal annealing or fast surface laser pulses, have been investigated. Rutherford backscattering, SIMS, electrical measurements have been used. Finally, characteristics and performance of the devices are presented. (Author)

A80-37992 Solar energy conversion by fluorescent materials for utilization in space communication systems. A. K. Sen and J. S. Sehra (Calcutta, University, Calcutta, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1167-1183.

52 refs.

In space communication, solar energy is widely employed to obtain the electrical power required to operate various electrical systems in a spacecraft. However, the efficiency of conversion of solar energy to electrical energy is typically under 10%. A major part of the electrical power obtained is utilized for the operation of the onboard communication systems. Direct utilization of solar energy for communication may increase the overall efficiency of the energy conversion involved. There are two ways in which such direct utilization can be affected. Firstly, solar energy can be utilized directly as the carrier of intelligence and secondly, solar energy may be utilized directly as a pump source for an onboard laser. The use of fluorescent materials may further extend the possibilities of using lasers at longer wavelengths for which the pump is derived from the fluorescent emission. There is also a possibility of utilizing the fluorescent emission directly as a carrier of intelligence. All these possibilities have been studied in this paper with special reference to space communication systems. (Author)

A80-37993 New possibilities of solar energy conversion by means of refractory thermoelements. S. Abdalla, J. M. Dusseau, F. Roche, and J. M. Darolles (Montpellier II, Université, Montpellier, France). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1184-1191.

It is shown that high-efficiency thermoelectric conversion can be obtained by using refractory compounds with low thermal conductivity and high thermoelectric power. Boron silicon compounds with a high boron concentration such as B₁₄Si are considered. Samples are obtained by chemical vapor deposition by pyrolysis of mixture of BBr₃ and SiBr₄ under reduced pressure. Experimental results show that the thermoelectric figure of merit is 3.75×10 to the $-3rd/deg$ and $zT(H)$ equals 7.5 at 1700 K; moreover, the total conversion efficiency would exceed 20 percent. This is particularly interesting for solar energy conversion. (Author)

A80-37994 On direct conversion of sunlight to electricity. M. A. Melehy (Connecticut, University, Storrs, Conn.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3.

New York, Pergamon Press, Inc., 1980, p.

1192-1209. 10 refs.

A new physical theory for homojunction and heterojunction solar cells is presented. The theory relates the voltage-current characteristics of such cells to the device physical parameters and the spectral distribution of the incident radiation. The derived formula is shown to be accurately in agreement with experiment for Si solar cells. In the treatment, the photon-generated electron-hole pairs are considered and their transport through the device and its battery (or load) is determined. The analysis is based on this author's thermodynamic theory of generalized fields (TTGF). The TTGF is a theory particularly developed for interfacial phenomena and more generally for all systems which have gradients of any physical parameters, when the particle fluxes are vanishing in the system. (Author)

A80-37995 Performance of the novel solar cell substitute for the future. S. C. Rastogi (M.M.M. Engineering College, Gorakhpur, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1210-1215.

This paper deals with a future solar cell, in which solar radiations obtained from the sun have been utilized for the phase transformation of the electrolytic crystal by developing a potential difference between the electrodes placed in different phases (viz., solid, liquid). The paper also reviews the earlier investigations made by the author regarding the working principle, experimental observations and design considerations. Further investigation has been carried out on long-life performance of the cell in respect to power. An effort has also been made for improvement in the design of the proper electrode. The investigations show a great potential of such a cell in the future. (Author)

A80-37996 MOS solar cells. H. M. Kizilyalli (Middle East Technical University, Ankara, Turkey). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3.

New York, Pergamon Press, Inc., 1980, p. 1216-1229.

36 refs.

The solid state physical principles of MOS structure and their electrical characteristics is reviewed for its application to solar cells. The various parameters like insulator thickness, resistivity of the substrate, insulator charge, surface-state density, minority carrier lifetime, and crystal orientation that affects the performance of MOS solar cells will be discussed. The paper is concluded with a summary of recent developments in the field. (Author)

A80-37998 Optimization of graded doping CdTe solar cells. A. S. Bouazzi (Laboratoire d'Energie Solaire, Tunis, Tunisia). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1242-1256. 5 refs.

From the CdTe band gap value (1.5 eV), a high efficiency is predicted for CdTe solar cells. The high surface recombination velocity and the small minority carrier lifetime make the present efficiency below 7%. The existence of an electric field in the frontal region of CdTe solar cells can counterbalance the recombination effects by accelerating the minority carriers towards the junction. A p-n CdTe junction with a graded frontal doping is studied; its efficiency is computed to fix the optimum depth of the junction and the optimum frontal electric field resulting from the graded doping. Two recombination parameters are taken into account: the surface recombination velocity and the minority carrier lifetime. The quantum responses of the optimized structure are simulated by the computer and the results are compared to those of the CdTe homojunction and to the graded-band-gap CdHgTe heterojunction. (Author)

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A80-37999 Solar thermal power plant - Thermodynamic analysis. A. A. Samuel, U. S. P. Shet, and M. C. Gupta (Indian Institute of Technology, Madras, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3.

New York, Pergamon Press, Inc., 1980, p. 1279-1292. Research supported by the Council of Scientific and Industrial Research.

There have been several proposals for solar thermal power plants using a Rankine cycle with a low boiling point fluid as the working medium. Organic Rankine-cycle engines are particularly suited for a number of reasons such as, high thermal efficiency and reliability, relatively uncomplicated mechanical components and adaptability for use over a wide power range. In this study three working fluids: butane, dichloro tetrafluoroethane and trichloro trifluoroethane are examined. These three fluids were chosen in view of their desirable properties such as high molecular weight, low boiling point and the slope of their vapor saturation curve. (Author)

A80-38000 Solar power units with screw expanders. J. M. Merigoux and P. Pocard (Alsthom-Atlantique, Bruyères-le-Châtel, Essonne, France). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1293-1317.

A low-power solar electric generator based on a screw expander which drives an ac motor is presented. The choices of flat plate or concentrating Rankine or Brayton cycle, and an oil-injected screw expander motor in the development of the unit are examined, and the effects of Mediterranean and subtropical locations on plant performance are discussed. Results of solar engine performance simulation testing are presented, and an application of the screw expander solar unit as a deep well pump is illustrated. It is concluded that the screw expander is well adapted to low-power solar energy applications due to (1) its small efficiency variation over a large range of expansion ratios and rotating speeds, (2) its compatibility with low-concentration solar collectors and (3) its ability to be used with conventional organic working fluids and inexpensive heat transfer fluids. A.L.W.

A80-38001 New developments for future solar power plants. J. Lorenz, J. Feustel, and M. Kraft (M.A.N.-Neue Technologie, Munich, West Germany). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1318-1328.

The development of a planned solar farm providing 15 to 500 kW of electrical and mechanical energy in regions with high insolation is discussed. In the proposed power plant, 200 to 300 C heat generated in tracking parabolic cylindrical collectors is used to produce high-pressure steam as a source of mechanical energy, electricity or low-temperature heat. The optimization of system operating temperature and collector area with respect to collector and machine efficiency is discussed, and the first plant prototype is presented. Advanced development of the modular collector units and the energy conversion circuit, which consists of the boiler, expansion machine, electrical generator, condenser, cooling tower and control, monitoring and auxiliary devices, is then considered. A.L.W.

A80-38002 Power from the sun by thermodynamics French tower type projects. M. J. Bignon (CETHEL, Paris, France). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1329-1337.

The main features of three solar-power tower-type projects designed in France are discussed. Consideration is given to THEMIS, INTI 800(R), and EEC developments. The THEMIS prototype 2 MWe unit utilizing a cavity receiver with molten salt transfer and storage is due for start-up in 1980. V.T.

A80-38003 Steam and gas turbines for small outputs using solar energy. K. Bammert (Hannover, Universität, Hanover, West Germany) and H. Pösentrup (M.A.N.-Neue Technologie, Munich, West Germany). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1338-1350.

The conversion of the solar energy into electrical or mechanical energy in turbine power plants requires new design criteria. The choice of the working fluid and the configuration of the cycle are of great importance. Not every variant is suitable for the solar farm and the solar tower concept in the same way. The design of the turbomachinery and the other components of the cycle do strongly influence each other. An important point of view in designing a small solar power station is the simplicity of the construction so that no special service is required in remote locations. The efficiency should be as high as possible. Some important criteria for the choice and design of small power turbine plants using solar energy are discussed. The advantages of open cycle air turbines are compared with steam turbines. Indications to the choice of suitable cycles and turbomachinery are given. (Author)

A80-38004 Turbine selection for small capacity solar-power generation. A. Mobarak, N. Rafat (Cairo, University, Cairo, Egypt), and M. Saad (UNESCO, Regional Office, Cairo, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1351-1367. 10 refs.

In developing countries lying within the solar belt, there is an urgent need for power generation systems of sufficient capacity to supply power to small communities in remote areas. The turbine for small power units in the range from 1 to 100 kW is not of the conventional type and requires special design. To attain high cycle efficiency (Rankine cycle) for power systems of small capacity, the enthalpy drop should be as high as possible whereas the mass flow rate is small. This leads to problems such as partial admission, multistaging, high rotative speeds, etc. The present study indicates that the most suitable choice of turbine is a multistage radial Ljungstrom-type turbine. (Author)

A80-38005 A helioelectric farm. O. J. M. Smith and P. S. Smith. In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1368-1407. 17 refs.

A multi-modular solar thermal electric plant based on conventional materials and engineering techniques is presented. In the proposed 100-MW system, the electrical generator is driven by a conventional steam turbine utilizing heat derived from 600 concentrating collector modules covering a total of 5.5 sq km in a solar farm. A sophisticated computer design program is used for the optimization of mirror dimensions, and spacing, module dimensions, tower height and receptor dimensions for cost reduction, and the mirrors are computer controlled to track the sun. The 300,000 small mirrors and 600 short towers permit mass production techniques which significantly reduce production costs, which are estimated at \$175,000,000 for a 100-MW plant. Half of the construction costs are direct labor wages, which would have a desirable impact on local economy, while environmental effects are minimal. A.L.W.

A80-38006 A central receiver solar power system for remote locations. R. J. Holl (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1408-1425. 11 refs.

A solar power plant was designed to supply electrical and/or thermal power for remote locations isolated from a utility grid. Applications include domestic, agricultural, and light industrial use.

Means of achieving attractive economics are identified. Simplicity in system design and maximum use of commercial equipment are stressed. A small central receiver is used for solar energy collection, and steam is utilized as the working fluid. Modular thermal storage matches various applications without changing the system balance.

S.D.

A80-38007 Investigation of pool boiling heat transfer in the energy carrying liquids of solar energy power plants. N. S. Abdelhafiez (Alexandria University, Alexandria, Egypt) and M. A. Abdelsalam (Helwan University, Cairo, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1426-1442.

37 refs.

The present paper suggests a generalized equation which gives the heat flux of the pool boiling of refrigerants from horizontal surfaces at the normal earth gravity. The suggested relationship was obtained by using the dimension analysis theory and regression analysis. A large volume of experimental data, up to 600 points collected from 12 different researches with P/Per in the range of 0.003-0.78 was used in the analysis with the aid of a digital computer. Verification of the obtained equation shows that the absolute average deviation of the Nusselt number calculated by it, from that obtained by experimentation, does not exceed 10%.

(Author)

A80-38008 The use of solar furnaces in materials research. D. Suresh (Indian Institute of Science, Bangalore, India) and P. K. Rohatgi (Council of Scientific and Industrial Research, Trivandrum, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 3. New York, Pergamon Press, Inc., 1980, p. 1443-1473. 54 refs. Research supported by the Tata Energy Research Institute.

Solar furnaces are promising tools for studying ultrahigh temperature properties of materials. In this paper, the applications of solar furnaces in the field of materials research are reviewed in detail and some of their industrial applications are briefly projected. Research on crystal growth, high temperature phase diagrams of oxide systems, ignition of materials, purification and stabilization of refractories is being conducted, utilizing the very high temperatures attainable in solar furnaces, without any contamination. Specific future opportunities for research in these areas have been identified. Some of the future prospects of solar furnaces could be the study on freezing of superheated alloys, zone-refining of large quantities of materials, growing new single crystals for semiconductor and laser applications, vacuum welding and materials research in outer space.

(Author)

A80-38009 Street lighting by sunlight. J. G. Sakas. In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4. New York, Pergamon Press, Inc., 1980, p. 1723-1741.

The feasibility of street lighting by sunlight reflected or diffused satellites in orbit around the earth is examined. The following systems are considered: a large oriented mirror rotating with a constant velocity on a circular orbit around the earth, plane mirrors of random orientation, spheres and objects of similar shape, cubic mirrors, and light diffusing satellites. The construction of a large oriented mirror of sufficient illumination capacity is shown to be impossible. All other systems, while technically possible, are found to be uneconomical, unless the reflected sunlight also used for purposes other than street lighting, e.g. for ice melting or in agriculture.

V.L.

A80-38010 The first solar energy system in West-Germany for industrial utilization. I. Hoffmann (Consulting Office for Solar Technology, Vechta, West Germany). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4. New York, Pergamon Press, Inc., 1980, p. 1742-1747.

About 3000 to 4000 liters of water are consumed daily in the steam pressing facilities of the coat factory. This water is prewarmed up to 333 K by means of a solar energy system. For this purpose a thermal heat storage of 1300 l is used. In the summer a factory swimming pool is also heated; in this case a heat storage of 14,000 l is used. The solar energy system has a collector surface area of 85 square meters facing south and inclined at 45 deg. Switching for both applications is arranged so that they can be operated either simultaneously or separately.

(Author)

A80-38011 A simple water pump, powered by solar energy. K. Speidel (Dornier System GmbH, Friedrichshafen, West Germany). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4. New York, Pergamon Press, Inc., 1980, p. 1748-1761. Research sponsored by the Bundesministerium für Forschung und Technologie.

A project is being implemented whose objective is to design a simple solar water pump system which could meet the drinking water requirements in small village communities, far from other sources of energy. The basic specifications of the system are: pump energy output at about 1 kW, delivery head of 20-50 m, self-priming every day with sufficient solar radiation, and maintenance interval of one year; the system should be easy to construct and repair. Because of the requirement of a simple design, flat plate solar collectors will be used. Several drive system designs are considered, and it is shown that only expansion machines can meet the desired specifications. A double-acting cylinder machine has been designed and is being constructed. To improve the total efficiency, a new direct evaporator will be used.

V.L.

A80-38013 Comfortable heating and cooling by solar reflectors and wind. S. A. Husain (Aligarh Muslim University, Aligarh, India). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4. New York, Pergamon Press, Inc., 1980, p. 1850-1861. 7 refs.

A solar and wind energy system is proposed which would meet the home heating, cooling, lighting, hot water, and cooking requirements in tropical countries. Direct and diffused solar radiation together with radiation reflected from frame-mounted reflectors is collected by a flat-plate collector mounted on the room window. The collector carries water tubes for heating and three generators connected to the ammonia absorption unit for cooling the room. At night, room insulation helps to retain to a certain extent the heat or cold of the day. The reflectors can be used partly for heating and cooling, and partly for cooking food from 8 A.M. to 4 P.M. Wind energy is used for energizing ceiling fans and to power a generator which would supply heating, cooking, and lighting power needs. An immersion heater will be used for warming water.

V.L.

A80-38014 Combination of wind and solar energies at the Northern Coast of Egypt. I. A. Sakr (National Research Centre, Solar Energy Laboratory, Cairo, Egypt), M. S. Abdel Hafiez (Alexandria University, Alexandria, Egypt), and A. S. Hegazy (Minufiya University, Shibin el Kom, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4. New York, Pergamon Press, Inc., 1980, p. 1862-1890. 7 refs.

Various combinations of wind and solar units are analyzed in order to determine the effect of such combinations on the storage system capacity and performance. The analysis is made for the site of Mersa Matruh on the Northern Coast of Egypt. Wind and solar energy may be combined either in a direct arrangement, whereby all energy produced by wind and solar units is first accumulated in a storage unit, or in a bypassing arrangement, in which only the power produced in excess of the load demand is accumulated in the storage unit. It is shown that the storage losses are greater in the direct arrangement. A method is proposed to select the optimum solar fraction at which the storage capacity is minimum; this fraction is

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found to be 0.68 for a wind machine combined with a focusing collector, and 0.70 for a wind machine combined with a flat plate collector. V.L.

A80-38015 *Solar energy - UNIDO programme of action for developing countries.* S. Rao (United Nations, Industrial Development Organization, Vienna, Austria). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 1901-1910.

UNIDO activities with regard to the promotion, development, and utilization of solar energy in developing countries include: feasibility studies, strengthening of existing solar energy research and development institutions or establishment of new ones, establishment of prototype pilot manufacturing units and industrial liaison, manufacturing and investment promotion, training, and information dissemination. In this program UNIDO will rely on cooperation among the developing countries in the fields of training, research, and development, as well as on technology transfer from industrialized countries: information and expertise exchange, joint research and development programs, manufacturing promotion, and training programs. V.L.

A80-38019 *Economic considerations of solar energy.* J. D. Parker (Oklahoma State University, Stillwater, Okla.) and J. A. Tipton (U.S. Department of Energy, Bartlesville Energy Research Center, Bartlesville, Okla.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 2021-2043.

The performance and economics of several solar systems are discussed, including a solar home, an asphalt heater, and a water heater for a research building. Summary of economic data is also presented for the world's largest solar water heating system for an industrial laundry in California, and the world's largest solar installation on a secondary school in Arizona. In the latter system, 343 collectors give a receiver area of about 20,000 sq ft and heat 280 gallons of water per minute for space heating, cooking, and domestic hot water. It has a 50,000 gallon underground storage tank and can handle 80% of the school's peak load. The system cost \$769,000 and is expected to save \$1 million over the 20 year life of the system. V.L.

A80-38020 *The comparative economics of passive and active systems.* F. Roach, S. Noll, and S. Ben-David (California, University, Los Alamos, N. Mex.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 2044-2083. 13 refs. Research supported by the U.S. Department of Energy.

Design criteria, solar performance characteristics, and incremental solar cost are examined for one passive design, the thermal mass storage wall, and compared to those of one active design, the air collector/rock storage. It is shown that the potential use of passive solar system in residential space heating applications is enhanced by incentives against all fuel types. This enhancement is especially evident in the natural gas and heating oil comparisons. The passive design is economically competitive against the electric resistance alternative in all but a few states, and is feasible today on a life cycle cost basis. Employment of the low interest loan incentive option gives rise to higher solar fractions than under the proposed NEA income tax credit option. V.L.

A80-38021 *An economic analysis of solar energy alternatives.* D. A. Huettner, B. J. Taylor, C. A. Ingene, and J. F. Horrell (Oklahoma, University, Norman, Okla.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 2084-2105. 5 refs.

The economic feasibility of several central station solar electric systems is analyzed with comparison to four traditional power generating options (nuclear, oil, gas, and coal). Mass production, optimal scale of production, and compliance with environmental laws are used for costing each of the solar and non-solar options, with consideration of energy storage and electrical distribution costs. The analysis is made for a specific site - Hobbs, New Mexico. It is shown that the best solar option should become competitive with nuclear and imported oil options under a reasonable range of assumptions, but are not generally competitive with low sulfur coal, except under the scenario of escalating fuel costs. If non-quantifiable costs (cost of pollution, mortality) are considered, central station solar electric power may be preferred to low sulfur coal on an overall basis toward the end of the century even without major technological breakthroughs. V.L.

A80-38022 *Impact of solar heating and cooling of buildings on electric utilities.* A. S. Debs (Georgia Institute of Technology, Atlanta, Ga.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 2106-2125. 22 refs.

The effect of widespread utilization of solar heating and cooling of buildings on the planning cost and production of electric power systems is discussed with special reference to the techniques for reducing peaks of electrical demand by adequately designed solar systems. After considering utility production costs, their relation to electric load profiles, electric generation planning, and load management, several basic solar systems with electrical backup are analyzed and a two-level optimization problem is formulated involving the utility and its customers. It is shown that by means of modified designs and peak-sharing control systems, solar systems for heating and cooling can contribute positively to reductions in the cost of electric energy production. V.L.

A80-38023* *Evaluation of solar thermal power plants using economic and performance simulations.* N. El-Gabawali (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 2138-2161. 5 refs. Contract No. NAS7-100.

An energy cost analysis is presented for central receiver power plants with thermal storage and point focusing power plants with electrical storage. The present approach is based on optimizing the size of the plant to give the minimum energy cost (in mills/kWe hr) of an annual plant energy production. The optimization is done by considering the trade-off between the collector field size and the storage capacity for a given engine size. The energy cost is determined by the plant cost and performance. The performance is estimated by simulating the behavior of the plant under typical weather conditions. Plant capital and operational costs are estimated based on the size and performance of different components. This methodology is translated into computer programs for automatic and consistent evaluation. V.L.

A80-38024 *The American experience with solar energy in centralized electricity generation - Technology and economics.* D. L. Hurwood (Energy Economics and Alternatives, New York, N.Y.). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 2162-2188. 27 refs.

The technological and economical feasibility of solar power for central-station generation is examined within the framework of existing fuel power technologies. Consideration is given to the fuel trends expected through 1986; cost of conventional fuels, impediments to early utilization of solar energy, prospects for growing decentralization of electricity generation, utility response to growing public and industry interest in solar power, advances in solar electric technologies, and a balanced program for electricity generation in the

United States. It is shown that solar technologies may play a part in a balanced electric energy 'mix' based on nuclear power, renewable sources (hydro, solar, and wind), and the orderly exploitation of existing and still-to-be discovered fossil-fuel deposits. V.L.

A80-38025 Solar energy - Will it conserve our non-renewable resources. S. Baron (Burns and Roe, Inc., Oradell, N.J.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4. New York, Pergamon Press, Inc., 1980, p. 2210-2229. 22 refs.

Solar energy applications, including heating, thermal electric, and photovoltaic, are examined in terms of consumed energy-intensive materials in order to determine their economic expediency. These applications will be justified economically if the energy consumed for fabrication, construction, and operation of solar power plants is less than the energy recovered by the plants over their operating life. It is shown that solar thermal electric plants in the Southwest United States will pay back their energy requirements in less than five years, which is not the case in other U.S. areas. Photovoltaic plants are highly energy-intensive, and an assessment shows that in operating such a plant for 30 years, the energy payback would be close to 20 years. The solar energy development program must concentrate on designs and technological developments that utilize less energy consuming materials in order to be competitive with present energy alternatives. V.L.

A80-38026 Accelerated commercialization of solar energy - A new priority for international action. L. Rishell and N. D. Jorstad (Rishell International, Inc., Potomac, Md.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4. New York, Pergamon Press, Inc., 1980, p. 2251-2269.

13 refs.

International activities in the field of solar energy commercialization, involving the United States, are reviewed. Synergistic and reinforcing effects of combining the purchasing power of cost-effective markets in several countries could be most favorable for the economics of solar energy systems. A plan is formulated in which international solar markets can be aggregated for mutual benefit by establishing an Organization of Solar Energy Countries (OSEC) which would concentrate on the current and proposed solar energy initiatives, both national and international. V.L.

A80-38274 Three-dimensional numerical evaluation of heat loss through natural convection in a solar boiler. P. Le Quere and T. Alziary de Roquefort (Poitiers, Université, Poitiers, France). In: Conference on Numerical Methods in Fluid Mechanics, 3rd, Cologne, West Germany, October 10-12, 1979, Proceedings.

Braunschweig, Friedr. Vieweg und Sohn Verlagsgesellschaft mbH, 1980, p. 241-250. 6 refs.

An implicit finite difference method is presented for the integration of compressible Navier Stokes equations. The scheme involves a generalized linearization process and the Douglas-Gunn ADI technique. The variables are defined on a variable mesh staggered grid and the spatial differencing satisfies some integral conservation properties for mass, momentum and energy. Stability is demonstrated for time steps much larger than the CFL limit. The method is applied to the computation of free convection flows in two and three dimensions with high values of the Grashoff number. (Author)

A80-38282 Detailed balance limit of the efficiency of tandem solar cells. A. De Vos (Gent, Rijksuniversiteit, Ghent, Belgium). *Journal of Physics D - Applied Physics*, vol. 13, May 14, 1980, p. 839-846. 10 refs.

The fundamental (detailed balance) limit of the performance of a tandem structure is presented. The model takes into account the fact that a particular cell is not only illuminated by part of the solar irradiance but also by the electroluminescence of other cells of the

set. Whereas under 1 sun irradiance a single solar cell only converts 30% of the solar energy, a tandem structure of two cells can convert 42%, a tandem structure of three cells can convert 49%, etc. Under the highest possible light concentration, these efficiencies are 40% (one cell), 55% (two cells), 63% (three cells), etc. The model also allows one to predict the ideal efficiency of a stack with an infinite number of solar cells. Such a tandem system can convert 68% of the unconcentrated sunlight, and 86% of the concentrated sunlight.

(Author)

A80-38305 Wangen EVS-solarhouse with a positive balance sheet (EVS-Sonnenhaus Wangen mit positiver Bilanz). *Energie-wirtschaftliche Tagesfragen*, vol. 30, May 1980, p. 347-349. In German.

The results achieved with a solar house after one year of operation are reviewed. It is stressed that conventional solar collectors are not sufficient for heating the test house. Further, improvements are also needed for the task of hot water heating. Other disadvantages of solar collectors and of heatpumps working only with ambient air are discussed. It is demonstrated that a heat pump system using solar absorbers and a heat storage tank of damp the weekly to annual average values with the RMSE decreasing from 5 down to 2, respectively. A sensitivity study of these four improvements indicated that the first three were the most significant.

(Author)

A80-39055 I-V and C-V characteristics of Au/TiO₂ Schottky diodes. N. Szydlo and R. Poirier (Thomson-CSF, Laboratoire Central de Recherches, Orsay, Essonne, France). *Journal of Applied Physics*, vol. 51, June 1980, p. 3310-3312. 14 refs. Délégation Générale à la Recherche Scientifique et Technique Contract No. 77-7-1203.

A80-39061 Single-crystal solar cell heterojunctions involving N-cadmium sulfide. M. Arienzo and J. J. Loferski (Brown University, Providence, R.I.). *Journal of Applied Physics*, vol. 51, June 1980, p. 3393-3403. 24 refs. NSF-sponsored research.

A chemical vapor deposition method capable of depositing high-quality epitaxial layers of CdS on single-crystal substrates was used for the fabrication of heterojunction photovoltaic devices of the type n-CdS/p-InP, n-CdS/p-CdTe, n-CdS/p-GaAs and n-CdS/p-Ge. An analysis of the photovoltaic responses shows that all the devices have good collection efficiency, i.e. that at zero bias, photogenerated carriers crossing the junction do not suffer appreciable recombination at interface states. The solar energy conversion efficiency is, however, strongly influenced by the interface states through the open circuit voltage and the fill factor; analysis of the dark current-voltage characteristics shows the existence of a low temperature low-bias voltage tunneling current in all of the devices. A.T.

A80-39288 The sunship - The case for a solar powered airship. G. A. Khoury (Imperial College of Science and Technology, London, England). In: Economics and technology of airships; International Symposium, Paris, France, March 28-30, 1979, Proceedings. Volume 1. Paris, Association d'Etude et de Recherche sur les Aéronefs Allégés, 1979, p. 147-156.

The solar-powered airship is examined with reference to overall design, solar cell arrays, solar power speed, the weight problem, costs, and areas of application. It is noted that a sunship has, in addition to the known merits of an ordinary airship, the advantage of constant weight and an evenly distributed fuel system. It does not require refueling facilities and is even safer than an ordinary airship in that it does not carry inflammable fuel. Its operations, however, will be limited to the sunny regions of the world, where it can only sustain an average of nine hours flight a day unless satisfactory electrical storage units are installed or an auxiliary fuel system is used to support extended daily flights. B.J.

02 SOLAR ENERGY

A80-39785 # Determination of the unsteady heat fluxes in the focal plane of a radiant energy concentrator (Opredelenie nestatsionarnykh teplovykh potokov v fokal'noi ploskosti kontsentratora energii izlucheniia). P. G. Krukovskii and K. B. Isaev. *Promyshlennaiia Teplotekhnika*, vol. 2, May-June 1980, p. 3-6. In Russian.

A two-dimensional nonlinear inverse heat conduction problem is examined, which consists of determining, on the basis of given temperature measurements, the law of heat flux variation at the face of a cylindrical titanium specimen during the process of radiative heat transfer in the focal plane of a solar radiant-energy concentrator. A numerical solution is obtained, using an explicit finite-difference scheme to approximate the differential equation of the heat-transfer model. The obtained expressions for calculating the temperature field and the thermal fluxes are discussed. V.P.

A80-39937 Properties of low cost, high volume glasses. M. A. Lind, J. S. Hartman, and C. O. Buckwalter (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Physical properties of optical materials; Proceedings of the Seminar, San Diego, Calif., August 27, 28, 1979. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1980, p. 111-117. Contract No. EY-76-C-06-1830.

The properties of new and weathered samples of low cost, high volume glasses have been studied to determine their usefulness for solar energy applications. Glasses of varying compositions produced by float, drawn, rolled, fusion, and twin ground techniques were examined. Spectral transmittance and reflectance were measured and solar weighted values calculated. Laser raytrace techniques were used to evaluate surface parallelism and bulk homogeneity. Compositional changes were examined with scanning electron microscopy, X-ray fluorescence, and Auger electron spectroscopy. These techniques were used in conjunction with ellipsometry to study the surface effects associated with weathering. (Author)

A80-40252 * Ion-implanted laser annealed silicon solar cells. J. S. Katzeff (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Laser applications in materials processing; Proceedings of the Seminar, San Diego, Calif., August 27-28, 1979.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1980, p. 42-48. Research sponsored by the U.S. Department of Energy and NASA.

Development of low cost solar cells fabrication technology is being sponsored by NASA JPL as part of the Low Cost Solar Array Project (LSA). In conformance to Project requirements ion implantation and laser annealing were evaluated as junction formation techniques offering low cost-high throughput potential. Properties of cells fabricated utilizing this technology were analyzed by electrical, transmission electron microscopy, Rutherford backscattering and secondary ion mass spectrometry techniques. Tests indicated the laser annealed substrates to be damage free and electrically active. Similar analysis of ion implanted furnace annealed substrates revealed the presence of residual defects in the form of dislocation lines and loops with substantial impurity redistribution evident for some anneal temperature/time regimes. Fabricated laser annealed cells exhibited improved spectral response and conversion efficiency in comparison to furnace annealed cells. An economic projection for LSA indicates a potential for considerable savings from laser annealing technology. (Author)

A80-40334 Application of reliability, maintainability, and availability engineering to solar heating and cooling systems. P. S. Chopra and R. M. Wolosewicz (Argonne National Laboratory, Argonne, Ill.). In: Annual Reliability and Maintainability Symposium, San Francisco, Calif., January 22-24, 1980, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 248-253. 12 refs. Research supported by the U.S. Department of Energy.

This paper compares the reliability of solar hot-water and heating systems with that of conventional systems using block diagrams, failure modes and effects analysis, and fault trees. Although stand-alone solar-energy systems are not as reliable as conventional systems, the RMA of the combined solar and conventional system can be made comparable to currently available heating and hot-water systems. An availability matrix is presented that can be used to develop maintenance schedules that do not decrease the system's availability. Field data presented on operating solar heating and cooling systems indicate that these systems experience four major generic problems: freezing, leakage, controls, and collectors.

(Author)

A80-40473 Class of axisymmetric mirrors with uniform flux concentration properties along their axes. U. H. Kurzweg (Florida, University, Gainesville, Fla.). *Optical Society of America, Journal*, vol. 70, June 1980, p. 750-752. 5 refs.

The shape of axisymmetric mirrors capable of producing a constant concentrated flux density along a coaxial cylindrical surface is determined via both a series solution and a phase plane analysis of the governing second-order nonlinear differential equation. It is shown that there exists a class of such concentrators and that they all have a characteristic bell shape with two finite principal radii of curvature. Mirrors of this type may find application in processes requiring concentrated uniform illumination over extended areas such as in photovoltaic energy conversion. (Author)

A80-40474 Required minimum value of barrier height in minority-carrier M.I.S. solar cells. O. M. Nielsen (Danmarks Tekniske Højskole, Lyngby, Denmark). *IEE Proceedings, Part 1 - Solid-State and Electron Devices*, vol. 127, pt. 1, no. 3, June 1980, p. 105-108. 9 refs.

The saturation currents of minority- and majority-carrier MIS solar cells have been compared to find the value of the barrier height where the dominating saturation current changes from a majority-carrier current to a minority-carrier current. For an interfacial oxide layer of 20Å the value of the barrier height has been calculated to be in the range 750-800 mV, whereas for an oxide layer of 10Å, the barrier height is found to be about 900-950mV. (Author)

A80-40538 The effect of a black chrome selective surface on the thermal performance of a solar collector. J. A. Manrique and R. Suarez (Monterrey, Instituto Tecnológico y de Estudios Superiores, Monterrey, Mexico). *Letters in Heat and Mass Transfer*, vol. 7, Jan.-Feb. 1980, p. 25-31. 5 refs. Research supported by the United Nations Developing Program and UNESCO.

The radiation properties of a black chrome selective surface are presented in this work. Similarly, a comparison between the thermal performance of a flat plate solar collector with and without selective surface on the absorber is described. (Author)

A80-40709 Attenuation of solar energy by high, thin clouds. V. E. Derr (NOAA, Wave Propagation Laboratory, Boulder, Colo.). *Atmospheric Environment*, vol. 14, no. 6, 1980, p. 719-729. 22 refs.

The paper discusses the attenuation of solar energy by high, thin clouds. The estimates of the effect of clouds on solar energy rarely include high ice curriiform clouds because of the difficulty of direct, human detection. Lidar studies and aircraft observations show that cirrus is frequently present; the attenuation of solar energy by curriiform clouds is calculated, and the data used in combination with cirrus frequency results to estimate average effects of cirrus on solar energy devices. The marginal cost effectiveness of large solar installations requires that the effects of cirrus be considered in design. A.T.

A80-40712 Review of amorphous and polycrystalline thin film silicon solar cell performance parameters. H. K. Charles, Jr. and A. P. Ariotedjo (PRC Energy Analysis Co., McLean, Va.). *Solar*

Energy, vol. 24, no. 4, 1980, p. 329-339. 40 refs. Contract No. EG-77-C-01-4024.

The paper presents a state-of-the-art technology review for amorphous and polycrystalline thin film silicon solar cells. It details the performance parameters for the diversity of cell types and structures (e.g., p-n junctions, p-i-n and MIS structures, Schottky barriers, and heterojunctions) fabricated with amorphous and polycrystalline silicon film materials. Trends in performance improvement and fabrication techniques are outlined. V.T.

A80-40714 * **New technologies for solar energy silicon - Cost analysis of BCL process.** C. L. Yaws, K.-Y. Li (Lamar University, Beaumont, Tex.), C. S. Fang (Southwestern Louisiana University, Lafayette, La.), R. Lutwack, G. Hsu, and H. Leven (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Solar Energy*, vol. 24, no. 4, 1980, p. 359-365. 46 refs. Research sponsored by the U.S. Department of Energy.

New technologies for producing polysilicon are being developed to provide lower cost material for solar cells which convert sunlight into electricity. This article presents results for the BCL Process, which produces the solar-cell silicon by reduction of silicon tetrachloride with zinc vapor. Cost, sensitivity, and profitability analysis results are presented based on a preliminary process design of a plant to produce 1000 metric tons/year of silicon by the BCL Process. Profitability analysis indicates a sales price of \$12.1-19.4 per kg of silicon (1980 dollars) at a 0-25 per cent DCF rate of return on investment after taxes. These results indicate good potential for meeting the goal of providing lower cost material for silicon solar cells. (Author)

A80-40717 **Measurement of wind speed distributions across a solar collector.** M. V. Oliphant (South Australia, Flinders University, Bedford Park, Australia). *Solar Energy*, vol. 24, no. 4, 1980, p. 403-405.

A80-40718 **Thermal performance predictions and sensitivity analysis for high temperature flat-plate solar collectors.** J. G. Symons (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia) and R. Gani (Monash University, Clayton, Victoria, Australia). *Solar Energy*, vol. 24, no. 4, 1980, p. 407-410. 10 refs.

The long-term thermal performances of high-temperature flat-plate solar collectors are compared for typical process heating loads in significantly different climates. Consideration is given to the collectors which are double and triple glazed and to those with a single cover and convection suppression device. V.T.

A80-40721 **Solar elevation angle probability distribution.** D. C. Larson and C. R. Acquista (Drexel University, Philadelphia, Pa.). *Solar Energy*, vol. 24, no. 4, 1980, p. 417-420. 5 refs. Research supported by the U.S. Department of Energy.

The probability distribution of solar elevation angles is determined, and the importance of this distribution on concentrator design is discussed. It is concluded that the time probability function for the solar elevation angle is important when considering alternative low-concentration systems for year-round or seasonal applications. V.T.

A80-40937 **Temperature distributions in the flat-plate collector under actual unsteady insolation.** M. F. El-Refai and M. A. Hashish (Cairo University, Giza, Egypt). *Applied Mathematical Modelling*, vol. 4, June 1980, p. 181-186. 7 refs.

The dynamic behavior of the flat-plate solar energy collector is analyzed taking into account the continuous variation of the received radiant flux. Closed-form mathematical formulas are derived for the fluid and absorber-plate temperatures as functions of both the time and the position along the collector. Different mathematical forms are given for the diurnal heating and the nocturnal cooling periods. The temperature expressions are presented in dimensionless form in terms of a limited number of dimensionless groups. Samples of the

results obtained by using the derived formulas are displayed graphically. (Author)

A80-41324 **Solar energy economics - Orbiting reflectors for world energy.** K. W. Billman, W. P. Gilbreath, and S. W. Bowen. In: *How big and still beautiful. Macro-engineering revisited.* Boulder, Colo., Westview Press, Inc. (AAAS Selected Symposia Series, No. 40), 1980, p. 293-342. 19 refs.

The paper outlines a recent study made on a space-terrestrial solar energy system (SOLARES) consisting of a set of orbiting mirrors that provide nearly continuous reflected sunlight to a world-distributed set of solar conversion sites. This solar concept is examined under the four criteria which any candidate energy system must satisfy: (1) technical feasibility, (2) significant and renewable energy impact, (3) economic feasibility, and (4) social/political acceptability. V.T.

A80-41470 # **Design of a heat pipe absorber for a concentrating solar water heater.** K. T. Feldman, Jr. (New Mexico, University; Energy Engineering, Inc., Albuquerque, N. Mex.) and D. L. Noreen (Solar Energy Research Institute, Golden, Colo.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1506.* 9 p. 16 refs. Research supported by the New Mexico Department of Energy and Minerals.

The heat pipes used in the absorber of a solar water heater with a concentrating collector were analyzed. The absorber was made of one or more gravity-assisted heat pipes. The heat pipe analysis included the effects of counterflow liquid-vapor shear and nucleate boiling. It was found that 2.09 to 2.66 cm inside diameter (3/4 to 1 inch nominal pipe) heat pipes operated horizontally or at small tilt angles could provide the required axial heat transport rate over the reasonably long distances encountered in concentrating solar collectors. A heat pipe solar collector can be highly cost-effective. December performance of 46% thermal efficiency with 61 deg C (142 deg F) end-of-day water temperature in a 208 kg (55 gal) tank was predicted for a 4 m long non-tracking collector with a 4 sq m area. Experimental results agree closely with the analysis predictions. (Author)

A80-41471 # **Heat pipe receiver for a 20 MWe solar tower.** H. Kreeb and K. Schaber (Dornier System GmbH, Friedrichshafen, West Germany). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1507.* 7 p.

Since October 1978 a German industrial group is working on the plant design and the development of a 20 MWe gas cooled central receiver solar power plant. During the phase of preliminary design, which is now finished, various configurations for each of the main components of the power plant have been investigated and a conception for further work is defined. The objective point of this project will be the erection of a pilot plant in a partner country, to be designated, and the commencement of operation in 5 years. The design of the central heat pipe receiver, using air up to 800 C as coolant, is described in detail. (Author)

A80-41502 # **Optimization of liquid desiccant systems for solar/geo-thermal dehumidification and cooling.** C. S. P. Peng and J. R. Howell (Texas, University, Austin, Tex.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1546.* 11 p. 23 refs.

A80-41948 **Plastic solar collectors for 'low energy' applications.** A. Addeo, G. Campanile, L. Nicolais, and G. Romeo (Montedison - DIRS, Naples Research Centre, Naples, Italy). *Applied Energy*, vol. 6, July 1980, p. 265-274. Research supported by the Consiglio Nazionale delle Ricerche.

The possibility of constructing, with plastic materials, solar collectors for 'low temperature' (less than 60 C) applications is investigated. Several prototypes are analyzed for their performance and efficiency. The results indicate a strong possibility of large-scale use of these solar collectors for many applications. (Author)

02 SOLAR ENERGY

A80-41950 Concentration characteristics of composite parabolic concentrators. R. N. Singh, S. S. Mathur, and T. C. Kandpal (Indian Institute of Technology, New Delhi, India). *Applied Energy*, vol. 6, July 1980, p. 315-321. 5 refs.

The effects of the widths of individual strip mirrors in a composite cylindrical parabolic solar concentrator on the concentration ratio are investigated. Calculations of the geometrical concentration ratios for a circular cylindrical receiver and a flat plate receiver are presented as a function of rim angle, and the effects of strip widths are illustrated for rim angles of 60 and 45 deg for the circular cylindrical and flat plate receivers, respectively. It is pointed out that the concentration decreases sharply at first with increasing strip width, attaining a more or less constant value at widths greater than approximately 10 cm. A.L.W.

A80-41951 Thermal insulation of a low capital cost solar-energy collector. B. Norton and S. D. Probert (Cranfield Institute of Technology, Cranfield, Beds., England). *Applied Energy*, vol. 6, July 1980, p. 323-327. 5 refs. Research supported by the Science Research Council.

To achieve least steady-state heat losses across the atmospheric pressure air in a concentric horizontal cavity between a heated inner cylinder and a naturally cooled surrounding cylinder, the radial supports along the length of the cavity should be at approximately 60 deg from the vertically downwards position. This design recommendation has been incorporated in a simple prototype solar energy collector. (Author)

A80-42101 Current from the sun - A look at the economics of solar cells. J. J. Loferski (Brown University, Providence, R.I.). *The Sciences*, vol. 20, July-Aug. 1980, p. 6-9, 29.

The use and cost efficiency of photovoltaic solar cells in space and terrestrially is surveyed. Attention is given to systems in which lenses or mirrors are used to concentrate sunlight, and to flat plate collector systems which do not employ concentration. Lowering costs of silicon cells is considered along with the substitution of polycrystalline or amorphous semiconductor thin films for the single crystal silicon wafers. Also discussed is the use of high efficiency cells such as in tandem solar cell systems. J.P.B.

A80-42135 Effect of plasma reflection on open-circuit voltage of a solar cell at ultrahigh light intensities. V. K. Tewary (Birla Institute of Technology and Science, Pilani, India), L. S. Kothari (Delhi, University, Delhi, India), and S. C. Jain (Solid State Physics Laboratory, Delhi, India). *Applied Physics Letters*, vol. 37, July 1, 1980, p. 58, 59.

A80-42140 Efficient indium tin oxide/polycrystalline silicon semiconductor-insulator-semiconductor solar cells. A. P. Genis, P. A. Smith, K. Emery, R. Singh, and J. B. DuBow (Colorado State University, Fort Collins, Colo.). *Applied Physics Letters*, vol. 37, July 1, 1980, p. 77-79. 8 refs. Research supported by the Solar Energy Research Institute.

The fabrication of high efficiency (10.94% AM1) and large area (11.46 sq cm) indium tin oxide/polycrystalline silicon semiconductor-insulator-semiconductor solar cells using neutralized-ion-beam sputtering is discussed. It was shown that the proper surface preparation and the incorporation of hydrogen during milling and oxidation of the substrate are important fabrication steps. The photovoltaic conversion parameters were the open circuit voltage of 0.526 V, the short-circuit density of 27.39 mA/sq cm, and the FF of 0.759. A.T.

A80-42161 # The prospects for solar-powered closed-cycle gas turbines. S. C. Kuo, T. L. O. Horton, and H. T. Shu (United Technologies Research Center, East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-26*. 9 p. 14 refs. Members, \$1.50; nonmembers, \$3.00.

This paper presents the results of a systems study to evaluate the technological and economic feasibility of utilizing closed-cycle gas

turbines integrated with an advanced-design central receiver for solar power generation. Applicable turbomachinery technologies were reviewed to estimate their future advances expected. System design-point performance, component size, and cost characteristics of closed-cycle air turbines were estimated, and system operational and control characteristics, including off-design and part-load performance characteristics, are discussed. Critical system components were reviewed to estimate the appropriate testing and development time and cost schedules required. (Author)

A80-42167 # Reciprocal efficiency improvement of high temperature fossil and low temperature solar heat sources for power generation. Z. P. Tilliette and B. Pierre (Commissariat à l'Énergie Atomique, Division d'Étude et de Développement des Réacteurs; Gif-sur-Yvette, Essonne, France). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-34*. 7 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

Gas turbine systems are investigated for solar energy conversion because they can offer satisfactory performances, particularly in case of combined cycles, and interesting solutions for plant operation. Hybrid concepts, associating solar heating with fossil firing, reduce the need for energy storage. Key problems are: matching of combined gas and steam cycles for performance enhancement; coupling of solar heating with fossil firing, use of as much solar energy as possible and priority use of solar energy at medium temperature (200/650 C), because, within this temperature range, technology is more readily available for the solar receiver system (central receiver, fixed mirror concentrators, parabolic dish collectors) and for the primary circuit (Giloterm, Dowtherm, sodium, molten salts). (Author)

A80-42244 # The design of a solar receiver for a 25-kWe gas turbine engine. M. Greeven, M. Coombs, and J. Eastwood (AiResearch Manufacturing Company of California, Torrance, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-131*. 5 p. Members, \$1.50; nonmembers, \$3.00.

This paper describes a solar receiver designed to be used with a single-point-focus, parabolic concentrator. The receiver accepts the concentrated solar radiation and uses it to heat the working gas of a small, open-cycle gas turbine to about 1500 F (815 C). The receiver employs a high-efficiency, metallic plate-fin heat transfer surface to effect this energy transfer. The thermal and mechanical design features of the receiver are discussed. (Author)

A80-42435 Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Course supported by the University of Waterloo, U.S. Department of Energy, and International Centre for Theoretical Physics. Edited by A. E. Dixon and J. D. Leslie (Waterloo, University, Waterloo, Ontario, Canada). Toronto and New York, Pergamon Press, 1979. 1324 p. \$60.

The course concentrated on solar radiation and collectors, selective surfaces, heating and cooling of buildings, architecture and planning, direct conversion, control and measurement, bioconversion, and biomass. Papers were presented on basics of solar energy, technology of flat plate collectors, concentrating collectors, spectrally selective surfaces, solar energy air systems, cooling of buildings, solar architecture, hybrid energy optimization, polycrystalline solar cells, MIS and SIS solar cells, sensors, microprocessors, bioconversion of solar energy, solar powered refrigeration, and wind power. A.T.

A80-42436 Basics of solar energy. A. A. M. Sayigh (Riyadh, University, Riyadh, Saudi Arabia). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 1-7.

Basic data related to solar energy are summarized, including mass, radius, average density, and average surface temperature of the sun, as well as definitions of the common terminology. Equations are given for the calculation of the solar declination and the length of the day. V.L.

A80-42437 Characteristics of solar radiation. A. A. M. Sayigh (Riyadh, University, Riyadh, Saudi Arabia). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 9-36. 14 refs.

The intensity and spectral and temporal characteristics of solar energy received at the earth's surface are discussed in relation to solar energy applications. Measurements of the solar constant and the extraterrestrial solar spectral energy distribution are presented, and the determination of total and spectral solar irradiance at ground level taking into account the variability of incident solar energy due to solar inclination, cloud cover and atmospheric attenuation is considered. The calculation of direct solar radiation incident on an inclined surface, diffuse and reflected solar radiation on inclined and horizontal surfaces and total or global radiation on an inclined surface is then examined, and the effects of turbidity and surface albedo on solar radiation intensity are indicated. Finally, various means for the estimation of total solar radiation are reviewed and a new formula is proposed. A.L.W.

A80-42438 Methods for the estimation of solar energy on vertical and inclined surfaces. J. K. Page (Sheffield, University, Sheffield, England). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 37-99. 23 refs. Science Research Council of England Grants No. B/RG/93199; No. GR/A/34788.

The paper presents two methods for the assessment of monthly mean solar radiation falling on vertical and inclined surfaces anywhere in the inhabited world. Both methods involve splitting the incident flux into three components: direct, sky diffuse, and ground reflected diffuse using mean monthly sunshine data as their starting point. The first method is simple and provides daily values of the irradiation on slopes; the second method involves more complex mathematical modelling and is dependent on the availability of digital computers, and it rapidly produces hourly values of the mean monthly irradiance on slopes which check with field observations. This model does not assume isotropic radiation from the sky. A.T.

A80-42439 The technology of flat plate collectors. A. A. M. Sayigh (Riyadh, University, Riyadh, Saudi Arabia). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 101-124. 23 refs.

The capabilities and limitations of flat plate collectors of solar energy for heating are discussed. The properties of commonly used insulation materials are presented, and it is shown how collector efficiency varies with the temperature gain of the collector per unit insolation for different kinds of covers. Attention is given to the optimum air gap between the absorber and the glass covers as well as to reducing losses due to convection by producing a vacuum in the collector spacing or by placing transparent honeycombs in the air gap. Also considered are the radiative interchange within the gap between the hot collector plate and the top transparent cover, and processes of heat transfer by convection. J.P.B.

A80-42440 Free convection in solar collectors. K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 125-147. 7 refs.

Free convective heat transfer in solar collectors is discussed. The heat transfer coefficient in a stationary fluid is considered along with buoyancy and viscous forces, and both the horizontal and inclined air layers. Attention is also given to combined free convective and radiative coefficients across air layers. In addition, the practical problems of choosing the spacing between the individual covers and between the inner cover and the absorber plate in a flat plate solar collector are addressed. J.P.B.

A80-42441 Advanced non-concentrating solar collectors. K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 149-166. 15 refs.

Three classifications of advanced flat plate collector designs are considered. In the reduced pressure solar collector, the pressure in the air layer between the absorbing surface and the transparent cover is reduced as well as the tendency for free convection, with virtually no effect on the thermal conductivity of the air until very low pressures are reached. In evacuated collectors reduction in the heat transfer across an air layer is achieved by obtaining such a high vacuum that the thermal conductivity of air is effected; difficulties with regard to the unbalanced pressure force acting on the glass cover and maintenance of the vacuum against leaks are addressed. In honeycomb collectors the inner set of covers are cut into lengths and placed perpendicular to the absorber plate with the result that reflections of solar radiation are not lost and absorption in the partitions can be avoided; attention is given to cell size and calculation of radiant exchange across a honeycomb. J.P.B.

A80-42442 Concentrating collectors. A. S. Roy. In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 185-252. 86 refs. Contract No. W-7405-eng-26.

A review of the state-of-art of solar concentrating collectors is presented. Moderately concentrating systems which are defined as those operating below the intensity ratios of three are discussed including evacuated tube absorbers, vee-troughs, and compound parabolic concentrators; strongly concentrating collectors are being developed which utilize reflecting, refracting, mirror, and Fresnel optical principles, and parabolic, spherical, and flat contours. Point-focusing parabolic dish collectors, a 2-G axis parabolic dish, fixed-mirror two-axis focusing concentrators, and fixed-reflector-rotating absorber types are described. Economic considerations are analyzed, presenting a simplified model which computes the cost of electricity and the system efficiency; finally, the optical losses are examined by the consideration of point focusing paraboloidal reflectors and absorber efficiency. A.T.

A80-42443 Spectrally selective surfaces in photothermal solar energy conversion. B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 287-329. 14 refs. Contracts No. EY-76-S-04-3709; No. ER-78-S-02-4899.

The paper examines photothermal conversion which directly converts solar into thermal energy. The principle is illustrated by depicting the energy flow in a conversion unit, and showing that the ideal converter should have an absorption profile that resembles a Fermi function. The spectral selectivity requirement depends on the flux concentration and the converter surface operating temperature; selective surfaces must have a proper spectral profile, and the properties of the surface must resist elevated temperatures. Methods of obtaining spectral selectivity including the single material approach, based on the spectral positions of the plasma edge in As-doped germanium and Ag, and the spectral selectivity of Mo-MoO₃ thin films are discussed; the temperature dependence of optical properties is described by thermal emittances vs temperature

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of metals. Absorber-reflector tandems used because of inability of obtaining an ideal selective surface with a single material are examined, concluding with a discussion of interference coatings, such as the Al₂O₃-Mo-Al₂O₃ type. A.T.

A80-42444 Solar air systems. G. O. G. Lof (Colorado State University, Fort Collins, Colo.). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 331-375. 14 refs.

The paper examines solar air systems and compares them with solar liquid systems. The solar air systems built since 1945 in houses including an overlapped glass plate heater are described, along with the design of a typical collector which includes a pebble bed heat storage unit, a thermostat, air handler, hot water preheat tank, an evaporative cooler, and an auxiliary furnace. Pebble bed heat storage performance is evaluated, noting that the heat at the highest temperature is available from the collector, and it can be stored and delivered later; also, during the winter months, one end of the chamber remains unheated so that the collector is nearly always at about 70 F. This increases the collector efficiency so that it can operate with poorer sunshine and for longer periods than if warmer fluid was circulated. It is concluded that the air system is superior for residential use due to high reliability and low maintenance, but liquid systems are more economical for commercial and industrial application because of larger air duct and pebble bed storage requirements. A.T.

A80-42445 Solar energy for heating and cooling. J. R. Williams (Georgia Institute of Technology, Atlanta, Ga.). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 377-391.

Active and passive approaches to solar heating, hot water and cooling systems are reviewed. Consideration is given to passive solar heating systems, including direct gain systems, thermal storage walls, thermal storage roofs, attached greenhouses and convective loops, to active solar heating and cooling systems based on flat plate solar collectors using various absorber plate and cover plate materials, and to active solar domestic hot water systems. Solar heating and cooling systems developed for applications in Kuwait, at an elementary school in Georgia and in a large new multipurpose community center are indicated, and the cost advantages of active and passive systems in different areas of the world are discussed. It is pointed out, however, that in addition to cost, factors such as performance, durability, reliability and appearance must also be considered in the selection of a solar system. A.L.W.

A80-42446 Cooling of buildings. R. K. Swartman (Western Ontario, University, London, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 393-416. 13 refs.

The cooling of buildings is discussed and possible systems utilizing solar energy for this end are considered. The science of psychrometrics, which deals with the thermal properties of moist air, is introduced, and the three major processes for conditioning the atmosphere of a space, sensible cooling, cooling and dehumidification and cooling and humidification, are examined. The effects of environmental conditions on human comfort are considered, and the components and determination of building cooling loads are discussed. The various types of solar cooling systems are then examined in detail, with attention given to solar sorption cooling by absorption and adsorption cycles, solar-mechanical systems and solar-related cooling using heat pumps, sky radiation, rock bed regenerators, passive systems and flat-plate solar collectors. It is pointed out that cooling seems to be the most attractive application for solar energy,

due to the concurrence of supply and demand, and can make significant contributions to saving money and energy. A.L.W.

A80-42447 A completely instrumented solar building - The Shenandoah Solar Recreational Center. J. R. Williams (Georgia Institute of Technology, Atlanta, Ga.). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 417-433.

The hydronic solar energy system of the Shenandoah Solar Recreational Center, with double glazed black chrome selectively coated copper tube-in-strip flat plate solar collectors, contains 63 collectors that are each 8.61 by 20.7 ft. A sawtooth roof structure is employed and the entire system is pressurized. The design incorporates the use of constant circulating loops, aluminum reflectors instead of aluminized mylar and the avoidance of downrain for freeze protection; basically, one or more loops are used to control energy transfer to or from a component and each of these subsystems operates somewhat independently of the others. Attention is given to building load calculations, operation when there is sufficient or excess insolation and problems encountered with the freeze protection system. J.P.B.

A80-42448 Fundamentals of solar architecture. A. Bowen (Miami, University, Coral Gables, Fla.). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 481-553. 18 refs.

The paper reviews fundamentals of solar architecture with emphasis on the thermal and luminous properties of building materials. The exterior factors such as solar, wind, and precipitation which affect the building site, and the interior specifications such as the number of occupants, volume, and floor area are discussed considering that the prime provision of buildings is shelter from climate. Insulation characteristics of materials are tabulated, noting that they are classified into 'resistance insulation' and 'capacity insulation'; thermal reflectivities and emissivities of material surfaces are summarized, noting that solar radiation is reradiated in the long wave infrared range. Thermal exchange in buildings as caused by thermal conduction through walls and solar heat gain through openings is expressed in a thermal balance equation. Luminous behavior of materials is analyzed, along with factors which determine channels of daylight in buildings. It is concluded that solar engineering equipment can be used to satisfy energy needs of passive vernacular solar buildings, dynamic energy responsive designs and hybrid solar mechanically equipped buildings. A.T.

A80-42452 Systematic techniques of design for solar houses in high latitudes. J. K. Page (Sheffield, University, Sheffield, England). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 629-713. 34 refs. Science Research Council Grants No. B/RG/93199; No. GR/A/34788.

The paper discusses techniques of design of high altitude solar houses. Computer design methods are particularly valuable in reducing analysis time; eventually, architectural rules of thumb should be formulated, but at this stage it is too early to predict when this will be accomplished. The dangers of copying solar houses from other locations out of environmental context without adequate performance analysis are great; every unsatisfactory solar building makes it more difficult for designers to build other solar houses. It is concluded that the design of solar houses at high altitudes will remain a difficult challenge since the amount of available solar energy in winter is low. A.T.

A80-42453 The potential of renewable energies in planning the development of rural areas. T. A. Lawand (McGill University, Sainte Anne de Bellevue, Quebec, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 757-771.

A80-42454 Review of solid state physics. A. E. Dixon (Waterloo, University, Waterloo, Ontario, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 773-784.

A solid state physics background necessary to understand solar cell physics is presented. Some physical insight into the band structure of solids is provided, and the band structure is used to explain the physical properties of semiconductors. These properties are then used to illustrate the workings of a simple pn junction. V.T.

A80-42455 Silicon solar cells. I - Basics. II - Practical aspects. R. E. Thomas (Carleton University, Ottawa, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 785-803. 805-830. 67 refs.

The paper reviews the principles and practical aspects of silicon solar cells. The photovoltaic effect which generates electrical energy by absorption of ionizing radiation is produced in semiconductors used in solar cells; the cell operation is depicted, noting that its limiting behavior can be predicted by determining the photocurrent and the diode (dark) current. Expressions are derived for the dark current density of the diode and the conversion efficiency of the solar cell. The conversion efficiency is discussed relative to voltage and fill factors as a function of energy gap and temperature; current efficiency can be determined as the ratio of collected current to the maximum photon current. The solar cell equivalent circuit is examined with respect to the effect of shunt and series resistances on I-V characteristics, and factors affecting cell efficiency such as surface reflection, junction depth, and cell thickness are analyzed.

A.T.

A80-42456 Polycrystalline solar cells. D. E. Brodie (Waterloo, University, Waterloo, Ontario, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 831-841.

Polycrystalline solar cells are discussed as possible low-cost components for solar energy conversion systems. Consideration is given to the properties and problems of crystalline heterojunction solar cells, including optimum parameters for providing a high conversion efficiency. The application of polycrystalline films with crystallites large compared to film thickness in heterojunction solar cells is then discussed, and factors such as film thickness, grain boundaries and fabrication methods that should be controlled in order to produce a useful cell are indicated.

A.L.W.

A80-42457 Metal-insulator-semiconductor (MIS) and semiconductor-insulator-semiconductor (SIS) solar cells. I - Basic principles. II - Performance characteristics. J. Shewchun (McMaster University, Hamilton, Ontario, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 843-867, 869-884. 16 refs.

The paper examines metal-insulator-semiconductor (MIS) and semiconductor-insulator-semiconductor (SIS) principles and perfor-

mance characteristics. They are of interest in solar cells applications because of possible processing cost reductions; since the junctions are virtual or induced, it may be possible to use polycrystalline film semiconductors to avoid grain boundary effects. It may also be possible to reduce or eliminate grids and built-in AR coatings; however, it should be noted that these devices are controlled by very thin interfacial layers which are difficult to produce. At present, a 12% efficiency plateau has been reached with these systems, and their features include the control by diffusion current flow in the bulk of the base semiconductor, and the ability to measure the interfacial layer directly and predict its effect on efficiency. It is concluded that the loss mechanisms which limit the efficiency can be removed and the performance should be limited only by the bulk characteristics of the base semiconductor.

A.T.

A80-42458 Basic electrochemistry. A. F. Janzen (Western Ontario, University, London, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 885-903. 8 refs.

The concept and definitions of electrochemistry are introduced. A cyclic photogalvanic silver halide cell is used as an example. Oxidation reduction reactions are discussed, electrochemical potentials are outlined, and losses in electrochemical cells are considered. Emphasis is placed on frictional losses, concentration polarization, and overvoltage.

V.T.

A80-42460 Short course in microprocessors for solar energy applications - Microprocessors, microcomputers and single chip computers. B. E. Paton (Dalhousie University, Halifax, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 939-951. 12 refs.

A80-42461 Short course in microprocessors for solar energy applications - Sensors. B. E. Paton (Dalhousie University, Halifax, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 953-965. 7 refs.

In the first part of the paper, it is shown how a microprocessor could be used to produce a computer controlled light meter which is capable of measuring both instantaneous and integrated solar light power. The second part deals with a thermistor interfaced to a single chip computer. The computer is used to convert measured resistance into temperature.

V.T.

A80-42462 Short course in microprocessors for solar energy applications - Control. B. E. Paton (Dalhousie University, Halifax, Nova Scotia, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 967-978. 5 refs.

The paper shows how microcomputers may be interfaced with simple (on-off) mechanical relays and proportional mechanical devices. Single channel operation where each output line is connected to only one output device is considered. In the other example, a link between the digital and mechanical parts of a system is provided with a stepping motor. These motors may be used to control flow rates by operating a valve or to track the sun.

V.T.

A80-42463 Short course in microprocessors for solar energy applications - Systems. B. E. Paton (Dalhousie University, Halifax, Nova Scotia, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo,

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Ontario, Canada, August 6-19, 1978, Selected Lectures.

Toronto and New York, Pergamon Press, 1979, p. 979-992. 10 refs.

A 16-channel data logger with a RS 232C serial output port is described. The circuit requires four integrated circuits: a data acquisition chip, DAS voltage reference, Vref single-chip computer, and line driver. Consideration is given to a microprocessor module with emphasis placed on a computer program. V.T.

A80-42464 Short course in microprocessors for solar energy applications - The microcomputer family. B. E. Paton (Dalhousie University, Halifax, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 993-1004. 6 refs. Research supported by the National Research Council of Canada.

Microprocessors and their applications, particularly for solar energy systems, are described. Consideration is given to a single-chip, single-board, and multiboard computers. Arithmetic using microprocessors are outlined, and distributing processing is emphasized. V.T.

A80-42465 Bioconversion of solar energy. D. O. Hall (King's College, London, England). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures.

Toronto and New York, Pergamon Press, 1979, p. 1005-1057. 143 refs.

The paper discusses the bioconversion of solar energy. Plant photosynthesis fixes about 2×10 to the 11th tons of carbon yearly with an energy content of 3×10 to the 21st J which is 10 times the world annual use and 200 times the food energy consumption. All the atmospheric CO₂ is cycled through plants every 300 years, all the O₂ every 2000 years, and the H₂O every 2 million years. The magnitude and role of photosynthesis is unrecognized primarily because such a small fraction of the fixed carbon is utilized and the recycling phenomena are not understood; however, the plants are very adaptable and exist in great diversity, so they can indefinitely supply renewable quantities of food, fiber, fuel, and chemicals. It is suggested to evaluate what photosynthesis can provide by various methods such as H₂ production and carbon fixation. (Author)

A80-42468 Solar power. J. R. Williams (Georgia Institute of Technology, Atlanta, Ga.). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures.

Toronto and New York, Pergamon Press, 1979, p. 1129-1136.

Solar-thermal-electric technologies, whereby solar radiation is converted into heat from which electric power is generated, are considered. These technologies consist of central receiver systems which use a field of mirrors to concentrate sunlight onto the heat receiver to generate power, and dispersed systems. Attention is given to the thermodynamic efficiency of solar power plants and to concentrating solar collectors, both point- and line-focusing systems. The parabolic trough concentrator and linear single axis tracking concentrators are also considered, along with a total energy plant that uses four types of collectors as well as tanks of oil for thermal storage. J.P.B.

A80-42469 Solar powered refrigeration. E. Bilgen (Ecole Polytechnique, Montreal, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures.

Toronto and New York, Pergamon Press, 1979, p. 1223-1243. 35 refs.

Utilization of solar powered refrigeration units in cooling and food preservation is reviewed. Refrigeration for air-conditioning is discussed, including absorption systems. Refrigeration machines suitable for food preservation, such as intermittent or continuous-

type absorption systems are considered. It is noted that there has been no systematic development of solar powered refrigeration units for ice making. V.T.

A80-42471 Solar energy at the P.E.I. Ark. K. T. Mackay and D. Bergmark. In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 1267-1277. 7 refs.

The use of solar energy in the Prince Edward Island Ark, a 490-sq m alternative energy and agriculture demonstration facility containing a home, two greenhouses, an aquaculture facility and office/laboratory space, is discussed. The passive solar system, which makes use of south and west-facing glass doors for collection and rocks, concrete and water for heat storage, provides over 50% of the heating requirements, without overheating in the summer. Supplemental heating and hot water is supplied by an active solar system comprised of 36 flat plate collectors mounted vertically at the peak of the building, with an efficient air-tight wood stove as back up. The commercial greenhouse employs a hybrid solar system with both active and passive features and has produced crops year round. Greenhouse horticulture involves solar-driven biological processes in place of energy-intensive processes, and is associated with a solar-driven aquaculture system employing algae as a purification system for the hatching of trout. Many of the techniques tested at the Ark have been incorporated into other projects. A.L.W.

A80-43118 Scanning light spot analysis of faulty solar cells. K. Lehovc and A. Fedotowsky (Southern California, University, Los Angeles, Calif.). *Solid-State Electronics*, vol. 23, June 1980, p. 565-576. 35 refs. NBS-supported research.

Current output patterns of a solar cell panel exposed to a scanning light spot are computed for fault-free and for faulty cell containing either cracks with leakage conductances across the exposed junction at the crack, or point shorts in series with various spreading resistances. Low light level, uniform attenuation length, and an external panel termination of low impedance are assumed. It is shown that various boundary conditions can be satisfied by appropriate imaging techniques. A general equivalency theorem for the cell output of an illuminated point with that of an illuminated line through that point parallel to the finger electrode is derived and utilized. The preferred attenuation length of about half the finger electrode spacing can be achieved by modulating the light beam at an appropriate frequency which is typically in the low MHz range. Output patterns generated by a modulated light beam are compared with those obtained by unmodulated light. (Author)

A80-43122 A low-high-junction solar-cell model developed for use in tandem cell analysis. R. J. McPartland and A. G. Sabnis (Pittsburgh, University, Pittsburgh, Pa.). *Solid-State Electronics*, vol. 23, June 1980, p. 605-610. 16 refs.

A comprehensive low-high (L-H) junction solar cell model has been developed. It accounts for actual solar spectrum related photogeneration of carriers in all regions of the n-p-p(+) cell and allows for any value of rear surface-recombination-velocity (SRV). In typical GaAs L-H junction solar cells, photogeneration in the p(+) region, but not the p region, is found to be negligible. The L-H junction's space-charge-layer recombination current density is also negligible. Assigning a non-infinite value of rear surface SRV makes this model applicable to tandem multi-junction structures made from materials with different band gaps. (Author)

A80-43344 * # Generalized shading analysis for paraboloidal collector fields. D. B. Osborn (Ford Aerospace and Communications Corp., Newport Beach, Calif.). *American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper 80-Pet-33*. 8 p. 8 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. JPL-955115.

This paper presents the development and results of a generalized shading analysis for a field of point-focus parabolic dish concentra-

tors. Shading of one concentrator by another with attendant loss of energy is a function of the position of the sun and the relative locations of the concentrators within the field. A method is presented for determining the annualized energy loss which includes a trade-off of system life-cycle energy as a function of concentrator spacing and field geometric layout. System energy output is computed on an annualized basis, employing 15 minute-increment environmental data tapes for the year 1976 at Barstow, California. For a land cost of \$5000 per acre, lowest system energy cost occurs at about a 25 percent packing fraction (concentrator area/land area) for a typical 1-MWe dish-Stirling solar thermal power plant. Basic equations are given for computing the shading and concomitant energy loss as a function of concentrator center-to-center spacing, field layout site location. (Author)

A80-43367 Quasi-optimum pseudo-Lambertian reflecting concentrators - An analysis. A. Luque (Madrid, Universidad Politécnica, Madrid, Spain). *Applied Optics*, vol. 19, July 15, 1980, p. 2398-2402. 9 refs.

A two-stage concentrator is analyzed, in which the first stage is reflective and the second stage considers the first one as a Lambertian source in order to obtain the highest possible gain. The profile and the position of this first stage, which happens to be a parabola, is determined, and the value of the gain is calculated as a function of the acceptance angle and the focal length of the first stage. M.E.P.

A80-43368 Information theory and solar energy collection. R. P. Patera and H. S. Robertson (Miami, University, Coral Gables, Fla.). *Applied Optics*, vol. 19, July 15, 1980, p. 2403-2407. 7 refs.

Information theory is applied to the problem of solar radiation collection. It is found that the optimum solar concentrator corresponds to a perfect imaging system, i.e., one that images the entire sky on the absorber with no aberrations. For a nonisotropic distribution of radiation at the collector aperture, many thermally separated absorber segments are necessary at the absorber for optimum performance. The heat transfer fluid is first passed through the warm segments and then passed sequentially through the progressively hotter segments. (Author)

A80-43473 Medium and high temperature solar processes. J. F. Kreider (Jan F. Kreider and Associates, Boulder, Colo.). New York, Academic Press, Inc., 1979. 357 p. 150 refs. \$38.

The subject matter of the book is concerned with those solar-thermal processes operating above 100 C. A broad division between medium- and high-temperature processes is made at 300-400 C, corresponding to practical operating temperatures achieved by single- and compound-curvature solar concentrators. Systems for power production, shaft power, industrial process heat, and total energy (shaft power plus thermal power) are treated. Engineering design data for high-temperature collectors and their use in solar furnaces, central solar power plants, distributed power plants, and solar thermionics are described. V.T.

A80-43477 The estimation of global and sky radiation in Austria. F. Neuwirth (Zentralanstalt für Meteorologie und Geounit area is noted. To evaluate this influence, comparative space-diversity measurements were made (1976 through 1978) with different instruments. It was found that for a procedure based on the application of surface gauge data to the correction of radar calculations, the best results could be obtained using the mean value of two-hour measurements made with three gauges spaced 100 to 200 m apart. V.P.

A80-43479 Solar thermoelectric generation using bismuth telluride alloys. H. J. Goldsmid, J. E. Giutronich, and M. M. Kaila (New South Wales, University, Kensington, Australia). *Solar Energy*, vol. 24, no. 5, 1980, p. 435-440. 7 refs.

The possibility of using thermocouples made from Bi₂Te₃ alloys in solar thermoelectric generators is investigated. Experiments have

been carried out for two systems. The first employs a commercial thermoelectric module operating at the relatively low source temperatures that can be achieved with a flat plate collector. The second system uses an asymmetric stationary concentrator with thermocouples fabricated so as to withstand higher temperatures. Present overall efficiencies are less than one percent but this could rise to about three percent with improvements in the concentration system. (Author)

A80-43482 Cusp mirror - Heat pipe evacuated tubular solar thermal collector. U. Ortabasi and F. P. Fehlner (Corning Glass Research and Development Laboratories, Corning, N.Y.). *Solar Energy*, vol. 24, no. 5, 1980, p. 477-489. 22 refs. Contract No. EY-76-C-02-2608.

A solar thermal collector was constructed based on an internal 1.15 X cusp concentrator, thermal insulation involving a vacuum and selective absorber, and thermal transfer to a manifold via heat-pipe action. Performance of the collector was compared with that of an evacuated, selectively coated, flat-plate absorber equipped with flow-through heat transfer. It was shown that with single collector tubes, mirror losses lowered the optical efficiency of the cusp, heat-pipe collector below that of the flat plate, while the smaller absorber area of the heat pipe reduced thermal losses at absorber temperatures above ambient. Thus, a crossover in efficiency occurred such that the flat plate was more efficient at low Delta T/H while the cusp-heat pipe was more efficient at high Delta T/H. The testing of modules showed that manifold losses and gains could dominate these collector effects when the collector area approximately equaled the manifold area. (Author)

A80-43484 The economics of solar heating - A note on the appropriate discount rate and the use of the pay back period. J. M. Sulock (North Carolina, University, Asheville, N.C.). *Solar Energy*, vol. 24, no. 5, 1980, p. 505, 506. 5 refs.

A80-43485 On a class of axisymmetric concentrators with uniform flux concentration for photovoltaic applications. U. H. Kurzweg (Florida, University, Gainesville, Fla.). *Solar Energy*, vol. 24, no. 5, 1980, p. 507-509. 5 refs.

Substantial cost reduction in photovoltaic conversion of solar energy can be achieved by means of solar concentrators. However, the concentrators must be inexpensive as compared to the cost of an equivalent area of solar cells, have concentration ratios in the range of ten to several hundred suns, and must be capable of providing a uniform flux density over each of the individual solar cells of an array of optimal conversion efficiency. In the present paper, some new configurations which meet these requirements are proposed. V.P.

A80-43486 Transmission of diffuse radiation through CPC and flat plate collector glazings. M. J. Brandemuehl and W. A. Beckman (Wisconsin, University, Madison, Wis.). *Solar Energy*, vol. 24, no. 5, 1980, p. 511-513.

Solar-collector glazings reduce convective losses from the absorber to the environment and protect the absorber from dust and other contaminants. Expressions for the transmittance of a glazing system as a function of the angle of incidence are currently available. To obtain the transmittance of a glazing system for diffuse radiation, the expressions must be integrated numerically over the appropriate range of incidence angles. A compound parabolic collector (CPC) accepts diffuse radiation over a lune-shaped segment of the hemisphere, while a tilted flat plate collector receives one level of diffuse radiation from the sky and a different level from the ground. In the present paper, effective beam radiation incidence angles are calculated for these two collector types. V.P.

A80-43513 Infrared spectra of the hydrogenated amorphous silicon layers on metallic substrates of solar absorbers. D. E.

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Soule (Argonne National Laboratory, Argonne, Ill.; Western Illinois University, Macomb, Ill.) and G. T. Reedy (Argonne National Laboratory, Argonne, Ill.). In: *Metallurgical coatings 1979; Proceedings of the Sixth International Conference, San Diego, Calif., April 23-27, 1979. Volume 1.* Lausanne, Elsevier Sequoia, S.A., 1979, p. 175-181. 10 refs. Research supported by the U.S. Department of Energy.

A80-43514 **Optical and topographical properties of selective black chrome.** P. K. Gogna and K. L. Chopra (Indian Institute of Technology, New Delhi, India). In: *Metallurgical coatings 1979; Proceedings of the Sixth International Conference, San Diego, Calif., April 23-27, 1979. Volume 1.* Lausanne, Elsevier Sequoia, S.A., 1979, p. 183-187. 5 refs.

The optical and surface topographical properties of black chrome deposited onto differently treated substrates were investigated to study the effect of substrate surface roughness. Coatings with a solar absorptance of 0.94 and a thermal emittance of 0.14 at 100 C were obtained on steel substrates with dull nickel overlayers and anodically etched nickel overlayers. A polarimetric technique was employed to study the angular dependence of the reflectance of the coatings. (Author)

A80-43516 **The design and fabrication of high efficiency thin film CdS/Cu₂S solar cells.** R. B. Hall and J. D. Meakin (Delaware University, Newark, Del.). In: *Metallurgical coatings 1979; Proceedings of the Sixth International Conference, San Diego, Calif., April 23-27, 1979. Volume 1.* Lausanne, Elsevier Sequoia, S.A., 1979, p. 203-211. 18 refs. Contract No. EG-77-C-03-1576-2.

Thin film photovoltaic cells of CdS/Cu₂S which exhibit conversion efficiencies in excess of 9% have been designed and fabricated. Specific cell designs are prepared from an analysis of optical and electronic loss mechanisms operative in the cell. Material and engineering modifications to the fabrication process are then made to minimize specific energy conversion losses. The present cell design consists of five thin film layers which are sequentially prepared on a copper substrate 35 microns thick. In addition to the material control required for each component layer, the electrical, chemical, mechanical and topological compatibilities at the interfaces between each adjoining layer must be assured to achieve the desired cell performance. The present analysis shows that a fully optimized solar cell based on a CdS/Cu₂S junction will have a practical conversion efficiency limit of about 11%. It is anticipated that practical conversion efficiencies of 14-15% can be achieved utilizing a (CdZn)S/Cu₂S junction designed to produce the maximum open-circuit voltage possible using Cu₂S as the absorbing layer. Present cell results which incorporate this design are presented. (Author)

A80-43528 **A field ion microscope study of microstructural features of solar collector coatings.** O. T. Inal and W. Yarbrough (New Mexico Institute of Mining and Technology, Socorro, N. Mex.). In: *Metallurgical coatings 1979; Proceedings of the Sixth International Conference, San Diego, Calif., April 23-27, 1979. Volume 2.* Lausanne, Elsevier Sequoia, S.A., 1979, p. 129-141. 12 refs. Contract No. ER-78-04-4226.

The nucleation and growth characteristics of the systems electroplated nickel on stainless steel and black chrome on nickel were investigated for thin coverages and for thick coverages utilizing the techniques of field ion microscopy (FIM) and scanning electron microscopy (SEM). The SEM study shows that increasing the plating voltage and/or decreasing the nickel concentration in the plating bath produces finer overgrowths in the nickel/stainless steel system, whereas this trend is reversed for black chrome electroplatings on nickel field emission end forms. FIM analysis of the plated growths shows an epitaxial attachment at thin coverages (less than 50 atomic layers), while at thicker deposits (greater than 50 atomic layers) the overgrowth goes through a zone of excessive defect structure to a polycrystalline layer of the plated material with its own lattice

structure. These results are consistent with earlier studies of Cu/W systems utilizing the deposition of copper through cementation, electroplating and flash evaporation. (Author)

A80-43583 **An induced back surface field solar cell employing a negative barrier metal-insulator-semiconductor contact.** N. G. Tarr, D. L. Pulfrey (British Columbia University, Vancouver, Canada), and P. A. Iles (Applied Solar Energy Corp., City of Industry, Calif.). *Journal of Applied Physics*, vol. 51, July 1980, p. 3926-3929. 12 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada.

A80-43589 **A computer analysis of heteroface solar cells with ultrathin window layer.** A. Yoshikawa (Chiba University, Chiba, Japan). *Journal of Applied Physics*, vol. 51, July 1980, p. 3990-3992. 8 refs. Research supported by the Sakkokoi Foundation.

A computer analysis of heteroface solar cells with thin window layer has been performed regarding the effects of multiple reflections in the window layer, as well as in antireflection layers. It is shown that the thickness of the window layer greatly affects the reflection characteristic of the cell, and there is an optimum thickness for the window, so the window layer thickness must be defined so as to minimize the reflection loss, as well as the absorption loss by the window. (Author)

A80-43761 **Grain boundary defects in thin semicrystalline material.** Z. C. Putney and W. F. Regnault (Semix, Inc., Gaithersburg, Md.). (*Photovoltaic Material and Device Measurement Workshop, Arlington, Va., June 11-13, 1979.*) *Solar Cells*, vol. 1, May 1980, p. 285-292.

The effects of grain boundaries on the electrical performance of semicrystalline silicon solar cells were investigated. It was found that there are at least three distinct types of grain boundaries. Type 1 is present in high efficiency cells and has little or no effect on the cell's performance. Type 2 is characterized by an ohmic shunting of the cell, possibly due to diffusion which has proceeded along open grain boundaries. This type of grain is also characterized by an enhanced red-to-blue ratio. Type 3 grain boundaries also lead to a shunted cell but in this case the shunting mechanism is apparently due to generation-recombination centers in the depletion region. Several experimental techniques were employed to substantiate these conclusions. (Author)

A80-43762 **Grain boundary effects and conduction mechanism studies in chromium metal-insulator-silicon solar cells on polycrystalline silicon.** W. A. Anderson, K. Rajkanan (New York State University, Buffalo, N.Y.), A. E. Delahoy, and S. L. Hyland (Rutgers University, Piscataway, N.J.). (*Photovoltaic Material and Device Measurement Workshop, Arlington, Va., June 11-13, 1979.*) *Solar Cells*, vol. 1, May 1980, p. 305-310. 7 refs. Contract No. ET-78-R-03-1876.

Chromium metal-insulator-silicon (MIS) solar cells fabricated on Wacker polycrystalline silicon and electron-beam-deposited thin film silicon were studied to determine current flow mechanisms. Wacker polycrystalline p-type silicon was shown to produce MIS solar cells which exhibit surface-state-controlled current for T greater than 150 K and tunneling-controlled current at lower temperatures. MIS cells on unpolished Wacker silicon are clearly space charge limited. Electron-beam-deposited polycrystalline silicon 20-30-microns thick has a conductivity which may be limited by the grain boundary trap density or the availability of free carriers. Surface state analysis, laser scan data and diffusion length studies also show the limitations which exist at grain boundaries of polycrystalline silicon. (Author)

A80-43763 **Noise spectral density as a device reliability estimator.** J. Dubow and C. Osterwald (Colorado State University, Fort Collins, Colo.). (*Photovoltaic Material and Device Measurement Workshop, Arlington, Va., June 11-13, 1979.*) *Solar Cells*, vol. 1, May 1980, p. 315-319. 10 refs.

The measurement of noise spectral density is proposed as an estimator of solar cell device reliability. The use of associated temperature and bias stresses is investigated as a nondestructive rapid test method. A novel technique which employs the cooling rather than the heating of the device was utilized. In certain cases the predominant failure mechanisms may be derived. Data are presented on indium-tin oxide/silicon as well as p-n junction devices. (Author)

A80-43764 Measurement techniques in thin film polycrystalline materials and devices /solar cells/. H. K. Charles, Jr., R. J. King, and A. P. Ariotedjo (PRC Energy Analysis Co., McLean, Va.). (*Photovoltaic Material and Device Measurement Workshop, Arlington, Va., June 11-13, 1979.*) *Solar Cells*, vol. 1, May 1980, p. 327-346. 53 refs. Contract No. EG-77-C-01-4024.

Measurement techniques used in the analysis of polycrystalline thin film materials and devices are surveyed to determine the most widely applied thin film resistivity and Hall effect measurement methods. Measurement techniques for other relevant parameters (e.g. minority carrier lifetime, diffusion length, etc.) are also identified, and an estimate of their efficiency in yielding results (i.e. parameter values) for thin films consistent with overall device performance is made. V.T.

A80-43836 * Implications for the UK of solar-power satellites /s.p.s./ as an energy source. R. M. Shelton (British Aerospace, Dynamics Group, Filton, Glos., England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 5, June 1980, p. 336-343. 13 refs. Research supported by the U.S. Department of Energy and NASA.

The solar power satellite concept which would make the sun's radiation available on earth as a source of energy, is discussed. Attention is given to the concept currently under evaluation in the USA, and also in Europe, though to a lesser extent. The advantages and problems associated with its adoption by the UK as a major source of electrical energy are discussed. The discussion covers topics such as sizing, reference system, and construction, costs, and problem areas. M.E.P.

N80-22774*# Florida Solar Energy Center. Cape Canaveral. **SOLAR HEATING AND COOLING DEMONSTRATION PROJECT AT THE FLORIDA SOLAR ENERGY CENTER Final Report**
Feb. 1980 175 p refs Sponsored in part by NASA
(Contract EG-77-A-01-4074)
(NASA-CR-161413) Avail: NTIS HC A08/MF A01 CSCL 10A

The retrofitted solar heating and cooling system installed at the Florida Solar Energy Center is described. The system was designed to supply approximately 70 percent of the annual cooling and 100 percent of the heating load. The project provides unique high temperature, nonimaging, nontracking, evacuated tube collectors. The design of the system was kept simple and employs five hydronic loops. They are energy collection, chilled water production, space cooling, space heating and energy rejection. Information is provided on the system's acceptance test results operation, controls, hardware and installation, including detailed drawings. R.E.S.

N80-22781*# Interactive Resources, Inc., Point Richmond, Calif. **SOLAR PROCESS WATER HEAT FOR THE IRIS IMAGES CUSTOM COLOR PHOTO LAB Final Report**
Mar. 1980 126 p Sponsored by NASA. Marshall Space Flight Center.
(Contract EX-76-C-01-2381)
(NASA-CR-161414) Avail: NTIS HC A07/MF A01 CSCL 10B

The solar facility located at a custom photo laboratory in Mill Valley, California is described. It was designed to provide 59 percent of the hot water requirements for developing photographic film and domestic hot water use. The design load is to provide 6 gallons of hot water per minute for 8 hours per

working day at 100 F. It has 640 square feet of flat plate collectors and 360 gallons of hot water storage. The auxiliary back up system is a conventional gas-fired water heater. Site and building description, subsystem description, as-built drawings, cost breakdown and analysis, performance analysis, lessons learned, and the operation and maintenance manual are presented. R.E.S.

N80-22784*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HANDBOOK OF SOLAR ENERGY DATA FOR SOUTH-FACING SURFACES IN THE UNITED STATES. VOLUME 2: AVERAGE HOURLY AND TOTAL DAILY INSOLATION DATA FOR 235 LOCALITIES. ALASKA - MONTANA

Jeff H. Smith 15 Jan. 1980 473 p Sponsored by NASA and DOE, Washington, D. C. 3 Vol.
(NASA-CR-162999; DOE/JPL-1012-25-Vol-2;
JPL-Pub-79-103-Vol-2) Avail: NTIS HC A20/MF A01 CSCL 10A

Average hourly and daily total insolation estimates for 235 United States locations are presented. Values are presented for a selected number of array tilt angles on a monthly basis. All units are in kilowatt hours per square meter. R.C.T.

N80-22785*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HANDBOOK OF SOLAR ENERGY DATA FOR SOUTH-FACING SURFACES IN THE UNITED STATES. VOLUME 3: AVERAGE HOURLY AND TOTAL DAILY INSOLATION DATA FOR 235 LOCALITIES. NORTH CAROLINA - WYOMING

Jeff H. Smith 15 Jan. 1980 476 p Sponsored by NASA and DOE, Washington, D. C. 3 Vol.
(NASA-CR-163000; DOE/JPL-1012-25-Vol-3;
JPL-Pub-79-103-Vol-3) Avail: NTIS HC A21/MF A01 CSCL 10A

The daily and hourly profiles used to compute total insolation data for 235 locations in the United States are presented. R.C.T.

N80-22791*# Department of Energy, Washington, D. C. Energy Storage Systems Div.

SOLAR APPLICATIONS ANALYSIS FOR ENERGY STORAGE

T. Blanchard In NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 43-46

Avail: NTIS HC A99/MF A01 CSCL 10B

The role of energy storage as it relates to solar energy systems is considered. Storage technologies to support solar energy applications, the status of storage technologies, requirements and specifications for storage technologies, and the adequacy of the current storage research and development program to meet these requirements are among the factors discussed. Emphasis is placed on identification of where the greatest potential exists for energy storage in support of those solar energy systems which could have a significant impact on the U.S. energy mix. J.M.S.

N80-22821*# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

THE SERI SOLAR ENERGY STORAGE PROGRAM

Robert J. Copeland, John D. Wright, and Charles E. Wyman In NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 361-374 refs
Avail: NTIS HC A99/MF A01 CSCL 10A

In support of the DOE thermal and chemical energy storage program, the solar energy storage program (SERI) provides research on advanced technologies, systems analyses, and assessments of thermal energy storage for solar applications in support of the Thermal and Chemical Energy Storage Program of the DOE Division of Energy Storage Systems. Currently, research is in progress on direct contact latent heat storage and thermochemical energy storage and transport. Systems analyses are being performed of thermal energy storage for solar thermal

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applications, and surveys and assessments are being prepared of thermal energy storage in solar applications. A ranking methodology for comparing thermal storage systems (performance and cost) is presented. Research in latent heat storage and thermochemical storage and transport is reported. A.R.H.

N80-22839# California Univ., Livermore. Lawrence Livermore Lab.

SOLAR-HEATED GAS-TURBINE PROCESS USING SULFUR OXIDES FOR POWER PRODUCTION AND ENERGY STORAGE M.S. Thesis

George Kohler Tyson, Scott Lynn, and Alan Foss Sep. 1979 108 p refs

(Contract W-7405-eng-48)

(LBL-9472) Avail: NTIS HC A06/MF A01

If any system of solar power generation is to provide a significant fraction of the power requirements of a community, some means of economical energy storage must be used. A process configuration using the heat of reaction of 2 SO₃ reversible 2 SO₂ + O₂ for energy storage was developed and evaluated. The process uses the sulfur oxides directly in a gas turbine in a hybrid Brayton-Rankine cycle to produce electricity. Heat for the system is supplied during sunlit hours by a field of heliostats focused on a central solar receiver. When sunlight is not available, the storage system provides the heat to drive the gas turbine. An efficient process configuration for this power cycle is proposed. Detailed material and energy balances are presented for a base case that represents a middle range of expected operating conditions. The average cost of the electricity produced is estimated to be 7.7 cents/kWh/sub e/hr. DOE

N80-22843# Institute of Gas Technology, Chicago, Ill. **LITHIUM-METAL SULFIDE AND SODIUM-SULFUR BATTERIES FOR SOLAR ENERGY STORAGE**

A. F. Sammells 19 Dec. 1978 12 p refs Presented at Reliability of Mater. for Solar Energy Workshop, Denver, Colo., 18 Dec. 1978

(Contract EC-77-C-02-4235)

(CONF-781228-3) Avail: NTIS HC A02/MF A01

The need for low-cost advanced batteries for solar energy storage is discussed, and the characteristics of the title batteries are described. The emphasis of the paper is on the status of materials problems associated with these batteries, including electrodes, current collectors, seals, and interelectrode spacing means. DOE

N80-22851# Waterloo Univ. (Ontario).

METHODS FOR REDUCING HEAT LOSSES FROM FLAT PLATE SOLAR COOLLECTORS, PHASE 3 Final Report, 1 May 1977 - 31 Jan. 1979

K. G. T. Hollands, G. D. Raithby, F. B. Russell, and R. G. Wilkinson Mar. 1979 88 p refs

(Grant EY-76-G-02-2597)

(COO-2597-5) Avail: NTIS HC A05/MF A01

The present study extends earlier studies by examining the effect of the emissivities of both the absorber plate and the glass cover on the honeycomb's ability to suppress free convection, and on the radiative and conductive heat transfer which takes place across the honeycomb in the absence of free convection. By means of heat transfer measurements on ten Mylar honeycomb, it is shown that the effect of the above emissivities on the suppression of convection by the honeycomb is slight and can probably be ignored. On the other hand, the measurements also showed that the effect of these emissivities on the nonconvective heat transfer is substantial, but not nearly so large as would have been predicted by existing theories. To explain this latter result theories were developed which take into account the important coupling (ignored by previous theories) between the conductive and radiative modes of heat transfer. These new theories predict the measured heat transfer rates to within about $\pm 15\%$, depending on the emissivities. The results have direct application to evaluating solar collectors which combine a selective surface with a honeycomb. DOE

N80-22856*# IBM Federal Systems Div., Huntsville, Ala. **SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR FERN, TUNKHANNOCK, PENNSYLVANIA Contractor Report, May 1978 - Apr. 1979** Jan. 1980 81 p refs Sponsored in part by DOE (Contract NAS8-32036) (NASA-CR-161392) Avail: NTIS HC A05/MF A01 CSCL 10A

The operational and thermal performance of a variety of solar systems installed in operational test sites are described. The analysis is based on instrumented system data monitored and collected for at least one full season of operation. The long-term field performance of the installed system is reported, and technical contributions to the definition of techniques and requirements for solar energy system design are made. The solar energy system was designed to supply space heating and domestic hot water for single-family residences. The system consists of air flat plate collectors, storage tank, pumps, heat exchangers, associated plumbing, and controls. F.O.S.

N80-22857# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottonbrunn (West Germany). Unternehmensbereich Raumfahrt.

DEVELOPMENT AND PREPARATION FOR SERIES PRODUCTION OF A MODULAR SOLAR SPACE HEATING SYSTEM, PHASES 1 AND 2 Final Summary Report

Ruediger Elchlepp, Herbert Grallert, Veit Merges, and Karl-Heinz Ott May 1979 247 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.

(BMFT-FB-T-79-02) Avail: NTIS HC A11/MF A01; Fachinformationszentrum Energie, Phys., Math., Eggenstein-Leopoldshafen, West Germany DM 51.45

A modular solar space heating system for residential use at central European latitudes was examined experimentally. Technical as well as economic factors were included. The system selected for the experimental test consisted of flat plate solar collectors and cubic water tanks for energy storage. Two test houses in Germany were equipped with this system, both of them single-family houses. One of these houses is a special, newly constructed prefabricated home, the other was retrofitted with the system. Results are presented. Author (ESA)

N80-22860# Stuttgart Univ. (West Germany). Inst. fuer die Technische Nutzung Solarer Energie.

TECHNICAL APPLICATIONS OF SOLAR ENERGY Final Report

Abdelraouf Arafa, Wolfgang Arndt, and Gerhard Bilger Bonn Bundesmin. fuer Forsch. u. Technol. Jul. 1979 272 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.

(BMFT-FB-T-79-06) Avail: NTIS HC A12/MF A01; Fachinformationszentrum Energie, Phys., Math., Eggenstein-Leopoldshafen, West Germany DM 56.70

Experimental and theoretical investigations of the conversion of solar energy are presented, including: laboratory investigations with flat plate water collectors; hot water heat storage; development and measurements of selective surfaces; thermoelectric energy conversion; measurements of meteorological and radiation data; data acquisition; outdoor testing of water and air flat plate collectors; and measurement of the energy balance in a solar house. Photovoltaic experiments with flat and concentrating generators, a system study on photovoltaic systems, hybrid flat plate collectors (thermal and photovoltaic), and technology of Cu₂S-CaS thin film solar cells are included. The improvement of solar cell use by light conversion with luminescent substances and time resolved measurement of the global radiation spectrum is also considered. Author (ESA)

N80-22864# National Technical Information Service, Springfield, Va.

SOLAR SPACE HEATING AND AIR CONDITIONING, VOLUME 3. CITATIONS FROM THE NTIS DATA BASE Progress Report, Sep. 1977 - Sep. 1978

Audrey S. Hundemann Dec. 1979 99 p (PB80-801707) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

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Design, technical feasibility, performance, and economic factors pertaining to solar heating and cooling of buildings are discussed. Commercial buildings, schools, and residential buildings are covered, with emphasis on the assessment of solar heating and cooling systems for residential buildings. Solar energy as a national energy resource, solar energy research program alternatives, and social, environmental, and institutional factors affecting the feasibility of using solar energy for heating and cooling buildings are included. This updated bibliography contains 90 abstracts, none of which are new entries to the previous edition. GRA

N80-22865# National Technical Information Service, Springfield, Va.

SOLAR SPACE HEATING AND AIR CONDITIONING, VOLUME 3. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, Sep. 1977 - Oct. 1979

Audrey S. Hundemann Dec. 1979 153 p Supersedes NTIS/PS-78/1017; NTIS/PS-77/0829; NTIS/PS-76/0728 (PB80-801723; NTIS/PS-78/1017; NTIS/PS-77/0829; NTIS/PS-76/0728) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Citations from worldwide literature on the use of solar energy to heat and cool buildings are presented, with emphasis on the heating and cooling of residential buildings, and performance simulation studies are cited. Abstracts pertaining to solar assisted heat pump systems and assessment of solar heated Rankine cycle cooling are included. This updated bibliography contains 146 abstracts, 49 of which are new entries to the previous edition. GRA

N80-22866# National Technical Information Service, Springfield, Va.

SOLAR SPACE HEATING AND AIR CONDITIONING, VOLUME 4. CITATIONS FROM THE NTIS DATA BASE Progress Report, Oct. 1978 - Oct. 1979

Audrey S. Hundemann Dec. 1979 235 p Supersedes NTIS/PS-78/1015; NTIS/PS-77/0827; NTIS/PS-76/0727; NTIS/PS-75/689; NTIS/PS-75/345 (PB80-801715; NTIS/PS-78/1015; NTIS/PS-77/0827; NTIS/PS-76/0727; NTIS/PS-75/689; NTIS/PS-75/345) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Design, technical feasibility, performance, and economic factors pertaining to solar heating and cooling of buildings are discussed. Commercial buildings, schools, and residential buildings are covered, with emphasis on the assessment of solar heating and cooling systems for residential buildings. Solar energy as a national energy resource, solar energy research program alternatives, and social, environmental, and institutional factors affecting the feasibility of using solar energy for heating and cooling buildings are included. This updated bibliography contains 226 abstracts, all of which are new entries to the previous edition. GRA

N80-22867# National Technical Information Service, Springfield, Va.

PASSIVE SOLAR SPACE HEATING AND COOLING, CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Oct. 1979

Audrey S. Hundemann Dec. 1979 50 p (PB80-801749) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Studies from worldwide literature on the passive solar heating and cooling of buildings are discussed. Abstracts cover design and performance simulation studies of trombe walls and air thermo-siphon solar heating systems. This report contains 45 abstracts. GRA

N80-22868# National Technical Information Service, Springfield, Va.

PASSIVE SOLAR SPACE HEATING AND COOLING, CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Oct. 1979

Audrey S. Hundemann Dec. 1979 66 p (PB80-801731) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Design, technical feasibility, performance, and economic factors pertaining to passive solar heating and cooling of buildings are discussed. Abstracts cover trombe walls and air thermo-siphon solar heating systems, comparative economics of passive and active systems, and performance simulation studies. Contains 58 abstracts. GRA

N80-22869# National Technical Information Service, Springfield, Va.

OPTICAL COATINGS FOR SOLAR CELLS AND SOLAR COLLECTORS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report 1970 - Dec. 1979

Brian Carrigan Jan. 1980 230 p Supersedes NTIS/PS-78/1342 (PB80-803794; NTIS/PS-78/1342) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

This bibliography of worldwide journal literature cites reports on materials and research for the development of selective coatings for solar energy conversion devices. These materials include types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Most studies concern antireflection, thermal control, or reflective coatings. Coatings which act as optical filters are also covered. This updated bibliography contains 223 abstracts, 54 of which are new entries to the previous edition. GRA

N80-22870# National Technical Information Service, Springfield, Va.

OPTICAL COATINGS FOR SOLAR CELLS AND SOLAR COLLECTORS, VOLUME 1. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - 1978

Brian Carrigan Jan. 1980 248 p (PB80-803778) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

Materials and research for the development of selective coatings for solar energy conversion devices are described in these citations. These materials include types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Most studies concern antireflection, thermal control, or reflective coatings. Coatings which act as optical filters are also covered. This updated bibliography contains 241 abstracts, none of which are new entries to the previous edition. GRA

N80-22871# National Technical Information Service, Springfield, Va.

OPTICAL COATINGS FOR SOLAR CELLS AND SOLAR COLLECTORS, VOLUME 2. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979

Brian Carrigan Jan. 1980 47 p Supersedes NTIS/PS-78/1341; NTIS/PS-77/1036; NTIS/PS-76/0855; NTIS/PS-75/692; NTIS/PS-75/137

(PB80-803786; NTIS/PS-78/1341; NTIS/PS-77/1036; NTIS/PS-76/0855; NTIS/PS-75/692; NTIS/PS-75/137) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

The different development towards selective coating for solar energy conversion devices are described. This includes types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Most studies concern antireflection, thermal control, or reflective coatings. Coatings which act as optical filters are also covered. This updated bibliography contains 40 abstracts, all of which are new entries to the previous edition. GRA

N80-22872# National Technical Information Service, Springfield, Va.

CADIUM SULFIDE SOLAR CELLS, VOLUME 2. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1978 - Nov. 1979

Brian Carrigan Dec. 1979 43 p Supersedes NTIS/PS-78/1213; NTIS/PS-77/7051; NTIS/PS-76/0929; NTIS/PS-75/693 and NTIS/PS-75/089 (PB80-802226; NTIS/PS-78/1213; NTIS/PS-77/1051; NTIS/PS-76/0929; NTIS/PS-75/693; NTIS/PS-75/089) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

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Citations from Federally-funded research on cadmium sulfide solar cell theory, design, development, fabrication, and degradation are presented. Studies include junctions with thin films of copper sulfide, selenides, and tellurides. The performance, testing, analysis, efficiency, and costs of these cells are covered. This updated bibliography contains 35 abstracts, 22 of which are new entries to the previous edition. GRA

N80-22873# National Technical Information Service, Springfield, Va.

CADMIUM SULFIDE SOLAR CELLS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Nov. 1979

Brian Carrigan Dec. 1979 233 p Supersedes NTIS/PS-78/1214; NTIS/PS-77/1052 and NTIS/PS-76/0930 (PB80-802234; NTIS/PS-78/1214; NTIS/PS-77/1052; NTIS/PS-76/0930) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

Worldwide research on cadmium sulfide solar cell design, development, fabrication, heterojunctions, doping, and performance are cited in this bibliography. Studies on defects, protective coatings, and arrays are included. Thin films of copper indium selenide, copper sulfide, indium phosphide, cadmium selenides, and cadmium tellurides are among those described in these photovoltaic systems. This updated bibliography contains 227 abstracts, 55 of which are new entries to the previous edition. GRA

N80-23179 Columbia Univ., New York.

OPTOELECTRONIC AND PHOTOVOLTAIC PROPERTIES OF METAL-SiO₂-SILICON TUNNELING STRUCTURES Ph.D. Thesis

Kwok Ng 1979 117 p
Avail: Univ. Microfilms Order No. 8009362

The short wave length (λ) response of near-ideal silicon Schottky barrier photodetectors was studied. It is shown that the major cause of reduced quantum efficiency in this range of λ is the collection by the metal of majority carriers photogenerated within the image force maximum. The potential barriers of ultrathin SiO₂ layers to electrons and holes tunneling between the semiconductor and the metal were measured independently on the same MOS samples. The results show that the tunnelling barriers for holes are consistently much larger than those for electrons. Metal-SiO₂-silicon (MIS) solar cells were investigated as a function of SiO₂ thickness d . Both majority carrier and minority carrier structures were studied and their performance compared for SiO₂ layers prepared under identical oxidation conditions and with identical silicon surface treatments. The short circuit current densities and the optimum conversion efficiencies for the majority carrier cells and for the minority carrier cells are given. Dissert. Abstr.

N80-23180*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

RADIATION DAMAGE IN HIGH VOLTAGE SILICON SOLAR CELLS

Irving Weinberg, Henry Brandhorst, Jr., Clifford K. Swartz, and Victor G. Weizer 1980 11 p refs Presented at 2nd European Symp. on Photovoltaic Generators in Space, Heidelberg, 15-17 Apr. 1980
(NASA-TM-81478; E-412) Avail: NTIS HC A02/MF A01 CSCL 20L

Three high open-circuit voltage cell designs based on 0.1 ohm-cm p-type silicon were irradiated with 1 MeV electrons and their performance determined to fluences as high as 10 to the 15th power/sq cm. Of the three cell designs, radiation induced degradation was greatest in the high-low emitter (HLE cell). The diffused and ion implanted cells degraded approximately equally but less than the HLE cell. Degradation was greatest in an HLE cell exposed to X-rays before electron irradiation. The cell regions controlling both short-circuit current and open-circuit voltage degradation were defined in all three cell types. An increase in front surface recombination velocity accompanied time dependent degradation of an HLE cell after X-irradiation. It was speculated that this was indirectly due to a decrease in positive

charge at the silicon-oxide interface. Modifications aimed at reducing radiation induced degradation are proposed for all three cell types. Author

N80-23500*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

FLUID CIRCULATING PUMP OPERATED BY SAME INCIDENT SOLAR ENERGY WHICH HEATS ENERGY COLLECTION FLUID

Earl R. Collins In NASA, Langley Res. Center Proc. of the 14th Aerospace Mech. Symp. May 1980 p 47-56 refs

(Contract NAS7-100)

Avail: NTIS HC A15/MF A01 CSCL 13K

The application of using a spacecraft solar powered pump terrestrially to reduce or eliminate the need for fossil fuel generated electricity for domestic solar hot water systems was investigated. A breadboard prototype model was constructed utilizing bimetal to convert thermal energy into mechanical motion by means of a toggle operated shutter mechanism. Although it did not meet expected thermal efficiency, the prototype model was sufficient to demonstrate the mechanical concept. R.E.S.

N80-23651# Los Alamos Scientific Lab., N. Mex.

DIRECT SOLAR PUMPED LASER

Howard C. Volkin Jul. 1979 33 p refs
(Contract W-7405-eng-36)

(LA-7982-MS) Avail: NTIS HC A03/MF A01

The development of a direct solar pumped laser is described. Laser operation on the phosphorescence transition T reacts with S, with a suitable dye/solvent system is described. The set of coupled rate equations that governs the solar pumping kinetics are formulated. The compatibility of the laser system with useful CW laser operation is discussed. DOE

N80-23766 Brown Univ., Providence, R. I.

SOLAR CELL HETEROJUNCTIONS INVOLVING N-CADMIUM SULFIDE AND CERTAIN P-TYPE SEMICONDUCTOR SINGLE CRYSTALS Ph.D. Thesis

Arienzo Maurizio 1979 214 p
Avail: Univ. Microfilms Order No. 8006969

The fabrication and testing of heterojunction photovoltaic solar cells of the type n-CdS/p-Ge, n-CdS/p-InP, n-CdS/p-GaAs and n-CdS/p-CdTe is described. The CdS layer was found to be single crystalline when it was grown on substrates whose lattice mismatch with CdS was less than 4%, i.e., in the case of growth on InP, GaAs and Ge. Analysis of the dark current characteristics revealed that in all of these heterojunction devices, there exists a low temperature, low bias voltage tunneling current. Analysis of the photovoltaic responses showed that they generally had respectable collection efficiencies; i.e., that the interface states did not act as recombination sites of photogenerated carriers crossing the junction. The solar energy conversion efficiency is, however, strongly influenced by interface states through the open circuit voltage and the fill factor. A maximum conversion efficiency without antireflection coating of 6.5% for n-CdS/p-InP under natural sunlight having an intensity of 74 mW/cm was observed. Dissert. Abstr.

N80-23767 Stanford Univ., Calif.

PROPERTIES OF SPUTTERED ITO/CdTe SOLAR CELLS Ph.D. Thesis

Francis Georges Courreges 1980 135 p
Avail: Univ. Microfilms Order No. 8011619

The properties of indium tin oxide/cadmium telluride (ITO/CdTe) solar cells prepared by RF sputtering of ITO on phosphorus-doped CdTe single crystals is investigated through measurements of dark and light current-voltage characteristics of ITO/CdTe heterojunctions and In/CdTe junctions and of surface photovoltage and photoluminescence of CdTe surfaces. An observed reduction in solar efficiency of ITO/CdTe solar cells with time and/or heat treatment is describable in terms of the change from a n(+)-ITO/n-CdTe/p-CdTe homojunction structure to a n(+)-ITO/p-CdTe heterojunction, characterized by high collection efficiency and poor rectifying properties. Dissert. Abstr.

N80-23771*# Spire Corp., Bedford, Mass.
**DEVELOPMENT OF PULSED PROCESSES FOR THE
 MANUFACTURE OF SOLAR CELLS** Final Report, Apr.
 1979

J. A. Minnucci Apr. 1979 238 p refs Sponsored in part by DOE

(Contract JPL-954786)

(NASA-CR-153188; DOE/JPL-954786-79/02; JPL-9950-324;
 FR-79-10052) Avail: NTIS HC A11/MF A01 CSCL 10A

Low-energy ion implantation processes for the automated production of silicon solar cells were investigated. Phosphorus ions at an energy of 10 keV and dose of 2×10 to the 15th power/sq cm were implanted in silicon solar cells to produce junctions, while boron ions at 25 keV and 5×10 to the 15th power were implanted in the cells to produce effective back surface fields. An ion implantation facility with a beam current up to 4 mA and a production throughput of 300 wafers per hour was designed and installed. A design was prepared for a 100 mA, automated implanter with a production capacity of 100 MW sub e/sq cm per year. Two process sequences were developed which employ ion implantation and furnace or pulse annealing. A computer program was used to determine costs for junction formation by ion implantation and various furnace annealing cycles to demonstrate cost effectiveness of these methods. R.E.S.

N80-23772*# Solarex Corp., Rockville, Md.
ANALYSIS OF THE EFFECTS OF IMPURITIES IN SILICON
 Final Report, 19 Jan. 1979 - 31 Jan. 1980

J. H. Wohlgemuth and M. N. Giuliano 1980 95 p refs Sponsored in part by DOE

(Contract JPL-955307)

(NASA-CR-163133; DOE/JPL-955307; JPL-9950-325) Avail:
 NTIS HC A05/MF A01 CSCL 10A

A solar cell fabrication and analysis program was conducted to determine the effects on the resultant solar cell efficiency of impurities intentionally incorporated into silicon. It was found that certain impurities such as titanium, tantalum, and vanadium were bad, even in very small concentrations. Cell performance appeared relatively tolerable to impurities such as copper, carbon, calcium, chromium, iron and nickel (in the concentration levels which were considered). R.E.S.

N80-23774*# Quality Inn of Key West, Miami Beach, Fla.
**SOLAR HOT WATER SYSTEM INSTALLED AT QUALITY
 INN, KEY WEST, FLORIDA** Final Report

Apr. 1980 25 p Sponsored in part by NASA

(Grant EG-77-G-01-1633)

(NASA-CR-161434) Avail: NTIS HC A02/MF A01 CSCL 10A

The solar energy hot water system installed in the Quality Inn, Key West, Florida, which consists of four buildings is described. Three buildings are low-rise, two-story buildings containing 100 rooms. The fourth is a four-story building with 48 rooms. The solar system was designed to provide approximately 50 percent of the energy required for the domestic hot water system. The solar system consists of approximately 1400 square feet of flat plate collector, two 500 gallon storage tanks, a circulating pump, and a controller. Operation of the system was begun in April 1978, and has continued to date with only three minor interruptions for pump repair. In the first year of operation, it was determined that the use of the solar facility resulted in forty percent fuel savings. R.E.S.

N80-23776*# Gilbert (W. E.) and Associates, Inc., Greenwood, S.C.

**SOLAR HEATING SYSTEM INSTALLED AT BLAKEDALE
 PROFESSIONAL CENTER, GREENWOOD, SOUTH CAROLINA** Final Report

Mar. 1980 33 p Sponsored in part by NASA

(Contract EX-76-C-01-2389)

(NASA-CR-161435) Avail: NTIS HC A03/MF A01 CSCL 10B

Information on the solar heating system installed at the Blakedale Professional Center, in Greenwood, South Carolina is presented. The information consists of site and building description,

solar system description, performance evaluation, system problems and installation drawings. The solar system was designed to provide approximately 85 percent of the building's heating requirements. The system was installed concurrently with building construction and heats 4,440 square feet of the building. There are 954 square feet of liquid flat plate collectors that are roof-mounted and have a drain-down system to protect the collectors from freezing. A 5,000 gallon steel, polyurethane insulated tank buried underground provides storage. The system was fully instrumented for performance evaluation and integrated into the National Solar Data Network. R.E.S.

N80-23777*# National Aeronautics and Space Administration,
 Lewis Research Center, Cleveland, Ohio.

REDOX STORAGE SYSTEMS FOR SOLAR APPLICATIONS

Norman H. Hagedorn and Lawrence H. Thaller 1980 28 p refs Proposed for presentation at Power Sources Conf., Brighton, England, 15-18 Sep. 1980

(Contract EF-77-A-31-1002)

(NASA-TM-81464; DOE/NASA/1002-80/5; E-383) Avail:
 NTIS HC A03/MF A01 CSCL 10A

The NASA Redox energy storage system is described. The system is based on soluble aqueous iron and chromium chloride redox couples. The needed technology advances in the two elements (electrodes and membranes) that are key to its technological feasibility have been achieved and system development has begun. The design, construction, and test of a 1 kilowatt system integrated with a solar photovoltaic array is discussed. R.E.S.

N80-23791# Hittman Associates, Inc., Columbia, Md.,

SOLAR APPLICATIONS OF THERMAL ENERGY STORAGE
 Final Report

C. Lee, L. Taylor, A. J. DeVries, and S. Heibein Jan. 1979
 158 p refs

(Contract EM-78-C-01-4275)

(TID-29430) Avail: NTIS HC A08/MF A01

The preparation technology assessment on solar energy systems which use thermal energy storage was studied. The characterization of the current state-of-the-art of thermal energy storage, an assessment of the energy storage needs of solar energy systems, and the synthesis of this information into preliminary design criteria which would form the basis for detailed designs of thermal energy storage are included. Since the goal of the solar thermal energy storage program is to provide optimum storage units for solar thermal energy systems, the focus was on storage concepts that are either commercially available or will be commercially available by 1979. DOE

N80-23792# Department of Energy, Washington, D. C. Office
 of Energy Technology.

NOAA'S ROLE IN THE SOLAR ENERGY PROGRAM Annual
 Report, 1978

Aug. 1979 244 p refs

(DOE/ET-0110) Avail: NTIS HC A11/MF A01

The efforts of the National Oceanic and Atmospheric Administration toward monitoring and documenting the USA solar radiation and related weather data are reported. A format to be used for transfer and processing of related solar data sets is presented. Solar radiation maps of the U.S. for total and direct radiation on a monthly and annual basis are presented and discussed. A section on solar and climatic data applied to subdivisions of the U.S. that are quasi-homogeneous in solar radiation heating demand and topography is included. A listing of the periods of record of all available wind observations in the National Climatic Center's meteorological archives is given. The computational of extra-terrestrial solar radiation, solar evaluation angle, and true solar time of sunrise and sunset is described. Also, research on the effects of aerosols and clouds on solar radiation is described. DOE

N80-23798# Midwest Research Inst., Golden, Colo. Solar
 Energy Research Inst.

**SOLAR ENERGY PROGRAM EVALUATION: AN INTRODU-
 CTION**

Peter deLeon Sep. 1979 112 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-51-294) Avail: NTIS HC A06/MF A01

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An overview of the practice and methodology of program evaluation is presented which defines more precisely the evaluation techniques and methodologies that are the most appropriate to government organizations which are actively involved in the research, development, and commercialization of solar energy systems. There are four basic types of evaluation designs: the pre-experimental design; the quasi-experimental design based on time series; the quasi-experimental design based on comparison groups; and the true experimental design. DOE

N80-23800# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

DEVELOPMENT OF A SOLAR THERMAL RECEIVER FOR HIGH TEMPERATURE APPLICATIONS

M. Bohn and G. Bessler Nov. 1979 7 p refs Presented at the Semiann. Conf. for Adv. Solar Thermal Tech., Phoenix, Ariz., 11 Dec. 1979

(Contract EG-77-C-02-4042)

(SERI/TP-333-485; CONF-791221-1) Avail: NTIS HC A02/MF A01

A thermal receiver for point focus collectors is described. The receiver uses as a buffer between the cavity surface and the heat transfer fluid a thermal mass, which with a very small temperature drop penalty smooths the flux distribution to eliminate hot spots. The design of the receiver enables significant spillage flux at the receiver to be used. Thus, lower quality optics can be employed in applications not requiring very high temperatures. Design and construction features of the receiver are presented and the testing program is described. DOE

N80-23806# Sandia Labs., Livermore, Calif.

HELIOSTAT DESIGN COST/PERFORMANCE TRADEOFFS

Miriam J. Fish and T. A. Dellin Nov. 1979 50 p refs

(Contracts EY-76-C-04-0789; DE-AC04-76DP-00789)

(SAND-79-8248) Avail: NTIS HC A03/MF A01

The heliostat field comprises the most expensive subsystem of a solar central receiver power plant. Cost reductions might be achieved by either total heliostat redesign or component substitution in existing design. The value of changing any of several design specifications, in the current baseline glass/metal heliostat is discussed. Results are quantified in terms of the breakeven cost; i.e., the cost of a new design which will yield the same total system energy cost as the baseline system. Changes in mirror reflectivity, pointing accuracy, surface quality, canting and focusing strategy, heliostat size, and stow requirements were evaluated. DOE

N80-23810# California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Molecular Research Div.

METAL FOILS FOR DIRECT APPLICATION OF ABSORBER COATINGS ON SOLAR COLLECTORS

Carl M. Lampert Aug. 1979 19 p refs Presented at the 2nd Am. Electroplaters Soc. Symp. on Coatings for Solar Collectors, St. Louis, 16-17 Oct. 1979

(Contract W-7405-eng-48)

(LBL-9324-Rev; CONF-791021-1-Rev) Avail: NTIS HC A02/MF A01

The basic materials and processing associated with the production of coated metal foils for solar collector absorber surfaces are discussed. Also covered are details of heavier metal strips for direct fabrication of solar collectors. Techniques including bonding methods and the use of adhesive are surveyed. Commercial solar foil manufacturers are covered along with the research efforts in this area. In conclusion, advantages and disadvantages are outlined, with specific recommendations. DOE

N80-23811# Monsanto Research Corp., Dayton, Ohio.

LOW-COST MIRROR CONCENTRATOR BASED ON DOUBLE-WALLED METALLIZED, TUBULAR FILMS

Semiannual Technical Progress Report, 20 Aug. 1978 - 19 Feb. 1979

J. W. Leffingwell, G. L. Ball, III, J. L. Schuendeman, and T. A. Orofino 30 Mar. 1979 44 p refs

(Contract EM-78-C-04-4227)

(ALO-4227-12; SAPR-2) Avail: NTIS HC A03/MF A01

The development of a potentially, low cost, air inflatable, tubular plastic, nontracking 3X solar collector is described. The design employs joined truncated cylindrical sections which reduce both cover and mirror material requirements by 40% compared with a conventional cylindrical design. Aluminum foil-plastic laminates were selected as an alternative to aluminized polyester films because of their low cost, ease of fabrication, good durability, high strength, and acceptable reflectivity. Specially UV-stabilized and polyester scrim reinforced flexible polyvinyl chloride film was selected for use as the outer transparent cover material because of its mechanical and optical durability, acceptable transmission characteristics and its potential low cost. DOE

N80-23812# Foster Wheeler Corp., Livingston, N.J.

SOLAR PRODUCTION OF INDUSTRIAL PROCESS STEAM RANGING IN TEMPERATURE FROM 300 DEG F TO 550 DEG F, PHASE 1. VOLUME 3: APPENDICES (CONT)

Final Report, 30 Sep. - 30 Jun. 1979

30 Jun. 1979 243 p refs

(Contract ET-78-C-03-2199)

(DOE/CS-32199-3) Avail: NTIS HC A11/MF A01

The following appendices are included: (1) instruments, (2) electrical specifications, (3) protective coverings, (4) welding requirements, (5) engineering specifications, and (6) administrative. DOE

N80-23813# Foster Wheeler Corp., Livingston, N.J.

SOLAR PRODUCTION OF INDUSTRIAL PROCESS STEAM RANGING IN TEMPERATURE FROM 300 DEGREES F TO 550 DEGREES F, PHASE 1. VOLUME 2: APPENDICES

Final Report

30 Jun. 1979 232 p

(Contract ET-78-C-03-2199)

(DOE/CS-32199-2) Avail: NTIS HC A11/MF A01

The following appendices are presented: (1) equipment requisitions, (2) instrument list, (3) mechanical subcontract requisition, (4) electrical subcontract requisition, (5) site preparation and subcontract requisition, (6) building subcontract requisition, and (7) job specifications. DOE

N80-23814# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SOLAR THERMAL REPOWERING UTILITY VALUE ANALYSIS Final Report

Roger Taylor, John Day (Westinghouse Electric Corp., Pittsburgh), Brian Reed (Westinghouse Electric Corp., Pittsburgh), and Mike Malone (Westinghouse Electric Corp., Pittsburgh) Dec. 1979 225 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-8016-1) Avail: NTIS HC A10/MF A01

The value of a retrofitting central receiver energy supply systems to existing steam-electric generating stations (repowering) is assessed. The modeling tools and assumption used are described and the results are presented and interpreted. DOE

N80-23815# Alabama Univ., Huntsville. Environmental and Energy Center.

DATA HANDBOOK FOR THE NATIONAL SOLAR ENERGY DEMONSTRATION PROGRAM

David L. Christensen May 1979 97 p

(Contract EM-78-S-01-5216)

(DSE/5216-T3) Avail: NTIS HC A05/MF A01

Information is presented in a matrix format listing the technical and programmatic data concerning the various project sites selected for the National Solar Energy Demonstration Program. It incorporates the commercial, residential, and other demonstration projects which are now a part of the national program. DOE

N80-23816# Mega Analytical Research Services, Inc., Silver Spring, Md. Mega Engineering Div.

STUDY AND ANALYSIS OF A LOW COST CEMENT BONDED FLAT PLATE SOLAR COLLECTOR Final Report

Jan. 1979 136 p refs

(Contract EG-77-04-4122)

(ALO-4122-T1) Avail: NTIS HC A07/MF A01

A flat plate collector was designed and tested using low cost materials. This collector absorber plate included copper circulating tubes bonded to a flat sheet of conductive material using high service temperature, low outgassing, high conductivity adhesives. A series of candidate adhesives were evaluated. Structural and thermal tests were performed using galvanized sheet steel collector plates and aluminum collector plates with copper tubes to determine the conductivity of bond joints. The structural integrity of bond joints was evaluated under relative thermal expansion forces at various temperatures (ranging from 35 C to 300 C). Thermal cycling tests were conducted to evaluate fatigue of bond joints and to evaluate the degradation of thermal conductivity of these bond joints. A cost/performance summary was made (using F-chart) to determine the potential cost savings realized compared with conventional systems. DOE

N80-23817# Monsanto Research Corp., Dayton, Ohio.
NON-CONCENTRATING COLLECTORS FOR SOLAR HEATING APPLICATIONS (MEDIUM TEMPERATURE AIR HEATERS BASED ON DURABLE TRANSPARENT FILMS)
Final Report, 30 Sep. 1977 - 31 Oct. 1978

J. W. Leffingwell, J. L. Schwendeman, G. L. Ball, and T. A. Orofino Mar. 1979 143 p refs

(Contract EG-77-C-04-4147)

(ALO-4147-T1; MRC-DA-867) Avail: NTIS HC A07/MF A01

A special UV-stabilized and scrim-reinforced flexible photovoltaic conversion film was developed, characterized, and tested on an air solar heater. Solar energy transmission of early precontract 20/mil thick film was determined to be about 83% after two months outdoor Florida exposure, dropping to 78% after two years. Outdoor exposure and artificial UV aging tests indicate that a 10 year lifetime could be possible. The fabricated solar heater had a lower efficiency than predicted from computer modeling (43% for 129 F output with 62 F temperature rise at an ambient temperature of 60 F) suggesting design problems which could most easily be overcome by changing from a double-glazed non-selective absorber collector to a single-glazed-selective absorber heater. DOE

N80-23822# California Univ., Livermore. Lawrence Livermore Lab.

APPLICATION OF SHALLOW SOLAR PONDS FOR INDUSTRIAL PROCESS HEAT: CASE HISTORIES

Alan B. Casamajor 4 May 1979 13 p refs Presented at the Intern. Solar Energy Soc., Atlanta, 28 May - 1 Jun. 1979
Submitted for publication

(Contract W-7405-eng-48)

(UCRL-82367; CONF-790541-57) Avail: NTIS HC A02/MF A01

The shallow solar pond collector system is approaching commercialization. Three prototype or demonstration projects, Sohio Petroleum Company, Sweet Sue Kitchens, and Fort Benning, are described. A critique of each project points out the significant factors that affect the individual projects and shallow-solar pond technology in general. Particular attention is drawn to problems encountered and solutions proposed. Finally, possible marketing organization and strategies are discussed. DOE

N80-23826# Northeast Solar Energy Center, Cambridge, Mass.
STATUS OF INSOLATION RESOURCE ASSESSMENT IN THE NORTHEAST

Susan L. Kannenberg Dec. 1979 35 p refs

(Contract EM-78-C-01-4274)

(NESEC-6) Avail: NTIS HC A03/MF A01

The status of insolation resource assessment is described. Activities performed, services offered, and general features of solar radiation which are significant to the application of solar energy in the Northeast are summarized. DOE

N80-23827# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

OFF-PEAK ELECTRIC AUXILIARY HEAT FOR SOLAR AIR-HEATING SYSTEMS Final Report, 1 Jun. 1977 - 31 Dec. 1978

Thomas B. Jones and Paul J. Wilbur Jan. 1979 51 p refs
(Contract EG-77-S-02-4516)

(COO-4516-1) Avail: NTIS HC A04/MF A01

The performance of various solar auxiliary heating system options was examined by means of computer simulation. A storage reservoir which is separate from the solar reservoir was found to be preferable. Performance was generally not found to be sensitive to the time at which off-peak energy is available. Control schemes that predict energy requirements for a forthcoming on-peak period and account for energy in solar storage are preferable and a reservoir heater that can be staged so heating can be accomplished over the full duration of the on-peak period to supply different levels of energy is desirable. The system installed in a solar house for testing is described. DOE

N80-23836# CCB/CUMALI Associates, Oakland, Calif.

PASSIVE SOLAR CALCULATION METHODS Interim Report

15 Apr. 1979 70 p refs

(Contract EM-78-C-01-5221)

(DSE/5221-T1) Avail: NTIS HC A04/MF A01

The results accomplished under the following tasks: (1) evaluation of existing passive solar calculation methods, (2) BLAST/DOE-1 program interface and comparison with BR-202, and (3) development of analytic relationships between the thermal balance and weighting factor techniques are detailed. The various methods available for use in thermal load analysis are presented with detailed information on algorithm used in the thermal balance and weighting factor techniques. DOE

N80-23837# Bechtel National, Inc., San Francisco, Calif. Research and Engineering Operation.

DESIGN OF LOW-COST STRUCTURES FOR PHOTOVOLTAIC ARRAYS. VOLUME 2: TECHNICAL STUDIES AND APPENDICES Final Report

Nov. 1979 238 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7002-Vol-2) Avail: NTIS HC A11/MF A01

A study of low cost support structures for flat photovoltaic panels set at a fixed angle to the ground was conducted. The work began with a survey of solar system manufacturers. The results showed a diverse approach to the design of support structures and a lack of systematic design criteria. Therefore, a series of conceptual designs of support structures and their foundations were developed based on the use of concrete, steel or aluminum, and timber. A 6 MWe peak baseline photovoltaic power plant was conceptualized in order to bring a practical perspective to cost estimating for the designs. Detailed civil-structural design criteria were developed. These criteria identified loadings for normal operating conditions and extreme environmental conditions. The study results include detailed designs for eight array support structures and foundations for flat plate arrays using 8 foot wide panels with foundations spaced 20 feet apart along the rows in the east-west direction. Cost estimates for supports and foundations were shown to vary between \$2 to \$3 per square foot of supported panels (deflated to 1975 dollars). DOE

N80-23852# Toledo Univ., Ohio. College of Engineering.
PERFORMANCE IMPROVEMENT OF A SOLAR HEATING SYSTEM UTILIZING OFF-PEAK ELECTRIC AUXILIARY
Semiannual Progress Report, 18 Jun. - 31 Dec. 1979

A. H. Eltimsahy Dec. 1979 10 p

(Contract DE-FG02-79R5-10140)

(DOE/R5/10140-1) Avail: NTIS HC A02/MF A01

A solar-assisted heat pump system, which was designed, installed, and operated in an experimental solar house, is described. The heat pump system is capable of operating in a wide range of temperatures which is needed in a solar house utilizing off-peak storage from the electric utility. The complete system consists of 584.1 square feet of flat plate solar collectors, a 5 horsepower compressor, an evaporator, a condenser, thermal storage units, and associated equipment. During the installation and initial operation of the system, numerous aspects of the feasibility of the system design were evaluated. Many of these aspects point

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to the potentially improved operating performance of a solar heating system utilizing off-peak storage from the electric utility. DOE

N80-23853# Sandia Labs., Albuquerque, N. Mex.
LOW COST STRUCTURES FOR PHOTOVOLTAIC ARRAYS
H. Post 1980 6 p refs Presented at the 14th Photovoltaics Specialists Conf., San Diego, Calif., 7 Jan. 1980
(Contract EY-76-C-04-0789)
(SAND-80-0142C; CONF-800106-9) Avail: NTIS
HC A02/MF A01

The design and analysis of low cost, ground-mounted flat plate non-tracking array structures for use in large intermediate and central power station applications are described. Design requirements for the array structure, especially wind loading criteria, are discussed and problem areas associated with the integration of the module panel and support structure are identified. Support system costs which include site preparation, foundation and support structure, and installation costs are summarized. Wind effects data derived from comprehensive wind tunnel tests of flat plate array field models are presented and compared with wind loading estimates based on existing design standards. DOE

N80-23855# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SOLAR PHOTOVOLTAIC PROJECT: MATERIALS, AND TESTING ACTIVITIES Quarterly Report, 1 Apr. - 1 Jun. 1979
S. E. Foreman and M. P. Themelis 31 Oct. 1979 36 p refs
(Contract EY-76-C-02-4094)
(COO-4094-60) Avail: NTIS HC A03/MF A01

Terrestrial photovoltaic modules were tested in the field to determine the extent of physical and electrical degradation which had taken place since previous inspections. Several modules were removed from the sites for more detailed laboratory analysis. In addition degradation analysis of modules from the rooftop of the Chicago Museum of Science and Industry, and failure analysis of modules from the Lincoln Laboratory Rooftop Test Bed and Residential Test Beds was performed. The results of both field testing and the laboratory analyses are reported. DOE

N80-23856# Midwest Research Inst., Kansas City, Mo. Solar Energy Research Inst.
SOLPOND: A SIMULATION PROGRAM FOR SALINITY GRADIENT SOLAR PONDS
Jon Henderson and Cecile M. Leboeuf Jan. 1980 7 p refs
Presented at the 2nd Ann. Systems Simulation and Econ. Analysis Conf., San Diego, Calif., 23-25 Jan. 1980
(Contract EG-77-C-01-4042)
(SERI/TP-351-559; CONF-800101-4) Avail: NTIS
HC A02/MF A01

A computer simulation design tool was developed to simulate dynamic thermal performance for salinity gradient solar ponds. Dynamic programming techniques allow the user significant flexibility in analyzing pond performance under realistic load and weather conditions. Finite element techniques describe conduction heat transfer through the pond, earth, and edges. Results illustrate typical thermal performance of salinity gradient ponds. Sensitivity studies of salty pond thermal performance with respect to geometry, load, and optical transmission are included. Experimental validation of the program with an operating pond is also presented. DOE

N80-23858# Boeing Computer Services, Inc., Seattle, Wash. Energy Technology Applications Div.
DEVELOPING AND UPGRADING OF SOLAR SYSTEM THERMAL ENERGY STORAGE SIMULATION MODELS Technical Progress Report, 1 Sep. 1978 - 28 Feb. 1979
J. K. Kuhn, G. F. vonFuchs, and A. P. Zob May 1979 70 p refs
(Contract EG-77-C-02-4482)
(BCS-40252) Avail: NTIS HC A04/MF A01

The rock bed solar energy storage model selected for validation was further explored and compared to test data. Correlation

with data from different experiments is showing improvement over the correlations reported earlier. Two more water tank models were obtained. Work is continuing with model testing, validation and evaluation. Additional laboratory test data on water tank performance was obtained. Some significant improvements were made in the SOLSYS algorithm resulting in a more powerful simulation tool referred to as the extended SOLSYS model. DOE

N80-23859# Battelle Pacific Northwest Labs., Richland, Wash.
SOLAR REFLECTOR MATERIALS
M. A. Lind 1979 23 p Presented at the USPE Seminar on High-Level Solar Energy, Seattle, 18 May 1979
(Contract EY-76-C-06-1830)
(PNL-SA-7698; CONF-7905134-1) Avail: NTIS
HC A02/MF A01

A overview is given of the current state-of-the-art in solar reflector materials which outlines the uses of reflectors in the solar industry and presents some insights into the operational and materials considerations that must be incorporated into the solar reflector design. Current problem areas and research goals are also emphasized. DOE

N80-23867# National Bureau of Standards, Washington, D.C.
SOLAR ENERGY SYSTEMS: TEST METHODS FOR COLLECTOR INSULATIONS
McClure Godette, Jack Lee, and James Fearn Oct. 1979 40 p
Sponsored in part by DOE
(PB80-132038; NBSIR-79-1908) Avail: NTIS
HC A03/MF A01 CSCL 10A

A preliminary study was performed to evaluate potential procedures for screening the insulation used in collectors. Both standard test methods and newly developed non-standard procedures were used to evaluate twenty-one insulation materials. The insulation parameters measured were selected on the basis of how and to what extent they were affected by the unique environmental conditions within solar collectors. Results of the laboratory tests are discussed and those procedures which offer a potential for screening insulations used in solar collectors are presented. GRA

N80-23868# National Bureau of Standards, Washington, D. C. Structures and Materials Div.
SOLAR ENERGY SYSTEMS: STANDARDS FOR RUBBER HOSE
Robert D. Stiehler and John L. Michalak Nov. 1979 38 p
Sponsored in part by DOE
(PB80-129828; NBSIR-79-1917) Avail: NTIS
HC A03/MF A01 CSCL 10A

A study of commercial rubber hose was made to develop standards for hoses used in solar energy systems. Twelve hoses were evaluated by cycling between temperatures of about 100 C and temperatures as low as -40 C during a period of about seven months. Laboratory tests for bursting strength, compatibility with metals, compression set, ozone resistance, and water vapor transmission were also made. The results of the tests are presented. Based on these findings a standard for rubber hose used in solar energy systems is proposed. GRA

N80-23869# National Bureau of Standards, Washington, D.C.
SOLAR COLLECTOR FLUID PARAMETER STUDY Final Report, Nov. 1978 - Jun. 1979
Wallace W. Youngblood, William Schultz, and Ralph Barber Oct. 1979 130 p
(Contract EG-77-C-01-4050)
(PB80-125891; NBS-GCR-79-184) Avail: NTIS
HC A07/MF A01 CSCL 10A

A series of instantaneous thermal performance tests were performed on four differently constructed, commercially available flat plate solar collectors with each of four commonly used heat transfer fluids. The tests were designed to illustrate the magnitude of fluid parameter effects on the thermal performance of flat plate solar collectors. The configurations were selected to provide a broad variety of flow conditions. The heat transfer fluids used were as follows: (1) water; (2) an ethylene glycol (Pres-tone 11) water solution (50 percent by weight); (3) a silicone based heat transfer fluid (SLYTHERM 444); and (4) a synthetic hydrocarbon (Therminol 44). GRA

N80-24205# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

TECHNICAL INFORMATION DISSEMINATION PLAN FOR THE US DEPARTMENT OF ENERGY, ETS/SOLAR DIVISIONS

Pete Mourning, Barbara Glenn, Stephen A. Rubin, F. Floyd Shoemaker, and Rob Soto Jan. 1979 74 p
(Contract EG-77-C-01-4042)

(SERI/SP-69-071) Avail: NTIS HC A04/MF A01

A plan for a technical information dissemination (TID) program is presented, the purpose of which is to build the most effective information transfer mechanisms possible to support the earliest appropriate commercialization of solar research and development (R&D) results in five technologies: photovoltaics, solar thermal power, biomass, ocean thermal energy conversion, and wind energy conversion. Coordination, evaluation, and maximum use of ongoing information support services, information activities where the leverage effect appears reasonably high in meeting the goals of the TID program, and involvement of in house and contractor personnel in planning, evaluating, and implementing these technical information dissemination activities are described. Users of solar R&D results are to be involved in external evaluation of technical information activities in each of the five solar technologies. DOE

N80-24344# Lockheed Missiles and Space Co., Sunnyvale, Calif.

STUDY OF MULTI-kW SOLAR ARRAYS FOR EARTH ORBIT APPLICATION

30 Apr. 1980 334 p

(Contract NAS8-32981)

(NASA-CR-161453; LMSC-D715841) Avail: NTIS HC A14/MF A01 CSCL 22B

Low cost low Earth orbit (LEO) and geosynchronous Earth orbit (GEO) Solar Array concepts in the 300 to 1000 kW range which could be reduced to hardware in the mid 1980's, are identified. Size scaling factors and longer life demands are recognized as the prime drivers for the designs if low life cycle costs for energy are to be achieved. Technology is identified which requires further development in order to assure component readiness and availability. Use of the low concentration ratio (CR) concentrator, which uses gallium arsenide solar cells for both LEO and GEO applications, is recommended. E.D.K.

N80-24345# Lockheed Missiles and Space Co., Sunnyvale, Calif.

STUDY OF MULTI-kW SOLAR ARRAYS FOR EARTH ORBIT APPLICATION Progress Report, 15 Mar. 1979 - 1 Mar. 1980

21 Mar. 1980 202 p

(Contract NAS8-32981)

(NASA-CR-161452; LMSC-D715827) Avail: NTIS HC A10/MF A01 CSCL 22B

Planar and concentrator solar array configurations based on silicon and gallium arsenide solar cells were conceptualized and on-orbit maintainability was addressed. Four basic categories emerged: (1) planar (non concentrated) with silicon cells, (2) low-CR (concentration ratio = 3.4) with silicon cells, (3) low-CR with GaAs, and (4) high-CR (concentration ratio = 62.5) with GaAs. A very high-CR (concentration ratio = 200) was investigated but rejected on thermal grounds. Nonrecurring and recurring cost elements for each of the four concepts selected were compared over a 15 year life cycle. Under conditions where the gallium arsenide cells can be produced for less than \$25 per 2 x 2 cm, the low CR concentrator emerges as the most cost effective configuration. However, the producibility risk remains higher on the gallium arsenide cell. R.E.S.

N80-24495# Sandia Labs., Livermore, Calif. Solar Programs Dept.

OVERALL EFFICIENCIES FOR CONVERSION OF SOLAR ENERGY TO A CHEMICAL FUEL

J. D. Fish 1979 22 p refs Presented at the 2nd Miami Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10 Dec. 1979

(Contracts EY-76-C-04-0789; DE-AC04-76DP-00789)

(SAND-79-8636; CONF-791204-9)

Avail: NTIS

HC A02/MF A01

A complete and consistent schema for determining the overall efficiency of a generalized process for the conversion of solar energy into a chemical fuel was developed and applied to seven conversion processes. The overall efficiency of each of these processes is determined by ten common factors: maximum theoretical efficiency; inherent absorption losses; inherent internal losses; rate limiting effects; reflection losses; transmission losses; coverage losses; system construction requirements; parasitic losses; and harvesting and conversion losses. DOE

N80-24741* National Aeronautics and Space Administration, Pasadena Office, Calif.

METHOD OF MITIGATING TITANIUM IMPURITIES EFFECTS IN P-TYPE SILICON MATERIAL FOR SOLAR CELLS Patent

Amal M. Salama, inventor (to NASA) (JPL) Issued 6 May 1980 7 p Filed 31 Jan. 1979 Supersedes N79-17315 (17 - 08, p 1001) Sponsored by NASA

(NASA-Case-NPO-14635-1; US-Patent-4,210,622;

US-Patent-Appl-SN-008212; US-Patent-Class-156-605;

US-Patent-Class-156-617SP; US-Patent-Class-156-DIG.64;

US-Patent-Class-136-89SG; US-Patent-Class-252-62.3E) Avail:

US Patent and Trademark Office CSCL 10A

An economical way to reduce the deleterious effects of titanium, one of the impurities present in metallurgical grade silicon material, is disclosed. By adding copper to approximately the same concentration level of the titanium during the melting process, the conversion efficiency will be restored to about 99.3% of what it would have been if the single crystal silicon had been grown free of titanium impurities.

Official Gazette of the U.S. Patent and Trademark Office

N80-24742* PRC Systems Services Co., Huntsville, Ala.

SOLAR ARRAY SUBSYSTEMS STUDY Final Report, Mar. 1979 - May 1980

P. W. Richardson, F. Q. Miller, and M. B. Badgley 6 Jun. 1980 284 p

(Contract NAS3-21926)

(NASA-CR-159857) Avail: NTIS HC A13/MF A01 CSCL 10A

The effects on life cycle costs of a number of technology areas are examined for a LEO, 500 kW solar array. A baseline system conceptual design is developed and the life cycle costs estimated in detail. The baseline system requirements and design technologies are then varied and their relationships to life cycle costs quantified. For example, the thermal characteristics of the baseline design are determined by the array materials and masses. The thermal characteristics in turn determine configuration, performance and hence life cycle cost. Author

N80-24744* Tao (William) and Associates, St. Louis, Mo. **SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT SAINT LOUIS, MISSOURI Final Report**

Apr. 1980 68 p refs Sponsored by NASA

(Grant EG-77-G-01-4085)

(NASA-CR-161420) Avail: NTIS HC A04/MF A01 CSCL 10A

The solar heating and hot water system installed at the William Tao & Associates, Inc., office building in St. Louis, Missouri is described, including maintenance and construction problems, final drawings, system requirements, and manufacturer's component data. The solar system was designed to provide 50 percent of the hot water requirements and 45 percent of the space heating needs for a 900 sq ft office space and drafting room. The solar facility has 252 sq ft of glass tube concentrator collectors and a 1000 gallon steel storage tank buried below a concrete slab floor. Freeze protection is provided by a propylene glycol/water mixture in the collector loop. The collectors are roof mounted on a variable tilt array which is adjusted seasonally and is connected to the solar thermal storage tank by a tube-in-shell heat exchanger. Incoming city water is preheated through the solar energy thermal storage tank. R.E.S.

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N80-24745*# Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

COMPARISON OF INDOOR-OUTDOOR THERMAL PERFORMANCE FOR THE SUNPAK EVACUATED TUBE LIQUID COLLECTOR

Mar. 1980 48 p Sponsored by NASA
(Contract DEN-000006)

(NASA-CR-161421; Wyle-TR-531-40-R) Avail: NTIS HC A03/MF A01 CSCL 10A

Performance data for current Sunpak production collectors is presented. The effects of an improved manifold are seen from the test results. The test results show excellent correlation between the solar simulator derived test results and outdoor test results. Also, because of different incident angle modifiers, the all-day efficiency of this collector with a diffuse reflector is comparable to the performance with the standard shaped specular reflector. R.E.S.

N80-24746*# General Electric Co., Philadelphia, Pa. Space Div.

SOLAR HEATING AND COOLING SYSTEM DESIGN AND DEVELOPMENT Final Report

Oct. 1979 106 p ref Sponsored in part by DOE
(Contract NAS8-32092)

(NASA-CR-161422) Avail: NTIS HC A06/MF A01 CSCL 10A

The design and development of marketable solar heating and cooling systems for single family and commercial applications is described. The delivery, installation, and monitoring of the prototype systems are discussed. Seven operational test sites are discussed in terms of system performance. Problems encountered with equipment and installation were usually due to lack of skills required for solar system installation. R.E.S.

N80-24747*# National Aeronautics and Space Administration. Pasadena Office, Calif.

SOLAR-HEATED FLUIDIZED BED GASIFICATION SYSTEM Patent Application

Shaik A. Qader, inventor (to NASA) (JPL) Filed 15 May 1980 13 p

(Contract NAS7-100)

(NASA-Case-NPO-15071-1; US-Patent-Appl-SN-150115) Avail: NTIS HC A02/MF A01 CSCL 10A

A solar-powered fluidized bed gasification system for gasifying carbonaceous material is disclosed. The system includes a solar gasifier which is heated by fluidizing gas and steam. Energy to heat the gas and steam is supplied by a high heat capacity refractory honeycomb which surrounds the fluid bed reactor zone. The high heat capacity refractory honeycomb is heated by solar energy focused on the honeycomb by solar concentrator through solar window. The fluid bed reaction zone is also heated directly by thermal contact to the high heat capacity ceramic honeycomb with the walls of the fluidized bed reactor. Provisions are also made for recovering and recycling catalysts used in the gasification process. A back-up furnace is provided for start-up procedures and for supplying heat to the fluid bed reaction zone when adequate supplies of solar energy are not available. NASA

N80-24750*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SOLAR THERMAL POWER SYSTEMS POINT-FOCUSING THERMAL AND ELECTRIC APPLICATIONS PROJECTS. VOLUME 1: EXECUTIVE SUMMARY Annual Technical Report, fiscal year 1979

A. Marriott 15 Jan. 1980 36 p 2 Vol.

(Contracts NAS7-100; DE-AI01-79ET-20307; JPL Proj. 5103-93)

(NASA-CR-163147; DOE/JPL-1060-31-Vol-1;

JPL-Pub-79-118-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 10A

The activities of the Point-Focusing Thermal and Electric Applications (PETEA) project for the fiscal year 1979 are summarized. The main thrust of the PFTEA Project, the small community solar thermal power experiment, was completed. Concept definition studies included a small central receiver

approach, a point-focusing distributed receiver system with central power generation, and a point-focusing distributed receiver concept with distributed power generation. The first experiment in the Isolated Application Series was initiated. Planning for the third engineering experiment series, which addresses the industrial market sector, was also initiated. In addition to the experiment-related activities, several contracts to industry were let and studies were conducted to explore the market potential for point-focusing distributed receiver (PFDR) systems. System analysis studies were completed that looked at PFDR technology relative to other small power system technology candidates for the utility market sector. R.E.S.

N80-24751*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SOLAR THERMAL POWER SYSTEMS POINT-FOCUSING DISTRIBUTED RECEIVER TECHNOLOGY PROJECT. VOLUME 2: DETAILED REPORT Annual Technical Report, fiscal year 1979

1 Apr. 1980 134 p refs Prepared in part by NASA. Lewis Res. Center, Cleveland, Ohio 2 Vol.

(Contracts NAS7-100; DE-AI01-79ET-20307; JPL Proj. 5104-61)

(NASA-CR-159715; DOE/JPL-1060-30-Vol-2;

JPL-Pub-79-112-Vol-2) Avail: NTIS HC A07/MF A01 CSCL 10A

The accomplishments of the Point-Focusing Distributed Receiver Technology Project during fiscal year 1979 are detailed. Present studies involve designs of modular units that collect and concentrate solar energy via highly reflective, parabolic-shaped dishes. The concentrated energy is then converted to heat in a working fluid, such as hot gas. In modules designed to produce heat for industrial applications, a flexible line conveys the heated fluid from the module to a heat transfer network. In modules designed to produce electricity the fluid carries the heat directly to an engine in a power conversion unit located at the focus of the concentrator. The engine is mechanically linked to an electric generator. A Brayton-cycle engine is currently being developed as the most promising electrical energy converter to meet near-future needs. R.E.S.

N80-24752*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

RESULTS OF THE 1979 NASA/JPL BALLOON FLIGHT SOLAR CELL CALIBRATION PROGRAM

C. H. Seaman and R. S. Weiss 1 May 1980 17 p refs

(Contract NAS7-100)

(NASA-CR-163013; JPL-Pub-80-31)

Avail: NTIS HC A02/MF A01 CSCL 10A

Calibration of solar cells to be used as reference standards in simulator testing of cells and arrays was accomplished. Thirty-eight modules were carried to an altitude of about 36 kilometers during the solar cell calibration balloon flight. E.D.K.

N80-24753*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE APPLICABILITY OF DOE SOLAR CELL AND ARRAY TECHNOLOGY TO SPACE POWER

John A. Scott-Monck, Paul M. Stella, and Paul A. Berman 1 May 1980 27 p refs

(Contract NAS7-100)

(NASA-CR-163143; JPL-Pub-80-29)

Avail: NTIS HC A03/MF A01 CSCL 10B

An evaluation of the main terrestrial photovoltaic development projects was performed. Technologies that may have applicability to space power are identified. Where appropriate, recommendations are made for programs to capitalize on developed technology. It is concluded that while the funding expended by DOE is considerably greater than the space (NASA and DOD) budget for photovoltaics, the terrestrial goals and the means for satisfying them are sufficiently different from space needs that little direct benefit currently exists for space applications. R.E.S.

N80-24755*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PROPOSED METHOD FOR DETERMINING THE THICKNESS OF GLASS IN SOLAR COLLECTOR PANELS

Donald M. Moore 1 Mar. 1980 74 p refs
(Contracts NAS7-100; EX-76-A-29-1012)
(NASA-CR-163151; DOE/JPL-1012-41; JPL-Pub-80-34) Avail:
NTIS HC A04/MF A01 CSCL 10A

An analytical method was developed for determining the minimum thickness for simply supported, rectangular glass plates subjected to uniform normal pressure environmental loads such as wind, earthquake, snow, and deadweight. The method consists of comparing an analytical prediction of the stress in the glass panel to a glass breakage stress determined from fracture mechanics considerations. Based on extensive analysis using the nonlinear finite element structural analysis program ARGUS, design curves for the structural analysis of simply supported rectangular plates were developed. These curves yield the center deflection, center stress and corner stress as a function of a dimensionless parameter describing the load intensity. A method of estimating the glass breakage stress as a function of a specified failure rate, degree of glass temper, design life, load duration time, and panel size is also presented. R.E.S.

N80-24760* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PROCEEDINGS OF THE FIRST SEMI-ANNUAL DISTRIBUTED RECEIVER PROGRAM REVIEW

15 May 1980 241 p refs Proc. held at Lubbock, Tex., 22-24 Jan. 1980; sponsored in part by Texas Tech. Univ. (Contracts NAS7-100; DE-A101-79ET-20307)
(NASA-CR-163135; DOE/JPL-1060-33; JPL-Pub-80-10) Avail:
NTIS HC A11/MF A01 CSCL 10B

Point focus and line focus distributed receiver solar thermal technology for the production of electric power and of industrial process heat is addressed. Concentrator, receiver, and power conversion development are covered along with hardware tests and evaluation. Mass production costing, parabolic dish applications, and trough and bowl systems are included.

N80-24761* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HEAT AND ELECTRICITY FROM THE SUN USING PARABOLIC DISH COLLECTOR SYSTEMS

Vincent C. Truscello and A. Nash Williams *In its Proc. of the First Semiannual Distributed Receiver Program Rev.* 15 May 1980 p 19-26 refs

Avail: NTIS HC A11/MF A01 CSCL 10A

Point focus distributed receiver solar thermal technology for the production of electric power and of industrial process heat is addressed. The thermal power systems project which emphasizes the development of cost effective systems which will accelerate the commercialization and industrialization of plants up to 10 MWe, using parabolic dish collectors is described. The projected size of the isolated load market in the 1990-2000 time period is 300 to 1000 MW/year. Although this market is small in comparison to the grid connected utility market, it is indicated that by assuming only a 20 percent market penetration, up to 10,000 power modules per year would be required to meet this need. At a production rate of 25,000 units/year and assuming no energy storage, levelized bus bar energy costs of 75 mills/kWeh are projected. These numbers are based on what is believed to be a conservative estimate regarding engine-generator conversion efficiency (40 percent) for the 1990 time period. With a more optimistic estimate of efficiency (i.e., 45 percent), the bus bar cost decreases to about 67 mills/kWeh. At very large production rates (400,000 modules/years), the costs decrease to 58 mills/kWeh. Finally, the present status of the technology development effort is discussed. J.M.S.

N80-24762* Sandia Labs., Albuquerque, N. Mex. Solar Energy Projects Dept.

LINE-FOCUS CONCENTRATING COLLECTOR PROGRAM

Virgil L. Dugan *In JPL Proc. of the First Semiannual Distributed Receiver Program Rev.* 15 May 1980 p 27-33

Avail: NTIS HC A11/MF A01 CSCL 10A

The Line-Focus Concentrating Collector Program has emphasized the development and dissemination of concentrating solar technology in which the reflected sunlight is focused onto a linear or line receiver. Although a number of different types of line-focus concentrators were developed, the parabolic trough has gained the widest acceptance and utilization within the industrial and applications sectors. The trough is best applied for application scenarios which require temperatures between 140 and 600 F. Another concept, the bowl, is investigated for applications which may require temperatures in the range between 600 and 1200 F. Current technology emphases are upon the reduction of system installation cost and the implementation of production oriented engineering. J.M.S.

N80-24763* E-Systems, Inc., Dallas, Tex. Energy Technology Center.

TEST BED CONCENTRATOR (TBC)

Vernon R. Goldberg *In JPL Proc. of the First Semiannual Distributed Receiver Program Rev.* 15 May 1980 p 35-39

Avail: NTIS HC A11/MF A01 CSCL 10A

A point focussing concentrator design adapted from an existing communications antenna for use in a solar test bed application is described. The structure design, configured for use with JPL's spherical radius mirror panels, made no attempt toward optimization. The key objectives of stiffness, pointing accuracy, and timely delivery were exceeded. The system weight is approximately 16,000 Kg (36,000 lbs) and has a calculated 1 sigma system error of 0.03 degrees. J.M.S.

N80-24764* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

TEST BED CONCENTRATOR MIRRORS

M. J. Argoud *In its Proc. of the First Semiannual Distributed Receiver Program Rev.* 15 May 1980 p 41-46

Avail: NTIS HC A11/MF A01 CSCL 10A

The test bed concentrator (TBC) was des point focusing distributed receiver (PFDR) systems. The reflective surface of the concentrator was fabricated using mirror facet designs and techniques. The facets are made by bonding mirrored glass to spherically-conducted substrates. Several aspects of earlier work were reevaluated for application to the TBC: optimum glass block size, material selection, environmental test, optical characteristics, and reliability. A detailed explanation of tooling, substrate preparation, testing techniques, and mirror assembly is presented. J.M.S.

N80-24765* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INITIAL TEST BED CONCENTRATOR CHARACTERIZATION

D. J. Starkey *In its Proc. of the First Semiannual Distributed Receiver Program Rev.* 15 May 1980 p 47-51

Avail: NTIS HC A11/MF A01 CSCL 10A

The operational characteristics and the mirror alignment technique of the test bed concentrator control system are highlighted. The final design of the TBC control system provided one axis of fast slew capability so that either the Sun acquisition or emergency off-Sun mode could be obtained in a minimum time. The procedure for getting on and off Sun is to run the elevation axis up to the approximate elevation of the Sun for the particular time of acquisition and then slew the concentrator on Sun in azimuth. The automatic Sun-acquisition system is controlled by two Sun sensors, one for each axis; each has a 2 deg acquisition cone angle within which the concentrators are programmed to point. The mirror alignment technique chosen utilized a semi-distant incandescent light source which produced a reflected image on the focal point target. The concentrator was boresighted to the light by moving the concentrator while sighting along the cross hairs and through the apertures in the disks to the light source resulting in a maximum point error of 0.11 deg. Test plans to install a solar flux mapper to characterize the solar spot and to measure the size, shape, and intensity of the Sun's image are outlined. J.M.S.

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N80-24766*# OMNIUM-G Co., Anaheim, Calif.
THE OMNIUM-G HTC-25 TRACKING CONCENTRATOR
S. Zelinger *In JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 53-57*

Avail: NTIS HC A11/MF A01 CSCL 10A

A point focusing, two axis tracking, high concentration ratio parabolic reflector is described. Field experience coupled with engineering improvements are shown to have manifested a design that is economic in the areas of manufacturing, packaging, delivering, installing, and commissioning the system into operation. The initial problems specifically with the OMNIUM-G model HTC-25 tracking concentrator are addressed. J.M.S.

N80-24767*# General Electric Co., Philadelphia, Pa. Advanced Energy Dept.

THE SHENANDOAH CONCENTRATOR
A. J. Poche *In JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 59-61 refs*

(Contracts DE-AC04-77ET-2D260; EG-77-C-04-3985)

Avail: NTIS HC A11/MF A01 CSCL 10A

A 7 meter diameter, parabolic dish solar collector was designed and developed for first application at Shenandoah, Georgia. Key features and requirements for the collector are outlined. Performance test results for collector testing at Sandia Laboratories in Albuquerque are summarized. The key features, requirements and performance of the solar collector subassemblies/subsystems are discussed; mount and drives, reflector, receiver, and collector control unit. Problems experienced during collector testing in Albuquerque are identified and solutions described. J.M.S.

N80-24768*# General Electric Co., Philadelphia, Pa.
THE 1ST GENERATION LOW COST POINT FOCUS SOLAR CONCENTRATOR

J. Zimmerman *In JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 63-67*

Avail: NTIS HC A11/MF A01 CSCL 10A

A point focus solar concentrator that, given a high volume of production, will optimize the ratio of performance to cost is considered. The concentrator design approach has evolved by a systematic process of examining the operating requirements particular to the solar application, minimizing material content through detail structural design and structurally efficient subsystem features, and utilizing materials and processes compatible with high volume production techniques. The design approach, the rationale for the configuration and subsystem selections, and the development status are described. J.M.S.

N80-24769*# Acurex Corp., Mountain View, Calif.
A CELLULAR GLASS SUBSTRATE SOLAR CONCENTRATOR

Roger Bedard and D. Bell *In JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 69-73*

Avail: NTIS HC A11/MF A01 CSCL 10A

The design of a second generation point focusing solar concentration is discussed. The design is based on reflective gores fabricated of thin glass mirror bonded continuously to a contoured substrate of cellular glass. The concentrator aperture and structural stiffness was optimized for minimum concentrator cost given the performance requirement of delivering 56 kWth to a 22 cm diameter receiver aperture with a direct normal insolation of 845 watts sq m and an operating wind of 50 kmph. The reflective panel, support structure, drives, foundation and instrumentation and control subsystem designs, optimized for minimum cost, are summarized. The use of cellular glass as a reflective panel substrate material is shown to offer significant weight and cost advantages compared to existing technology materials. R.E.S.

N80-24770*# AiResearch Mfg. Co., Torrance, Calif.
THE DEVELOPMENT OF AN AIR BRAYTON AND A STEAM RANKINE SOLAR RECEIVER

Max V. Greeven *In JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 75-85 refs*

Avail: NTIS HC A11/MF A01 CSCL 10B

An air Brayton and a steam Rankine solar receiver now under development are described. These cavity receivers accept concentrated insolation from a single point focus, parabolic concentrator, and use this energy to heat the working fluid. Both receivers were designed for a solar input of 85 kw. The air Brayton receiver heats the air to 816 C. A metallic plate-fin heat transfer surface is used in this unit to effect the energy transfer. The steam Rankine receiver was designed as a once-through boiler with reheat. The receiver heats the water to 704 C to produce steam at 17.22 MPa in the boiler section. The reheat section operates at 1.2 MPA, reheating the steam to 704 C. R.E.S.

N80-24771*# Ford Aerospace and Communications Corp., Newport Beach, Calif. Aeronutronic Div.

AN ORGANIC RANKINE RECEIVER FOR THE SCSTPE PROGRAM

D. B. Osborn *In JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 87-93 refs*

Avail: NTIS HC A11/MF A01 CSCL 10B

The organic Rankine cycle receiver which is presently being developed is described. The receiver employs an integrated cavity/pool boiler which permits the design of a small, lightweight, low cost and efficient moderate temperature receiver for use in a dish-Rankine solar thermal system. R.E.S.

N80-24777*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

OMNIUM-G CONCENTRATOR TEST RESULTS

Jack D. Patzold *In its Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 125-131*

Avail: NTIS HC A11/MF A01 CSCL 10A

A performance evaluation was conducted on a commercially available point-focus solar concentrator, the Heliodyne model HTC-25s tracker/concentrator. Thermal power test results indicate that slightly more than six kilowatts of thermal energy is available from a system of this configuration using a 10 cm aperture. R.E.S.

N80-24779*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

COSTING THE OMNIUM-G SYSTEM 7500

H. R. Fortgang *In its Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 139-144*

Avail: NTIS HC A11/MF A01 CSCL 10C

A complete OMNIUM-G System 7500 was cost analyzed for annual production quantities ranging from 25 to 10,000 units per year. Parts and components were subjected to in-depth scrutiny to determine optimum manufacturing processes, coupled with make or buy decisions on materials and small parts. When production quantities increase both labor and material costs reduce substantially. A redesign of the system that was analyzed could result in lower costs when annual production runs approach 100,000 units/year. Material and labor costs for producing 25, 100, 25,000 and 100,000 units are given for 17 subassembly units. A.R.H.

N80-24780*# Pioneer Engineering and Mfg. Co., Inc., Warren, Mich.

TBC COSTING

Henry L. Kaminski *In JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 145-152*

Avail: NTIS HC A11/MF A01 CSCL 10C

Procedures to be used in determining the cost of producing and installing a parabolic dish collector in annual production volumes of 10,000, 50,000, 100,000, and 1,000,000 units include (1) evaluating each individual part for material cost and for the type and number of operations required to work the raw material

into the finished part; (2) costing labor, burden, tooling, gaging, machinery, and equipment; (3) estimating facilities requirements for each production volume; and (4) considering suggestions for design and material alterations that could result in cost reduction. A.R.H.

N80-24782*# Ford Aerospace and Communications Corp., Newport Beach, Calif. Aeronutronic Div.

THE DISH-RANKINE SCSTPE PROGRAM (ENGINEERING EXPERIMENT NO. 1)

Robert L. Pons and Carl E. Grigsby *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 159-167 ref

Avail: NTIS HC A11/MF A01 CSCL 10A

Activities planned for phase 2 of the Small Community Solar Thermal Power Experiment (PFDR) program are summarized with emphasis on a dish-Rankine point focusing distributed receiver solar thermal electric system. Major design efforts include: (1) development of an advanced concept indirect-heated receiver; (2) development of hardware and software for a totally unmanned power plant control system; (3) implementation of a hybrid digital simulator which will validate plant operation prior to field testing; and (4) the acquisition of an efficient organic Rankine cycle power conversion unit. Preliminary performance analyses indicate that a mass-produced dish-Rankine PFDR system is potentially capable of producing electricity at a levelized busbar energy cost of 60 to 70 mills per KWh and with a capital cost of about \$1300 per KW. A.R.H.

N80-24783*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SITING SOLAR THERMAL POWER EXPERIMENTS

Herbert J. Holbeck *In* its Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 169-173

Avail: NTIS HC A11/MF A01 CSCL 10A

The Small Community Solar Thermal Power Experiment will test a point-focusing, distributed receiver system in a small community, electric utility application. Site planning is becoming increasingly important for solar experiments as well as all kinds of development due to increased competition for desirable sites and increased complexity of regulatory requirements. Siting issues can be categorized as: (1) resources and physical environmental at this site; (2) acquisition, permits and regulations; and (3) development requirements and costs. These issues are addressed with respect to the unique requirements of solar thermal power experiments. A.R.H.

N80-24784*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE JPL ISOLATED APPLICATION EXPERIMENT SERIES

Richard R. Levin *In* its Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 175-179

Avail: NTIS HC A11/MF A01 CSCL 10A

A set of small (approximately 60-150 kWe) solar thermal power experiments, each of which is meant to address a separate isolated load application, will employ point focusing distributed receiver technology with emphasis on electric and possibly some thermal power applications. The program will be closely integrated with the technology development element of the thermal power systems project with the objective of utilizing the technologies being developed under that program. A.R.H.

N80-24785*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INDUSTRIAL APPLICATION EXPERIMENT SERIES

Steven A. Bluhm *In* its Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 181-184

Avail: NTIS HC A11/MF A01 CSCL 10A

The deployment of parabolic dish systems into the industrial sector for the purpose of providing users, suppliers, sponsors, and developers with a realistic assessment of system feasibility in selected near-term industrial applications will be accomplished initially through the industrial module experiment and later through additional experiments involving thermal, electric, and combined

thermal and electrical systems. The approach is to progress through steps, from single module to multi-module systems, from thermal-only applications to more complex combined thermal and electric applications. The experience of other solar thermal experiments, particularly those involving parabolic dish hardware, will be utilized to the fullest extent possible in experiment planning and implementation. A.R.H.

N80-24786*# General Electric Co., Philadelphia, Pa.

SPS MARKET ANALYSIS

Hugh C. Goff *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 185-189

Avail: NTIS HC A11/MF A01 CSCL 05C

A market analysis task included personal interviews by GE personnel and supplemental mail surveys to acquire statistical data and to identify and measure attitudes, reactions and intentions of prospective small solar thermal power systems (SPS) users. Over 500 firms were contacted, including three ownership classes of electric utilities, industrial firms in the top SIC codes for energy consumption, and design engineering firms. A market demand model was developed which utilizes the data base developed by personal interviews and surveys, and projected energy price and consumption data to perform sensitivity analyses and estimate potential markets for SPS. A.R.H.

N80-24787*# BDM Corp., McLean, Va.

MILITARY MARKETS FOR SOLAR THERMAL ELECTRIC POWER SYSTEMS

James S. Hauger *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 191-195

Avail: NTIS HC A11/MF A01 CSCL 10B

The Department of Defense maintains an inventory of over 1,800 MW of engine-generators 15 KW and larger, with an estimated procurement rate of over 140 MW/year. Nearly the entire requirement could be met by advanced heat engines of the types being developed as point-focusing, distributed receiver power plants. A conceptual system consisting of a heat engine which efficiently burns liquid fossil or synthetic fuels, with a 'solarization kit' for conversion to hybrid solar operation could meet existing DOD requirements for new systems which are quieter, lighter, and multi-fueled. An estimated 24 percent (33 MW/year) or more could operationally benefit from the solar option. Baseline cost projections indicate levelized energy cost goals of 210 to 120 mills/KWh (15 to 1000 KW systems). Fuel cost escalation is the major factor affecting the value of the solar option. A baseline calculation for fuel at \$0.59/gal in spring, 1979, escalating at 8 percent above general inflation indicates a value of \$2700/KWe for a solarization kit. A.R.H.

N80-24788*# Science Applications, Inc., McLean, Va.

SOLAR THERMAL PLANT IMPACT ANALYSIS AND REQUIREMENTS DEFINITION

Yudi P. Gupta *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 197-209

(Contract JPL-955238)

Avail: NTIS HC A11/MF A01 CSCL 10B

Progress on a continuing study comprising of ten tasks directed at defining impact and requirements for solar thermal power systems (SPS), 1 to 10 MWe each in capacity, installed during 1985 through year 2000 in a utility or a nonutility load in the United States is summarized. The point focus distributed receiver (PFDR) solar power systems are emphasized. Tasks 1 through 4, completed to date, include the development of a comprehensive data base on SPS configurations, their performance, cost, availability, and potential applications; user loads, regional characteristics, and an analytic methodology that incorporates the generally accepted utility financial planning methods and several unique modifications to treat the significant and specific characteristics of solar power systems deployed in either central or distributed power generation modes, are discussed. E.D.K.

02 SOLAR ENERGY

N80-24789*# Little (Arthur D.), Inc., San Francisco, Calif.
A STUDY OF MASS PRODUCTION AND INSTALLATION OF SMALL SOLAR THERMAL ELECTRIC POWER SYSTEMS

John F. Butterfield *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 211-215

Avail: NTIS HC A11/MF A01 CSCL 10B

Technological constraints, materials availability, production capacity, and manufacturing and installations plans and costs at different production levels are included in a study of concentrating collector industrialization. As cobalt for the engine and receiver is supply limited, alternative lower temperature alloys and higher temperature materials such as ceramics are discussed. Economics and production efficiency favor co-location of cellular and thin glass production for reflectors. Assembly and installation are expensive for small sites and few alternatives exist to apply mass production techniques to lower these costs for the selected design. Stepping motors in the size and quantities required are not commercially available today but could be in the future.

E.D.K.

N80-24790*# Texas Technological Univ., Lubbock. Dept. of Electrical Engineering.

THE CROSSBYTON PROJECT

John D. Reichert *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 217-220

Avail: NTIS HC A11/MF A01 CSCL 10B

The Analog Design Verification System (ADVS), the largest single solar collector built, was tested. Referred to as the Solar Gridiron or Bowl Concept, it employs a stationary mirror, with tracking accomplished by the mirror.

E.D.K.

N80-24791*# Acurex Corp., Mountain View, Calif.
IEA/SPS 500 kW DISTRIBUTED COLLECTOR SYSTEM

Temple W. Neumann and Creighton D. Hartman *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 221-227

Avail: NTIS HC A11/MF A01 CSCL 10A

Engineering studies for an International Energy Agency project for the design and construction of a 500 kW solar thermal electric power generation system of the distributed collector system (DCS) type are reviewed. The DCS system design consists of a mixed field of parabolic trough type solar collectors which are used to heat a thermal heat transfer oil. Heated oil is delivered to a thermocline storage tank from which heat is extracted and delivered to a boiler by a second heat transfer loop using the same heat transfer oil. Steam is generated in the boiler, expanded through a steam turbine, and recirculated through a condenser system cooled by a wet cooling tower.

E.D.K.

N80-24792*# Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.

COOLIDGE SOLAR POWERED IRRIGATION PUMPING PROJECT

Dennis L. Larson *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 229-233 refs

Avail: NTIS HC A11/MF A01 CSCL 10B

A 150 kW solar thermal electric power plant which includes over 2100 square meters of parabolic trough type collectors and an organic Rankine cycle turbine engine was constructed on an irrigated farm. The plant is interconnected with the electrical utility grid. Operation is providing an evaluation of equipment performance and operating and maintenance requirements as well as the desirability of an on farm location.

E.D.K.

N80-24793*# Battelle Columbus Labs., Ohio.
THE 50-HORSEPOWER SOLAR-POWERED IRRIGATION FACILITY LOCATED NEAR GILA BEND, ARIZONA

Wilbur A. Smith, G. Alexander, and D. F. Busch *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 235-239

Avail: NTIS HC A11/MF A01 CSCL 10B

The 50 horsepower solar powered irrigation facility near Gila Bend, Arizona which includes a Rankine cycle demonstrates the technical feasibility of solar powered pumping. The design of a

facility specifically for the irrigation farmer using the technology that has been developed over the last four years is proposed.

E.D.K.

N80-24794*# New Mexico State Univ., Las Cruces.
PRELIMINARY OPERATIONAL RESULTS FROM THE WILLARD SOLAR POWER SYSTEM

Donald L. Fenton, G. H. Abernathy, G. Krivokapich, D. E. Ellibee, and V. Chilton *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 241-246 refs

Avail: NTIS HC A11/MF A01 CSCL 10B

The solar powered system located near Willard, New Mexico, generates mechanical or electrical power at a capacity of 19 kW (25 HP). The solar collection system incorporates east/west tracking parabolic trough collectors with a total aperture area of 1275 sq m (13,720 sq ft). The hot oil type thermal energy storage is sufficient for approximately 20 hours of power system operation. The system utilizes a reaction type turbine in conjunction with an organic Rankine cycle engine. Total collector field efficiency reaches a maximum of 20 percent near the winter solstice and about 50 percent during the summer. During the month of July, 1979, the system pumped 60 percent of the 35,300 cu m (28.6 acre-feet) of water delivered. Operating efficiencies for the turbine component, organic Rankine cycle engine and the complete power system are respectively 65 to 75 percent, 12 to 15 percent and 5 to 6 percent. Significant maintenance time was expended on both the collector and power systems throughout the operational period.

Author

N80-24795*# Georgia Power Co., Atlanta.
SOLAR TOTAL ENERGY-LARGE SCALE EXPERIMENT, SHENANDOAH, GEORGIA

Walter R. Hensley *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 247-249

Avail: NTIS HC A11/MF A01 CSCL 10A

The design and development of a 7 meter diameter parabolic dish solar collector are discussed. Each of the four main subsystems of the collector: (1) reflector, (2) mount and drives, (3) receiver and (4) the controls, is discussed briefly with the major emphasis on the receiver design. To minimize development risks and production costs, a dish design based on use of stamped aluminum petals (sectors) was chosen. This design is similar to the design of a communication antenna already commercially produced. The reflective surface of the petals has a total reflectance of .86 and a specularity (dispersion) of 8 mrd. This performance is obtained by mechanical polishing and chemical brightening of the petal surface, followed by application of a clear RTV silicone protective coating. Selection of the material and weather proofing coated are discussed. Results from performance tests on an engineering development dish collector are presented and compared with pretest predictions.

J.M.S.

N80-24796*# General Electric Co., Philadelphia, Pa.
SOLAR TOTAL ENERGY PROJECT AT SHENANDOAH, GEORGIA SYSTEM DESIGN

A. J. Poche *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 251-255

(Contracts EG-77-C-04-3985; DE-AC04-77ET-20260)

Avail: NTIS HC A11/MF A01 CSCL 10B

The solar total energy system (STES) was to provide 50% of the total electrical and thermal energy requirements of the 25,000 sq ft Bleyle of America knitwear plant located at the Shenandoah Site. The system will provide 400 kilowatts electrical and 3 megawatts of thermal energy. The STES has a classical, cascaded total energy system configuration. It utilizes one hundred twenty (120), parabolic dish collectors, high temperature (750 F) trickle oil thermal energy storage and a steam turbine generator. The electrical load shaving system was designed for interconnected operation with the Georgia Power system and for operation in a stand alone mode.

J.M.S.

N80-24798# Rockwell International Corp., Huntsville, Ala. **STUDY OF MULTI-kW SOLAR ARRAYS FOR EARTH ORBIT APPLICATIONS: MIDTERM PERFORMANCE REVIEW** 26 Jul. 1979 98 p
(Contract NAS8-32988)
(NASA-CR-161467) Avail: NTIS HC A05/MF A01 CSCL 10A

Planar and concentrator solar array concepts capable of providing 300 kW to 1000 kW in low Earth orbit applications in the 1987 time period at an array recurring cost less than or equal to thirty dollars per watt are examined. Silicon and gallium arsenide solar cell applicability are evaluated. On-orbit maintenance by space shuttle is also investigated. Design configurations for the solar arrays and solar cells are recommended. R.E.S.

N80-24805# Midwest Research Inst., Kansas City, Mo. **SOLAR REFLECTANCE, TRANSMITTANCE AND ABSORPTANCE OF COMMON MATERIALS**
B. C. Butler, P. J. Call, G. L. Jorgensen, and R. B. Pettit (Sandia Labs., Albuquerque, N.M.) Oct. 1979 8 p refs Presented at the Solar Industrial Process Heat Conf., San Francisco, 31 Oct. 1979
(Contract EG-77-C-01-4042)
(SERI/TP-334-457; CONF-791024-9) Avail: NTIS HC A02/MF A01

The solar reflectance, transmittance, and absorptance of common materials used for solar collector fabrication were compiled for easy reference. The data are derived from solar weighted averaging techniques and can be used for initial calculations of collector performance. DOE

N80-24807# Colorado State Univ., Fort Collins. Solar Energy Applications Lab. **RESIDENTIAL SOLAR HEATING AND COOLING USING EVACUATED TUBE SOLAR COLLECTORS: CSU SOLAR HOUSE 3 Final Report, Management Summary, 1 Feb. 1976 - 30 Sep. 1978**
Dan S. Ward, John C. Ward, and H. S. Oberoi Mar. 1979 11 p
(Contract EY-76-S-02-2858)
(COO-2858-24-Summ) Avail: NTIS HC A02/MF A01

An integrated evacuated tube solar collector and absorption space cooling system installed in a solar house was designed, tested, and evaluated. The seasonal performance was compared with two other solar heating and cooling systems installed in adjacent buildings with virtually identical thermal characteristics. The two comparison system consist of conventional solar water heating and air heating flat plate collectors. DOE

N80-24816# California Univ., Berkeley. Lawrence Berkeley Lab. **SENSIBLE HEAT STORAGE FOR A SOLAR THERMAL POWER PLANT M.S. Thesis**
Thomas F. Baldwin, Scott Lynn, and Alan S. Foss Jul. 1979 195 p refs
(Contract W-7405-eng-48)
(LBL-9321) Avail: NTIS HC A09/MF A01

One possible configuration for a solar power plant with a sensible-heat storage unit was investigated. The proposed flowsheet allows thermal energy storage between the heat collection unit and the power generation unit without a reduction in the thermodynamic availability of the energy supplied to the power turbines. Energy is stored by heating a checkerwork of magnesite bricks. A gas that is circulated from the solar collector through the storage unit and the power plant boiler serves as the heat-transfer medium. Nitrogen was found to be preferable to helium for this purpose. A computer model was used to predict the behavior of the sensible-heat storage unit and to aid in sizing the storage unit. Procedures were developed to estimate the cost of electricity generated by the solar power plant. The effects on the storage unit and on the total plant design of changing several processes and design parameters were then evaluated. Two alternative process configurations for solar power plants with sensible-heat storage were developed. DOE

N80-24817# Aerospace Corp., Los Angeles, Calif. Energy and Resources Div. **SOLAR THERMAL SMALL POWER SYSTEMS STUDY. INVENTORY OF US INDUSTRIAL SMALL ELECTRIC POWER GENERATING SYSTEMS**
1 Jun. 1979 59 p ref
(Contract ET-78-C-03-2226)

(ATR-79(7780)-1) Avail: NTIS HC A04/MF A01
This inventory of small industrial electric generating systems was assembled to provide a data base for analyses being conducted to estimate the potential for displacement of these fossil fueled systems by solar thermal electric systems no larger than 10 MW in rated capacity. The approximately 2100 megawatts generating capacity of systems in this category constitutes a potential market for small solar thermal and other solar electric power systems. The sources of data for this inventory were the (former) Federal Power Commission (FPC) Form 4 Industrial Ledger and Form 12-C Ledger for 1976. Alphabetical lists are presented of generating systems located at industrial plants and at Federal government installations in each of the 50 states. These systems are differentiated by type of power plant: steam turbine, diesel generator, or gas turbine. Each listing is designed as a power system rather than a power unit because the GPC Ledgers do not provide a means of determining whether more than one unit is associated with each industrial installation. The user should consider each listing to be a system capacity rating wherein the system may consist of one or more generating units with less than 10 MW/sub e/ combined rating. DOE

N80-24818# Minnesota Univ., Minneapolis. Dept. of Electrical Engineering. **COMPOSITION PROFILING OF SOLAR COATING MATERIALS Final Report, 16 Apr. 1976 - 15 Apr. 1979**
G. K. Wehner Sep. 1979 39 p refs
(Contract EY-76-S-02-2953)
(COO-2953-4) Avail: NTIS HC A03/MF A01

Auger electron composition vs. depth and optical analysis revealed that a very inexpensive-to-produce (15 min. 900 C heat treatment in air) Cr₂O₃ layer on stainless steels provides an excellent diffusion barrier for preventing stainless steel constituents from entering into an IR reflective Mo coating. It was shown that with sputter deposition of Mo at high rate in a clean noble gas plasma, one can obtain Mo coatings of excellent IR reflectance. The optical properties of various other absorber surfaces such as stacked razor blades, cone or whisker-covered metal surfaces, plasma-sprayed chromic oxide coatings etc. were measured and explored. DOE

N80-24820# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div. **MEAN MONTHLY PERFORMANCE OF PASSIVE SOLAR WATER HEATERS**
W. Place, M. Daneshyar (Univ. of Technology, Esfahan, Iran), and R. Kammerud Oct. 1979 8 p ref Presented at the 4th Natl. Passive Solar Energy Conf., Kansas City, Kas., 3 Oct. 1979
(Contract W-7405-eng-48)
(LBL-9295; CONF-791022-11) Avail: NTIS HC A02/MF A01

A simplified analysis was used to compare the average monthly performance of a compact heater (having combined collection and storage) and a thermosiphon heater (using natural convective transfer from a collector to an insulated tank). The comparison which was made for a range of climates and a variety of load profiles indicates that the performance of the thermosiphon is substantially superior to that of the compact heater. DOE

N80-24821# Springborn Labs., Inc., Enfield, Conn. **SOLAR COLLECTORS Technical Progress Report, 5 Sep. 1978 - 5 Mar. 1979**
B. Baum and Michael Gage 27 Apr. 1979 54 p
(Contract EM-78-C-04-5359)
(ALO-5359-T1; TPR-1) Avail: NTIS HC A04/MF A01

02 SOLAR ENERGY

A broad information search was carried out in four areas: glazings, housing materials, acrylic coatings, etching processes and AR coatings. An extensive list of all (known) US transparent polymers was developed as well as tables of plastic, ceramic and metallic materials that could conceivably function as a housing. In addition, a compilation was made of commercially available solvent and water base acrylic coatings for use as a uv protective coating for the glazing. Eighteen transparent polymers were chosen as possible glazings and twelve materials (plastic and wood) as possible housings and exposed in the Weather-Ometer as tensile bars and for the glazings as disks for optical transmission. These same materials were also exposed on our roof to monitor soiling. A variety of solvent and water base acrylics were selected as protective coatings and ordered. Two commercial films, Tedlar 20 and Halar 500, with strong absorption in the uv and two commercial films containing uv absorbers, Tedlar UT and Korad 201R, were laminated by several different processes to four promising glazing materials: polyvinyl fluoride (Tedlar), polymethyl methacrylate (Plexiglass), crosslinked ethylene/vinyl acetate and thermoplastic polyester (Lumar). A variety of etching processes were briefly explored and AR coating studies started on the above four glazing films. DOE

N80-24823# Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center.
HETEROSTRUCTURE SINGLE CRYSTAL SILICON PHOTO-VOLTAIC SOLAR CELLS Final Report, 27 Sep. 1976 - 31 Jul. 1979

J. R. Szedon, T. A. Temofonte, T. W. O'Keeffe, H. C. Dickey, S. J. Fonash, and T. E. Sullivan 31 Jul. 1979 209 p refs Prepared in cooperation with Pennsylvania State Univ., Univ. Park (Contract EY-76-C-03-1282) (DOE/ET/20408-1) Avail: NTIS HC A10/MF A01

Technical and commercial practicability (specifically, conversion efficiency of 10 percent or greater at a module selling price below \$0.50/peak watt in 1975 dollars) for power generation of metal-heterojunction silicon solar cell of the metal-insulator semiconductor (MIS) variety is assessed. Empirical and theoretical studies were made of cells using both single crystal (n- and p-type) and polycrystalline (p-type) silicon with a variety of metals (Al, Au, Ag, Pd) and silicon dioxide lasers of various thicknesses. Performance limitations were identified. Means to improve cell performance were evaluated, including material modifications, layer thickness control and changes in device structure. It is concluded that the program goals can be met. Encouraging results in analysis of cells made with polycrystalline material provide a good basis for proceeding with future work to assess the prospects of even lower cost cells. DOE

N80-24824# Midwest Research Inst., Golden, Colo. Thermal Conversion Branch.

FEASIBILITY EVALUATION FOR SOLAR INDUSTRIAL PROCESS HEAT APPLICATIONS

S. A. Stadjuhar Jan. 1980 7 p refs Presented at the Systems Simulation and Econ. Analysis Conf., San Diego, Calif., 23 Jan. 1980

(Contract EG-77-C-01-4042) (SERI/TP-333-538; CONF-800101-3) Avail: NTIS HC A02/MF A01

An analytical method for assessing the feasibility of Solar Industrial Process Heat applications was developed and implemented in a flexible, fast-calculating computer code, PROSYS/ECONMAT. The performance model PROSYS predicts long-term annual energy output for several collector types, including flat-plate, nontracking concentrator, one-axis tracking concentrator, and two-axis tracking concentrator. Solar equipment cost estimates, annual energy capacity cost, and optional net present worth analysis are provided by ECONMAT. User input consists of detailed industrial process information and optional economic parameters. Internal program data includes meteorological information for 248 US sites, characteristics of more than 20 commercially available collectors representing several generic collector types, and defaults the economic parameters. Because a fullscale conventional back-up fuel system is assumed, storage is not essential and is not included in the model. DOE

N80-24826# Foster Wheeler Corp., Livingston, N.J.
SOLAR PRODUCTION OF INDUSTRIAL PROCESS STEAM RANGING IN TEMPERATURE FROM 300 F TO 550 F (PHASE 1), VOLUME 1 Final Report, 30 Sep. 1978 - 30 Jun. 1979

30 Jun. 1979 176 p refs (Contract ET-78-C-03-2199) (DOE/CS/32199-1; FWDC-9-41-4010) Avail: NTIS HC A09/MF A01

This section summarizes the Phase 1 solar industrial process steam system and includes a system schematic, a brief system description, general specifications of the major system components, expected system performance, and a cost estimate summary for Phases 2 and 3. The objectives of Phase 1 are: (1) design a cost-effective solar steam generating system using state-of-the-art components and technology to supply steam for Dow Chemical Company's Dalton, Georgia, plant; (2) predict the performance of the solar process steam plant; (3) conduct a safety evaluation and an environmental impact assessment of the solar steam system; (4) conduct an economic analysis to determine the potential economic benefits of a solar-augmented process steam production system compared with an existing fossil-fuel-fired steam generator; and (5) promote the project extensively to make it visible to industry and the general public. DOE

N80-24828# American Science and Engineering, Inc., Cambridge, Mass.

DEVELOPMENT OF A SECOND-GENERATION CONCENTRATING TRACKING SOLAR COLLECTOR Technical Progress Report, 20 Jun. - 27 Dec. 1978

Roy W. Miller 16 Jan. 1979 58 p refs (Contract EM-78-C-04-4375) (ASE-4371) Avail: NTIS HC A04/MF A01

The objective is to develop a second generation parabolic mirror concentrator with a variation of the cylindrical blackbody receiver to provide a minimum concentration ratio of ten. Performance characteristics are to be determined by tests using a prototype unit. Probable mass production costs for the collector will be generated. Work performed during the first six months of the effort is described. The design of the prototype collector was completed. The collector design is described in detail. The performance analysis for the second generation collector was also completed during the first six months of the contract. The work consists of collector tradeoff studies together with optical and thermal analysis of detailed configurations. The analysis is described in detail with computer programs included and results given for conditions of interest. The performance analysis was conducted in concert with the collector design effort. Thus, the collector design features were driven by performance considerations and design details are optimum with respect to performance. The result is a collector design capable of producing outlet field of high enough temperature to drive air conditioning equipment. Concentration ratio is 12 and predicted efficiency is 60% at fluid outlet temperature of 200 F. DOE

N80-24829# Aerospace Corp., Los Angeles, Calif. Energy Systems Directorate.

NEW APPLICATIONS OF HIGH-TEMPERATURE SOLAR ENERGY FOR THE PRODUCTION OF TRANSPORTABLE FUELS AND CHEMICALS AND FOR ENERGY STORAGE

19 Jan. 1979 178 p refs (Contract EY-76-C-03-1101) (ATR-78(7691-04)-1) Avail: NTIS HC A09/MF A01

The solar fuels and chemicals study was limited to the examination of processes requiring temperatures in excess of 1000 K since lower temperature processes had already been examined in studies concerned with the application of waste heat from nuclear power plants to industrial processes. In developing the carbon cycle processes, the primary activity included an extensive literature search and the thermodynamic evaluation of a number of candidate chemical cycles. Although both hydrogen and carbon closed- and open-loop chemical cycles were studied, it was concluded that the carbon cycles offered sufficient additional potential to warrant concentrating on them in subsequent work. The section on new ideas for transportable fuels presents the elements of a new concept for a carbon

cycle recovery technique to produce transportable fuels. The elements discussed are sources of carbon dioxide, solar energy reduction of CO₂, potential carbon cycles, and use of carbon monoxide as fuel and feedstocks. Another section presents some new concepts for the use of high temperature solar energy in the production of essential materials and for closed-loop chemical storage, as well as for the production of hydrogen as a fuel and open-loop applications. Potential problem areas pertinent to solar derived fuels and chemicals have been identified. These problems are primarily associated with the limited high temperature experience in industry and include materials compatibility, separation of reaction products, development of solid electrolytes and high temperature electrodes, selective emission of receiver coatings at high temperature, and a lack of chemical kinetics data, and high temperature thermodynamic data. DOE

N80-24831# Midwest Research Inst., Golden, Colo.

BIOLOGICAL SOLAR CELLS

M. Seibert and A. F. Janzen Nov. 1979 7 p refs Presented at the 2nd Miami Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10 Dec. 1979. Prepared in cooperation with Photochemical Research Associates, Inc., London (Canada).

(Contract EG-77-C-01-4042)

(SERI/TP-332-478; CONF-791204-7) Avail: NTIS HC A02/MF A01

The bacterial photosynthetic reaction center isolated from *Rhodospseudomonas sphaeroides* was attached directly onto an SnO₂ electrode. The light-induced primary charge separation processes which occur across the reaction center macromolecule were then coupled to the electrode. In a two-electrode configuration, photovoltages as high as 70 mV and photocurrents as high as 0.5 micron A/sq cm are observed in an external circuit. Such reaction center electrodes may be the forerunner of future biological solar cells or may serve as model systems for future organic photovoltaic devices. DOE

N80-24832# Sandia Labs., Albuquerque, N. Mex.

PHOTOVOLTAIC CONCENTRATORS

E. C. Boes 1980 10 p refs Presented at the 14th Photovoltaics Specialist Conf., San Diego, Calif., 7 Jan. 1980

(Contract EY-76-C-04-0789)

(SAND-80-0143C; CONF-800108-7) Avail: NTIS HC A02/MF A01

A status report on photovoltaic (PV) concentrators technology is presented. The major topics covered are as follows: (1) current PV concentrator arrays: designs, performances, and costs; (2) current PV concentrator array components: cells and cell assemblies, optical concentrators, support structures, tracking, and drive; (3) design of PV concentrator arrays; and (4) array manufacturing technology. DOE

N80-24833# Sandia Labs., Albuquerque, N. Mex. Large Power Systems Div.

SOLAR CENTRAL RECEIVER SYSTEMS PROGRAMS

J. D. Fish 1979 5 p refs Presented at the Solar Ind. Process Heat Conf., San Francisco, 31 Oct. 1979

(Contract EY-76-C-04-0789)

(SAND-79-8777; CONF-791024-5) Avail: NTIS HC A02/MF A01

Major elements of the Solar Central Receiver Systems program include: (1) development of storage-coupled and hybrid system concepts; (2) the Central Receiver Test Facility in Albuquerque, NM; (3) the pilot plant under construction at Barstow, CA; (4) proposed repowering/industrial retrofit plants; and (5) heliostat, receiver, and storage subsystems development work. Current and proposed activities within each element are discussed. DOE

N80-24836# Mitre Corp., McLean, Va. METREK Div.

SOLAR THERMAL REPOWERING: UTILITY/INDUSTRY MARKET POTENTIAL IN THE SOUTHWEST

N. Lord, P. Curto, and S. True Dec. 1978 177 p refs

(Contract ET-78-C-01-2854)

(MTR-7919) Avail: NTIS HC A09/MF A01

An analysis of the utility and industrial solar thermal repowering market potential in the Southwest is presented. Repowering involves adding the solar thermal central receiver (power tower) system as a retrofit power source for existing utilities and industries. It would provide steam to drive utility turbogenerator or supply process heat for industry. The potential for repowering oil and gas using steam turbine utility sites with a capacity greater than 25 MWe and sufficient land adjacent to the plant for a minimum 25 MWe addition is analyzed. Industry projections based on an analysis of the energy requirements for the chemicals and petroleum industries in Texas and estimates of land availability are included. It is estimated that the potential solar thermal repowering market for utilities and industries in the Southwest is approximately one quad. DOE

N80-24837# Massachusetts Inst. of Tech., Cambridge.

BATTERY CHARGE/SOLAR CONTROLLER FOR A RESIDENTIAL SIZE PHOTOVOLTAIC POWER SYSTEM

R. N. Cadioux 31 Oct. 1979 20 p refs

(Contract EY-76-C-02-4094)

(COO-4094-62) Avail: NTIS HC A02/MF A01

A controller was designed to meet the initial requirements of an off-peak, utility-interactive solar photovoltaic power system now undergoing tests. A physical description of the controller, an explanation of the control algorithm, a circuit description and the theory of operation are presented. DOE

N80-24839# Delaware Univ., Newark. Inst. of Energy Conversion.

AMORPHOUS SI SOLAR CELLS Quarterly Report, 1 Apr. - 30 Jun. 1979

V. L. Dalal Aug. 1979 56 p refs

(Contract DE-AC03-79ET-23034)

(DOE/ET/23034-T1; QR-2) Avail: NTIS HC A04/MF A01

An analysis of a-Si devices was completed. The analysis shows that even with limited diffusion length and high defect density, a-Si devices can achieve J/sub sc/ approximately = to 15 mA/sq cm, V/sub oc/ approximately = to .IV and FF approximately = to 0.72. Novel a-Si devices were also designed and analyzed. The analysis shows that the flexibility in material properties offered by a-Si can be used advantageously to design high quality devices. DOE

N80-24840# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

APPLICATION OF CIRCUMSOLAR MEASUREMENTS TO CONCENTRATING COLLECTORS

D. F. Grether, D. Evans, A. Hunt, and M. Wahlig Jun. 1979 6 p refs Presented at the Intern. Solar Energy Soc. Meeting, Atlanta, 28 May 1979

(Contract W-7405-eng-48)

(LBL-9412; CONF-790541-58) Avail: NTIS HC A02/MF A01

A systematic measurement program is being carried out to assess the effects of circumsolar radiation (the solar aureole) on the performance of solar conversion systems using concentrating collectors. Four instrument systems were constructed and are providing detailed intensity vs. angle profiles of the solar and circumsolar (out to 3 deg from the center of the Sun) as well as other solar measurements. The instruments are briefly described. Results are presented of the average effect of the circumsolar radiation on the solar energy available to an idealized point focusing system. Results are also presented for an analysis of two specific central receiver designs. DOE

N80-24842# Sandia Labs., Albuquerque, N. Mex.

EXTRINSIC LOSSES IN SOLAR CELLS FOR LINEAR FOCUS SYSTEMS 4

C. Michael Gamer Dec. 1979 42 p refs

(Contract EY-76-C-04-0789)

(SAND-79-1781) Avail: NTIS HC A03/MF A01

Solar cell efficiency is dependent on the intrinsic one dimensional diode efficiency and on the extrinsic losses (i.e., contact shadowing, series resistance and losses arising from nonuniform illumination). These extrinsic losses can depend on

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cell size and should be considered in the design of concentrator systems. The carrier transport and junction phenomena are arbitrarily called intrinsic effects, and the efficiency resulting from the one dimensional transport equations will be called the intrinsic efficiency. The under consideration will be called extrinsic effects. The $I_{sq} R$ and shadowing losses have been calculated as a function of cell size, contact thickness and number of buses. In addition, losses resulting from nonuniform illumination and temperature have been calculated. These results should give clear guidelines for the design of receivers for linear focus systems.

DOE

N80-24847# Westinghouse Research and Development Center, Pittsburgh, Pa.

CADMIUM SULFIDE/COPPER SULFIDE HETEROJUNCTION CELL RESEARCH Final Report, 30 Sep. 1977 - 31 Jul. 1979

J. R. Szedon, F. A. Shirland, W. J. Biter, T. W. O'Keeffe, J. A. Stoll, and S. J. Fonash (Pennsylvania State Univ., University Park) 31 Jul. 1979 186 p refs

(Contract EG-77-C-03-1577)

(DOE/ET/20429-1) Avail: NTIS HC A09/MF A01

The objective of this program is to conduct research on solar cells of the copper sulfide/cadmium sulfide (and cadmium sulfide-zinc sulfide alloy) type with the goal of producing thin film cells capable of 10% AM1 conversion efficiency with less than 5% degradation in performance over a period of 20 years. New evaluation methods reveal cell microstructure details (grain size, Cu₂S penetration into grain boundaries, etch pit depth and density) whose modification and control should allow reproducible achievement of at least 9% conversion efficiency. Cell degradation primarily involves changes in heterojunction collection efficiency, not minority carrier transport in the thin Cu₂S, light absorbing layer. Analysis of current technology predicts a selling price of \$0.53/peak watt (1975 dollars) for glass encapsulated, 8% efficient modules. More conservative material use, especially gold grid electrode, should allow a selling price of \$0.38/peak watt. DOE

N80-24853# FMC Corp., Santa Clara, Calif. Engineered Systems Div.

LINE FOCUS SOLAR THERMAL CENTRAL RECEIVER RESEARCH STUDY Final Report, 30 Apr. 1977 - 31 Mar. 1979

D. G. DiCanio, William J. Treytl, Frank A. Jur, and C. Don Watson Apr. 1979 314 p refs

(Contract EY-76-C-03-1246)

(DOE/ET/20426-1) Avail: NTIS HC A14/MF A01

The results of a study to examine the line focus central receiver alternative for solar thermal generation of electric power on a commercial scale are presented. The baseline concept consists of the following elements: (1) A solar collector (heliostat) whose geometry is the equivalent of a focused parabolic cylinder. The heliostat reflecting surface is composed of an array of flexible rectangular mirror panels supported along their long edges by a framework which rotates about an axis parallel to the ground plane. (2) A linear cavity receiver, composed of 61 meter (200-foot) sections supported by towers at an elevation of 61 meters (200 feet). Each section receives feedwater and produces turbine-rated steam. (3) Heliostat control, consisting of a local controller at each heliostat module which communicates with a master control computer to perform elevation tracking and focal length adjustment. The control logic is open-loop, with sun position computer by the master computer with an algorithm.

DOE

N80-24855# Aerospace Corp., Los Angeles, Calif. Energy and Resources Div.

SOLAR THERMAL SMALL POWER SYSTEMS STUDY. PHASE 2: STUDY RESULTS

D. E. Lapedes, P. K. Munjal, and L. R. Sitney 12 Jul. 1979 239 p refs

(Contract ET-78-C-03-2226)

(DOE/ET/20516-2) Avail: NTIS HC A11/MF A01

This study of small solar power systems (SSPS) was structured to determine conditions under which SSPS can be cost-effective

sources of electric power in the US in the period 1985 to 2015. An extensive data base, which provides a discrete identification of all utility and industrial electric generating units up to and including 10 MW/sub e/ in rated capacity, was prepared. This data base defines the market for which comparative evaluations are made of SSPS and alternative fossil-fueled power plants. The market penetration of SSPS is determined and the effect of economic incentives on accelerating the penetration is evaluated. The solar electric power system is evaluated as either a complete replacement for existing conventional electric power systems or as a repowering installation for boilers supplying steam to turbine-driven generators. The cost data used in the market penetration analysis are for a central receiver-type of small solar thermal power system. While the market penetration discussed is for this type of SSPS, the sensitivity data in the report can be used to determine the market penetration of other types of solar thermal power systems (e.g., point focus distributed receiver) with different system costs.

DOE

N80-24858# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

PERFORMANCE EVALUATION OF A SOLAR AIR-HEATING AND NOCTURNAL COOLING SYSTEM IN CSU SOLAR HOUSE 2 Final Report, 1 Jun. 1977 - 30 Sep. 1978

Susumu Karaki Apr. 1979 173 p refs

(Contract EY-76-S-02-2868)

(COO-2868-5) Avail: NTIS HC A08/MF A01

The solar heating system in Colorado solar house No.2 consists of 67.1 sq m of double glazed air-heating collectors with flat-black absorbers, 10.3 cu m of pebble bed storage, air-to-water heat exchanger for preheating domestic water, and one blower to circulate the air through the system. The nocturnal cooling system consists of an evaporative cooler and utilizes the pebble bed for cool storage. A schematic diagram of the system is presented.

DOE

N80-24862# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

STANDARD ASSUMPTIONS AND METHODS FOR SOLAR HEATING AND COOLING SYSTEMS ANALYSIS

Cecile M. Laboef Jan. 1980 7 p refs Presented at the 2nd Ann. Systems Simulation and Econ. Anal. Conf., San Diego, Calif., 23-25 Jan. 1980

(Contract EG-77-C-01-4042)

(SERI/TP-351-548; CONF-800101-9)

Avail: NTIS

HC A02/MF A01

A set of inputs, assumptions, analytical methods, and a reporting format is presented to help compare the results of residential and commercial solar system analyses being performed by different investigators. For residential heating and cooling systems, three locations were selected. The weather data chosen to characterize these cities are the Typical Meteorological Year (TMY). A house for each location was defined that is typical of new construction in that locale. Hourly loads for each location were calculated using a computerized load model that interacts with the system specified inputs characterizing each house. Four locations for commercial cooling analyses were selected from among the existing sites for which TMYs were available. A light commercial (nominal 25 ton cooling load) office building was defined and is used in all four locations. Hourly cooling and heating loads were computed for each city.

DOE

N80-24867# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. **SOLAR-POWERED ENVIRONMENTAL DATA COLLECTION SYSTEM**

H. W. Randolph Feb. 1980 18 p

(Contract EY-76-C-09-0001)

(DP-1529) Avail: NTIS HC A02/MF A01

A solar powered system consisting of a multipurpose remote data collector, a radio data link, and a data receiving station was designed to acquire data from various remote areas at the Savannah River Plant. A prototype system was built to monitor gamma radiation at the plant perimeter. It is operating satisfactorily and will be installed to monitor gamma radiation or other environmental parameters at many remote locations on the plant.

DOE

N80-24874# New Mexico Energy Inst., Albuquerque.
PREPARATION OF HIGHLY EFFICIENT SOLAR CELLS AND CORROSION STUDIES ON SOLAR CELL MATERIALS Final Report, 1 Jul. 1978 - 30 Jun. 1979
 Su-Moon Park Jul. 1979 69 p refs Sponsored by New Mexico Energy and Minerals Dept.
 (PB80-141294; NMEI-46) Avail: NTIS HC A04/MF A01 CSCL 10B

The Pourbaix diagram was applied to the prediction and understanding of corrosion properties of semiconductor materials. With the aid of flat band potential information, the thermodynamic stability of semiconductor materials under various operating conditions, types of electrodes (n- or p-), conversion efficiencies, types of redox couples, and the proper operating pH-region can be determined. Electrolyte and pH dependencies of flat band potentials were studied to be able to design more efficient semiconductor-liquid junction solar cells. Various effects of electrolytes on flat band potentials were also studied. GRA

N80-24878# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Civil Engineering.
SNOW AND ICE ACCUMULATION AROUND SOLAR COLLECTOR INSTALLATIONS Final Report
 Michael J. O'Rourke Aug. 1979 75 p refs Sponsored in part by DOE

(Contract NB79-NAAA-6099)
 (PB80-127053; NBS-GCR-79-180) Avail: NTIS HC A04/MF A01 CSCL 13A

Half the installations had the collectors mounted flush with the roof surface, while the remainder had collectors mounted on racks at an angle to the roof. Contours of snow depth on the roof, snow densities, measurements of snow on the ground adjacent to the building, sketches, and photographs of the roofs, and comments of the owners of the installations are included in addition to a discussion of the state of the art of predicting snow accumulation on roofs of buildings. The effect of solar collectors on the design of roof structures for the support of snow loads is discussed and recommendations for future research are made. GRA

N80-25618# Virginia Polytechnic Inst. and State Univ., Blacksburg.
HEAT CONDUCTION IN PARTIAL VACUUM Technical Progress Report, 7 Aug. 1978 - 31 Jan. 1979
 J. R. Thomas Feb. 1979 32 p refs
 (Contract EM-78-C-04-5367)
 (ALO-5367-1) Avail: NTIS HC A03/MF A01

Basic theoretical work on heat conduction in evacuated solar collectors is reported. The results include estimates for minimum partial vacuum necessary to eliminate conduction, and the effects of helium penetration into the region. DOE

N80-25778 Oklahoma State Univ., Stillwater.
DESIGN PARAMETERS FOR SOLAR POWERED ABSORPTION COOLING SYSTEMS WITH CHILLED WATER STORAGE Ph.D Thesis
 Ping-Shian Shih 1979 120 p
 Avail: Univ. Microfilms Order No. 8013046

A simulation model of a solar cooling system with chilled water storage was formulated. Simulations were performed using typical meteorological year data of seven SOLMET stations to study the relationship between the performance of the system and design parameters. The chilled water storage was found to be an effective scheme for improving the performance of the solar cooling system. The effectiveness of this scheme depends largely on the proper sizing of the chilled water storage, and collector area. The predictions of the semi-empirical equation were found to be within six percent accuracy of the simulation results. This equation was also found to be valid for locations with considerable differences in their weather patterns. The annual cost analysis showed that proper sizing of the chilled water storage, hot water storage, and collector area can improve significantly the economics of the solar cooling system. Although the solar cooling system is not economically feasible at the present time due to the high cost of the solar energy collector and the low cost of the conventional fuel, a properly designed solar cooling system can become economically attractive when the fuel cost becomes more expensive. Dissert. Abstr.

N80-25782*# Pennsylvania Univ., Philadelphia. School of Electrical Engineering.
ANALYSIS AND EVALUATION IN THE PRODUCTION PROCESS AND EQUIPMENT AREA OF THE LOW-COST SOLAR ARRAY PROJECT Annual Report, Oct. 1978 - Oct. 1979

H. Goldman and M. Wolf Oct. 1979 203 p refs
 (Contract JPL-954796)

(NASA-CR-163208; JPL-9950-342; DOE/JPL-954796-79/7) Avail: NTIS HC A10/MF A01 CSCL 10A

Analyses of slicing processes and junction formation processes are presented. A simple method for evaluation of the relative economic merits of competing process options with respect to the cost of energy produced by the system is described. An energy consumption analysis was developed and applied to determine the energy consumption in the solar module fabrication process sequence, from the mining of the SiO₂ to shipping. The analysis shows that, in current technology practice, inordinate energy use in the purification step, and large wastage of the invested energy through losses, particularly poor conversion in slicing, as well as inadequate yields throughout. The cell process energy expenditures already show a downward trend based on increased throughput rates. The large improvement, however, depends on the introduction of a more efficient purification process and of acceptable ribbon growing techniques. R.E.S.

N80-25783*# Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

TEST RESULTS ON THE FRENCHMAN'S REEF SOLAR DATA ACQUISITION AND CONTROL SYSTEM

15 Jan. 1980 19 p refs Sponsored in part by DOE
 (Contract NAS8-32036)

(NASA-CR-161449) Avail: NTIS HC A02/MF A01 CSCL 10A

The Frenchman's Reef Data Acquisition and Control System (DACS), Sunlogger model 10000-1 was evaluated to determine the accuracy of control functions and the performance of the system in the environment of the planned installation site. The Sunlogger system was verified to perform normally in an environment of 100 F and approximately 90% humidity. It is recommended however that the Sunlogger be installed in a controlled environment with temperatures and humidity significantly lower than those referenced above. R.E.S.

N80-25784*# Radian Corp., Austin, Tex.
SOLAR HEATING AND COOLING DEMONSTRATION PROJECT AT RADIAN CORPORATION, AUSTIN, TEXAS Final Report

May 1980 41 p Sponsored in part by NASA
 (Contract EX-78-C-01-2396)

(NASA-CR-161442) Avail: NTIS HC A03/MF A01 CSCL 10A

The solar heating and cooling system located at the Radian Corporation, Austin, Texas, is discussed. A technical description of the solar system is presented. The costs of the major components and the cost of installing the system are described. Flow diagrams and photographs of the solar system are provided. R.E.S.

N80-25788*# Telex Communications, Inc., Blue Earth, Minn.
SOLAR HEATING SYSTEM INSTALLED AT TELEX COMMUNICATIONS, INC., BLUE EARTH, MINNESOTA Final Report

28 Oct. 1977 177 p
 (Contract E(49-18)-2376)

(NASA-CR-161437) Avail: NTIS HC A09/MF A01 CSCL 10A

The solar heating system for space heating a 97,000 square foot building which houses administrative offices, assembly areas, and warehouse space is summarized. Information on system description, test data, major problems and resolutions, performance, operation and maintenance manual, manufacturer's literature, and as-built drawings is presented. R.E.S.

N80-25787*# IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION:

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SEASONAL REPORT FOR DECADE 80 HOUSE, TUCSON, ARIZONA Progress Report, Nov. 1973 - Sep. 1979
May 1980 103 p refs Prepared for DOE
(Contract NAS8-32036)
(NASA-CR-161450) Avail: NTIS HC A06/MF A01 CSCL 10A

The operational and thermal performance of the Decade 80 solar energy system is described. The system was designed by Cooper Development Association, Inc. with space heating and space cooling to a one-story, single family residence located in Tucson, Arizona. The Decade 80 House was designed and built in the mid-70's to be a showplace/workshop for solar energy utilization. Superior construction techniques, the use of quality materials and a full time maintenance staff have served to make the entire system an outstanding example of the application of solar energy for residential purposes. The luxury of a full time, on-site maintenance person is perhaps the single most important aspect of this program. While most installations cannot support this level of maintenance, it was very useful in keeping all subsystems operating in top form and allowing for a full season data collection to be obtained. Several conclusions were drawn from the long term monitoring effort, among which are: (1) flat plate collectors will support cooling; (2) definite energy savings can be realized; and (3) more frequent periodic maintenance may be required on solar energy systems that are not custom built. R.E.S.

N80-25788*# Gilliland-Bell Associates, Inc., Greenwood, S.C. **SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT MUNICIPAL BUILDING COMPLEX, ABBEVILLE, SOUTH CAROLINA Final Report**
Nov. 1979 54 p Sponsored in part by NASA
(Contract EM-78-F-01-5202)
(NASA-CR-161443) Avail: NTIS HC A04/MF A01 CSCL 10A

Information on the solar energy system installed at the new municipal building for the City of Abbeville, SC is presented, including a description of solar energy system and buildings, lessons learned, and recommendations. The solar space heating system is a direct air heating system. The flat roof collector panel was sized to provide 75% of the heating requirement based on an average day in January. The collectors used are job-built with two layers of filon corrugated fiberglass FRP panels cross lapped make up the cover. The storage consists of a pit filled with washed 3/4 in - 1 1/2 in diameter crushed granite stone. The air handler includes the air handling mechanism, motorized dampers, air circulating blower, sensors, control relays and mode control unit. Solar heating of water is provided only those times when the hot air in the collector is exhausted to the outside. R.E.S.

N80-25789*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md. **UNFULFILLED TECHNOLOGY NEEDS IN SPACE POWER SYSTEMS**
Luther W. Slifer, Jr. Apr. 1980 21 p refs Proposed for presentation at 15th Intersoc. Energy Conversion Engr. Conf., Seattle, 18-22 Aug. 1980
(NASA-TM-80677) Avail: NTIS HC A02/MF A01 CSCL 10A

Major power system technology development needs related to the solution of currently existing problems are defined. The identified problems were initially listed and categorized by technical area. They were then translated into terms of technology development requirements and consolidated where commonality was found. From these requirements, a set of ten specific recommendations for technology development was formulated. R.E.S.

N80-25790*# IBM Federal Systems Div., Huntsville, Ala. **SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR IBM SYSTEM 1A, HUNTSVILLE, ALABAMA Contractor Report, Sep. 1978 - Aug. 1979**
May 1980 85 p refs Sponsored in part by DOE

(Contract NAS8-32036)
(NASA-CR-161464) Avail: NTIS HC A05/MF A01 CSCL 10A

The operational and thermal performance of the solar energy system, Sims Prototype System 1A, is described. The system was designed by IBM to provide 50 to 60 percent of the space heating and domestic hot water preheating load to a 2,000 square foot floor space single family residence in the Huntsville area. The load design temperature inside the building was to be maintained at 70 degrees fahrenheit with auxiliary energy for heating supplied by an electric heat pump assisted by an electric resistance strip heater. In general the disappointing operation of this system is attributed to the manner in which it was used. The system was designed for residential application and used to satisfy the demands of an office environment. The differences were: (1) inside temperature was not maintained at 70 F as expected; and (2) hot water usage was much lower than expected. The conclusion is that the solar energy system must be designed for the type of application in which it is used. Misapplication usually will have an adverse affect on system performance. R.E.S.

N80-25791*# IBM Federal Systems Div., Huntsville, Ala. **SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR SOLARON-AKRON, AKRON, OHIO Contractor Report, Nov. 1978 - Oct. 1979**
May 1980 87 p refs Sponsored in part by DOE
(Contract NAS8-32036)
(NASA-CR-161465) Avail: NTIS HC A05/MF A01 CSCL 10A

The operational and thermal performance of the solar energy system by Solaron Corporation is described. The system was designed to provide an 1940 square foot floor area with space heating and domestic hot water for a dual-level single family residence in Akron, Ohio. The solar energy system uses air as the heat transport medium, has a 546 square foot flat plate collector array subsystem, a 270 cubic foot rock thermal storage bin subsystem, a domestic hot water preheat tank, pumps, controls and transport lines. In general, the performance of the Solaron Akron solar energy system was somewhat difficult to assess for the November 1978 through October 1979 time period. The problems relating to the control systems, various solar energy leakages, air flow correction factors and instrumentation cause a significant amount of subjectivity to be involved in the performance assessment for this solar energy system. Had these problems not been present, it is felt that this system would have exhibited a reasonably high level of measured performance. R.E.S.

N80-25798# CCB/CUMALI Associates, Oakland, Calif. **PASSIVE SOLAR CALCULATION METHODS Final Report, 15 Oct. 1978 - 15 Jun. 1979**
Zulfikar O. Cumali, A. Osman Sezgen, and Robert Sullivan 15 Jun. 1979 112 p refs
(Contract EM-78-C-01-5221)
(DSE-5221-T1) Avail: NTIS HC A06/MF A01

An analytical treatment related to the generation of space specific weighting factors is presented using a recursion relationship which employs a heat balance of both the outside and inside surface. The multizone problem is then discussed. The use of frequency domain methods is detailed such that the amplitude ratio and phase shift characteristics for a sinusoidal excitation are derived for the thermal load resulting from radiation heat gain/loss and space air temperature fluctuations. The results of a parametric study related to variable floor properties, radiation distributions and space sizes are presented. The weighting factors generated for each perturbation were used to define the expected differences in space response characteristics. DOE

N80-25806# Colorado State Univ., Fort Collins. Solar Applications Energy Lab. **CSU SOLAR HOUSE 3: SOLAR HEATING AND COOLING SYSTEM PERFORMANCE Progress Report, 1 Oct. 1978 - 31 May 1979**
D. S. Ward Aug. 1979 47 p refs
(Contract DE-AC02-79CS-30122)
(COO-30122-3) Avail: NTIS HC A03/MF A01

During the period 1 October 1978 through 31 March 1979, the Chamberlain liquid-heating state-of-the-art flat-plate solar collector was evaluated for a complete heating season. Significant and important results of the systems evaluation include: (1) the demonstration of the critical importance of temperature differentials between the collector outlet and the absorption chiller generator inlet, the effects of alternative control strategies, the marginal feasibility of cool storage, the devastating effect on system performance due to heat losses from the thermal storage unit, and the importance of minimizing electrical parasitic power requirements in obtaining feasibility for solar absorption cooling systems; (2) the concept of overall system efficiency was shown to be essential in the determination of the feasibility of any solar installation; and (3) evaluation of acquired data on the performance of the Colorado solar house system has provided the theoretical construction and experimental No.3 verification of the importance of solar operating threshold. DOE

N80-25811# Chicago Univ., Ill. Enrico Fermi Inst.
DESIGN AND TEST OF NON-EVACUATED SOLAR COLLECTORS WITH COMPOUND PARABOLIC CONCENTRATORS
 A. Rabl, J. O'Gallagher, and R. Winston Jul. 1979 60 p refs
 (Contract EY-76-S-02-2446)
 (EFI-79-42) Avail: NTIS HC A04/MF A01

The intermediate range of concentration ratios (1.5X-10X) which can be achieved with CPC's without diurnal tracking provides both economic and thermal advantages for solar collector design even when used with nonevacuated absorbers. The present paper summarizes more than 3 years of research on nonevacuated CPC's and reviews measured performance data and critical design considerations. Concentrations in the upper portions of the practical range (e.g., 6X) can provide good efficiency (40 percent to 50 percent) in the 100 C to 160 C temperature range with relatively frequent tilt adjustments (12 to 20 times per year). At lower concentrations (e.g., 3X) performance will still be substantially better than for a double glazed flat plate collector above about 70 C and competitive below, while requiring only semiannual adjustments for year round operation. In both cases the cost savings associated with inexpensive reflectors, and the optimal coupling to smaller, simple inexpensive absorbers (e.g., tubes, fins, etc.) can be as important an advantage as the improved thermal performance. DOE

N80-25812# GTE Labs., Inc., Waltham, Mass.
DEVELOPMENT OF MATERIALS FOR A LUMINESCENT SOLAR COLLECTOR Annual Progress Report, 1 Sep. 1978 - 31 Aug. 1979
 A. Lempicki, L. Andrews, and B. C. McCollum 1979 42 p refs
 (Contract ER-78-C-02-4996)
 (COO-4996-1) Avail: NTIS HC A03/MF A01

The objectives of the research involved preparation of a number of Cr(3+) doped glasses beginning with common commercial types, and expansion of the number and variety of glasses as time allowed. The Cr(3+) doped glasses were evaluated by spectroscopic measurements which included absorption and emission as well as quantum yield determinations. In addition, the influence of concentration quenching was measured by studying the luminescence decay kinetics at various concentrations in a variety of glasses. As the program developed, and the problem of rather low quantum yields became apparent in all the glasses, a rather detailed investigation was undertaken to better understand the radiationless decay of Cr(3+) in order to best evaluate the future direction of the program. The results are summarized. DOE

N80-25813# General Electric Co., Philadelphia, Pa. Advanced Energy Program.
SOLAIR HEATER PROGRAM: SOLAIR APPLICATIONS STUDY Final Report
 Dec. 1977 96 p
 (Contract EY-76-C-02-2705)
 (COO-2705-3) Avail: NTIS HC A05/MF A01

The evaluation identified attractive applications, evaluated corresponding control procedures, estimated system performance, compared economically insolation and insulation, and evaluated

the repackaging of off-the-shelf equipment for improved cost effectiveness. A detailed commercialization study of a residential domestic water heating system using the Solair concept which has been selected as the most attractive application was done. Other attractive applications are space/domestic water heating and a heat pump assisted solar system/domestic water heating where the heat pump and the solar system function in parallel. A prime advantage of heated air solar systems over liquid systems is cost and longer life which results in higher Btu's/dollar. Other air system advantages are no liquid leakage problems, no toxicity of freezing problems, and less complicated equipment. A hybrid solar system has been identified that can improve the market penetration of solar energy. Details of this system are provided. DOE

N80-25814# Argonne National Lab., Ill. Solar Energy Group.
DESIGN OF A SYSTEM USING CPC COLLECTORS TO COLLECT SOLAR ENERGY AND TO PRODUCE INDUSTRIAL PROCESS STEAM
 C. K. Hsieh (Florida Univ., Gainesville) Aug. 1979 105 p refs
 (Contract W-31-109-eng-38)
 (ANL-79-102) Avail: NTIS HC A06/MF A01

A system was designed to use CPC collectors to collect solar energy and to generate steam for industrial process heat purposes. The system is divided into two loops with the collectors in the collector loop to operate a preheater and the collectors in the boiler loop to heat water to elevated pressures and temperatures. A flash boiler is used to throttle the heated water to steam. Two types of CPC collectors are chosen. In the collector loop the CPC collectors are fitted with concentric tube receivers. In the boiler loop the collectors employ heat pipes to transmit heat. This design is able to alleviate the scaling and plumbing problems. A fragile receiver tube can also be employed without rupture difficulties. The thermal processes in the collectors were analyzed using a computer modeling. The results were also used to develop a thermodynamic analysis of the total system. Calculations show that the design is technically feasible. The CPC collector is shown to have an efficiency that is very weakly dependent on its operating temperatures, which makes the collector particularly attractive in high temperature applications. DOE

N80-25816# International Business Machines Corp., Gaithersburg, Md.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION. ALBUQUERQUE WESTERN NO. 1, ALBUQUERQUE, NEW MEXICO Progress Report, Oct. 1978 - Mar. 1979
 C. M. Fu 1979 65 p refs
 (Contract EG-77-C-01-4049)
 (SOLAR/1011-79/14) Avail: NTIS HC A04/MF A01

The Albuquerque Western site is a four story, 110 unit apartment building in Albuquerque, New Mexico. The solar energy system consists of two independently controlled systems: one system serves domestic hot water (DHW) preheating needs, the other serves to preheat hot water used in space heating. Only the DHW system is described. The solar energy system has an array of tracking collectors with a gross area of 1782 square feet. The array faces south at an angle of 35 degrees to the horizontal. Water is the transfer medium that delivers solar energy from the collector array to storage. Solar energy is stored in a 2000 gallon wooden tank that contains a plastic liner. The DHW is continuously circulated throughout the building. When solar energy is insufficient to satisfy the hot water energy requirements, auxiliary heating is provided by an inline gas-fired boiler. An operational summary of the performance of the system for the period October 1978 through March 1979 is presented. DOE

N80-25817# Los Alamos Scientific Lab., N. Mex.
HIGH TEMPERATURE HYDROGEN CYCLES FOR SOLAR HEAT SOURCES
 M. G. Bowman 1979 16 p refs Presented at Solar Fuel Workshop, Albuquerque, N. Mex., 28-29 Nov. 1979; sponsored by Solar Thermal Test Facilities Users Assoc. Submitted for publication

02 SOLAR ENERGY

(Contract W-7405-eng-36)
(LA-UR-80-184; CONF-791143-3) Avail: NTIS
HC A02/MF A01

Some of the criteria required for high temperature thermo-chemistry hydrogen cycles to couple efficiently with solar heat sources are defined. Some of the experimentally validated cycles that have been developed over the years in terms of these criteria are examined and potential cycles that are being considered for the higher temperatures potentially available from solar concentrators are discussed. Cycles discussed include oxide sulfate cycles, halide hydrolysis cycles, direct decomposition of H₂O and CO₂, oxide cycles, and sulfuric acid-metal cycles. DOE

N80-25818# Boeing Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION FOR A-FRAME INDUSTRIES' SINGLE FAMILY RESIDENCE: KANEHOE, HAWAII

27 Jul. 1979 44 p
(Contracts EX-76-A-29-1020; HUD-H-2372)
(SOLAR/1010-79/50) Avail: NTIS HC A03/MF A01

A solar energy system designed to provide domestic hot water heating is described. The system uses city water as the common heat transfer medium, and contains no energy storage tank or DHW tank heat exchanger loop. Therefore, the total operating energy is in the energy collection and storage subsystem (ECSS). The house has been fully instrumented for performance evaluation of the solar system since February 1978 and the compiled data are discussed. Original cost estimates for provisioning and installation of the solar system are given. DOE

N80-25819# Boeing Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION. ALBUQUERQUE WESTERN-2 MULTI-DWELLING BUILDING ALBUQUERQUE, NEW MEXICO

D. Moore 23 Nov. 1979 43 p refs
(Contracts EX-76-A-29-1020; HUD-H-2372)
(SOLAR/1090-79/50) Avail: NTIS HC A03/MF A01

The Albuquerque Western-2 site is a four-story, 110 unit apartment building in Albuquerque, New Mexico. The solar energy system consists of a controlled system to preheat hot water used in space heating. The solar energy system is designed to provide approximately 54 percent of the conditioned space heating load. The system has an array of tracking collectors with a gross area of 6429 square feet. The array faces south at an angle of 35 degrees to the horizontal. Water is used as the medium for delivering energy from the collector array to storage. Solar energy is stored underground in a 57,000 gallon concrete storage tank. During the space heating season, the heated water from storage is continuously circulated through the building to satisfy the space heating needs for each apartment. Auxiliary heating is provided by three inline gas-fired boilers. The system has three modes of operation. Original cost estimates for provisioning and installation of the solar system are given. DOE

N80-25821# Boeing Aerospace Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION FOR PERL-MACK ENTERPRISES' SINGLE FAMILY RESIDENCES, DENVER, COLORADO

21 Aug. 1979 50 p
(Contracts EG-77-C-01-4049; HUD-H-2372)
(SOLAR/1015-79/50) Avail: NTIS HC A03/MF A01

The Perl-Mack Enterprises Co. solar energy systems, which are installed in a total of 25 single family dwellings located in Denver, Colorado, are described. The 25 dwellings are of three different configurations. Two of the twenty-five dwellings have been fully instrumented for performance monitoring and evaluation since September 1977. All the solar systems are designed to provide approximately 69 percent of the space heating and energy requirements for each dwelling. Solar energy is collected by an array of flat plate collectors having a gross area of 470 square feet. A water-glycol mixture is used as the medium for delivering solar heat from the collection to the storage tank. The storage tank has a total capacity of 945 gallons. A liquid-to-liquid heat exchanger, within the storage tank, transfers the stored heat from the transfer medium to the domestic hot water tank of the house. DOE

N80-25822# Bell Telephone Labs., Inc., Philadelphia, Pa.
WEST CHESTER WORK CENTER: SOLAR SPACE HEATING DEMONSTRATION PROJECT

May 1979 47 p ref
(Contract EY-76-C-02-4048)
(DOE/CS-4048/2; COO-4048-2) Avail: NTIS
HC A03/MF A01

The construction stage of an integrated system providing solar energy space heating for 9982 sq ft, newly built, one-story building is described. The building is located at 966 Matlack Street, West Goshen Township, Chester County, Pennsylvania. Functionally, the building consists of two sections: an office and a storeroom. The office section is heated by solar-assisted water-to-air heat pump units. The storeroom section is heated by an air-handling unit, containing a water-to-air coil. Solar energy is expected to provide 62% of the heating load, with the balance provided by a back-up electric boiler. The system includes 1900 active (2112 gross) square feet of flat-plate solar collectors, and a 6000 gallon above ground indoor storage tank. Freeze protection is provided by a gravity drain-down scheme combined with nitrogen pressurization in a closed circuit. DOE

N80-25823# Wisconsin Univ. - Madison. Solar Energy Lab.
SIMULATION AND DESIGN OF SOLAR THERMAL PROCESSES

31 Oct. 1979 16 p refs
(Contract EY-76-S-02-2588)
(COO-2588-T1) Avail: NTIS HC A02/MF A01

Research on simulation using TRNSYS and FCHART methods is described including systems analysis, user services, design procedures, and model validation. DOE

N80-25825# General Electric Co., Philadelphia, Pa. Advanced Energy Dept.

SOLAR TOTAL ENERGY PROJECT SHENANDOAH Final Design Report

10 Jan. 1980 340 p
(Contract EG-77-C-04-3985; DE-AC04-77ET-20260)
(ALO-3985-1-Rev-1) Avail: NTIS HC A15/MF A01

A description of the final design for the Solar Total Energy System to be installed at the Shenandoah, Georgia, site of utilization by the Bleyle knitwear plant, is presented. The system is a fully cascaded total energy system design featuring high temperature paraboloidal dish solar collectors with a 235 concentration ratio, a steam Rankine cycle power conversion system capable of supplying 100 to 400 kW(e) output with an intermediate process steam take-off point, and a back pressure condenser for heating and cooling. The design also includes an integrated control system employing the supervisory control concept to allow maximum experimental flexibility. The system design criteria and requirements are presented including the performance criteria and operating requirements, environmental conditions of operation; interface requirements with the Bleyle plant and the Georgia Power Company lines; maintenance, reliability, and testing requirements; health and safety requirements; and other applicable ordinances and codes. DOE

N80-25826# BDM Services Co., Albuquerque, N. Mex.
CONCEPTUAL DESIGN AND ANALYSIS OF A 100 MWE DISTRIBUTED LINE FOCUS SOLAR CENTRAL POWER PLANT Topical Report, 29 Sep. 1978 - 4 May 1979

M. G. Semmens, A. Fong, G. J. Collaros, R. E. Dascher, R. E. Grassberger, D. B. Griego, and T. F. Stueber 1979 327 p
(Contract ET-78-C-03-2073)

(SAN-2073-1) Avail: NTIS HC A15/MF A01
A program to develop the optimum line focus solar central power plant system conceptual design is reported in detail. The approach consisted of a parametric analysis of each of the seven major subsystems: collector, receiver tube, working fluid, heat transport subsystem, energy storage subsystem, electric power generating subsystem, and master control subsystem. Systems analysis and selection of the baseline 100 MWe line focus power plant are described. Detailed performance and cost summaries are included. DOE

N80-25839# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SOLAR TECHNOLOGY APPLICATION TO ENHANCED OIL RECOVERY

P. deLeon, K. C. Brown, J. W. Margolis, and L. H. Nasr Dec. 1979 101 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-352-392) Avail: NTIS HC A06/MF A01

Solar energy systems which generate steam for thermal enhanced oil recovery are discussed. Six solar technologies are evaluated and two parabolic troughs and central receivers are selected for closer study. The legal and environmental issues attending solar enhanced oil recovery are analyzed. The petroleum producing companies' preferences and requirements are discussed. Alternative means of financing solar enhanced oil recovery are addressed. DOE

N80-25843# Varian Associates, Palo Alto, Calif.

NOVEL SOLAR CELL CONCENTRATOR PHOTOVOLTAIC CONVERTER SYSTEM Final Report

L. W. James and A. VanderPlas Dec. 1979 91 p refs Prepared for Sandia Labs., Albuquerque, New Mex.

(Contract EY-76-C-04-0789)

(SAND-79-7048) Avail: NTIS HC A05/MF A01

Attainment of photovoltaic conversion efficiencies greater than 25% to 30% thought necessary to make concentrator photovoltaics economical, seems possible if the solar spectrum is more efficiently used by splitting the spectrum and using solar cells of different bandgaps. For initial work on multi-bandgap concentrator solar cells, the spectrum was split by an optical filter which transmits light above 1.6 eV and below 1.1 eV and reflects light between 1.1 and 1.6 eV. Theoretical modeling of possible conversion efficiencies led to the choice of the filter bandpass energies and practical solar cell fabrication considerations have led to the choice of silicon and the Al(x) Ga(1-x)As system for initial development work. Special silicon concentrator solar cells with a p(+):n(-):n(+) structure designed for this application and have attained apparent cell conversion efficiencies of 16.2% at a current ratio of 455 suns. DOE

N80-25850# Sperry Univac, St. Paul, Minn.

SOLAR COLLECTOR STUDIES FOR SOLAR HEATING AND COOLING APPLICATIONS Technical Progress Report, 18 Sep. 1978 - 18 Mar. 1979

S. O. Jensen, J. E. Kovacic, and J. H. Anderson (Scientific Sunsource Systems) 10 Mar. 1979 56 p refs

(Contract EM-78-C-04-5355)

(ALO-5355-T1) Avail: NTIS HC A04/MF A01

A summary of the literature, especially patent teachings pertaining to black fluid solar collectors, is given. Laboratory tests to determine the suspension stability of various carbon types in water/ethylene glycol are reported. The suspensions were aged at 160 F for 2000 hours and at -15 F for 500 hours. Tests to date demonstrate that colloidal carbon with Zanflow gum as the suspending agent gave excellent, stable suspensions even after evaporation and resuspension with water/ethylene glycol 50:50 solution. It is suggested that the suspending agent interacts with electrical charges on the carbon particles to prevent agglomeration. DOE

N80-25851# American Science and Engineering, Inc., Cambridge, Mass.

DEVELOPMENT OF A SECOND-GENERATION CONCENTRATING TRACKING SOLAR COLLECTOR Technical Progress Report, 28 Dec. 1978 - 19 Jun. 1979

William D. Antrim, Jr. 16 Aug. 1979 29 p

(Contract EM-78-C-04-4275)

(ASE-4460) Avail: NTIS HC A03/MF A01

A second generation concentrating tracking solar collector was developed. The approach combines an array of parabolic trough mirror concentrators each combined with a variation of the cylindrical blackbody receiver to provide a collector with a minimum concentration ratio of ten. The design of the prototype collector was completed, engineering model hardware produced, tested, and the design iterated. The collector design and some of the model hardware used to develop certain design features are described in detail. DOE

N80-25852# California Univ. at Berkeley. Sanitary Engineering Research Lab.

SOLAR ENERGY CONVERSION THROUGH BIOPHOTOLYSIS Annual Report, 1 Apr. 1978 - 31 Mar. 1979

J. R. Benemann, M. A. Murry, P. C. Hallenbeck, K. Miyamoto, A. G. Olafsen, D. J. Esteve, and L. V. Kochian 1 May 1979 236 p refs

(Contract EY-76-S-03-0034)

(SAN-0034-239-T1; AR-3) Avail: NTIS HC A11/MF A01

The state-of-the-art of biophotolysis was reviewed and a bioengineering analysis carried out. The conclusions were that practical biophotolysis systems are feasible; however, they will require, in most cases, relatively long-term R and D. The biophotolysis system developed, utilizing heterocystous blue-green algae, was demonstrated both indoors and outdoors with a model converter system using the heterocystous blue-green alga *Anabaena cylindrica*. Maximal light energy conversion efficiencies were 2.5 percent indoors and about 0.2 percent outdoors, averaged for periods of about two weeks. Achievement of such rates required optimization of N₂ supply and culture density. DOE

N80-25855# Solar Turbines International, San Diego, Calif. **DEVELOPMENT OF POLYIMIDE MATERIALS FOR USE IN SOLAR ENERGY SYSTEMS Semiannual Progress Report, 1 Aug. 1978 - 31 Jan. 1979**

A. L. Wilcoxson, U. A. Sorathia, and J. Gagliani 1979 39 p refs

(Contracts EM-78-C-04-5305)

(DOE/CS-35305/T1; SR-79-R-4650-09)

Avail: NTIS HC A03/MF A01

Two separate and distinct products were studied, a lightweight flexible insulating foam and a high density rigid, load bearing insulating foam. These products are derived from a polyimide resin. A critical characterization criteria was established in the form of environment exposure resistance. The foams were evaluated on the basis of this direct exposure test. Studies initiated to improve the resistance included additive studies, using reinforcements and uv absorbers, and postcure studies. The various formulations were also screened on the basis of humidity resistance. On the basis of testing conducted, four different resin formulations at a foam density of approximately 16 kg/cu m are meeting minimum requirements. The rigid foam was optimized through a glass reinforcement study and a process parameter study. The result was an optimized glass strand/microballoon reinforced foam which meets the tested property goals at a density of approximately 240 kg/cu m. DOE

N80-25858# Sandia Labs., Albuquerque, N. Mex. **SOLARIZATION OF HELIOSTAT GLASSES**

J. Vitko, Jr. and J. E. Shelby Dec. 1979 26 p refs Presented at the Solar Reflective Mater. Workshop, San Francisco, 12-14 Feb. 1980

(Contracts EY-76-C-04-0789; DE-AC04-79DP-00789)

(SAND-79-8754) Avail: NTIS HC A03/MF A01

A solar induced decrease in FE(2+) absorption in heliostat glasses from the solar furnace at Odeillo, France, has been observed. This decrease occurs throughout the sampled (not just at the exposed surface) and is of sufficient magnitude to result in an increase of 2.5% in solar transmittance in a period of nine years. Optical and ESR studies did not detect a corresponding increase in FE(3+) concentration. The implication of these results on a microscopic model for the observed solarization is discussed. Solar simulation studies produced effects of magnitude and sign similar to those observed in the field exposed samples, and appear to offer an attractive means for screening samples for solarization tendencies. DOE

N80-25860# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.

CLEANING AGENTS AND TECHNIQUES FOR CONCENTRATING SOLAR COLLECTORS

V. L. Morris 1980 65 p refs Presented at 2nd Solar Reflective Mater. Workshop, San Francisco, 12 Feb. 1980

(Contract EY-76-C-04-0789)

(SAND-80-7005C; CONF-800220-2)

Avail: NTIS HC A04/MF A01

02 SOLAR ENERGY

Tests were conducted to determine the nature of the soil which is irreversibly deposited on solar collectors during environmental exposure. Methods of removing this soil were investigated. The mechanism of attachment of the soil to the surface was determined as a potential aid to cleaning agent formulation. Reflector specimens were environmentally exposed at several industrial sites. Three types of reflector surfaces were studied: second surface silvered glass, aluminized FEK-244 film on aluminum substrate, and RTV 670 on aluminum. Cleaning procedures were evaluated by microscopic examination of the solid surfaces before and after cleaning by measurement of specular reflectance. The effect of local environmental degradation specific to an industrial process on solar collector surfaces was investigated. DOE

N80-25862# Department of Energy, Washington, D. C.
ENVIRONMENTAL DEVELOPMENT PLAN: SOLAR AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

Sep. 1979 41 p refs
(DOE/EDP-0033) Avail: NTIS HC A03/MF A01

The Environmental Development Plan system which provides a common basis for planning, managing, and reviewing the environmental aspects of solar agricultural and industrial process heat is described. Solar heating for fossil fuel generated process heat is considered along with shelter heating, drying, process hot water, process steam, and cooling and refrigeration. Materials development, system analysis, and component development and testing are among the factors discussed. R.G.D.

N80-25864# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

COMPARATIVE PERFORMANCE OF TWO TYPES OF EVACUATED TUBULAR SOLAR COLLECTORS IN A RESIDENTIAL HEATING AND COOLING SYSTEM Final Report, 1 Oct. 1977 - 30 Sep. 1978

G. O. G. Loef and W. F. Duff Sep. 1979 16 p
(Contract EY-76-S-02-2577)
(COO-2577-19) Avail: NTIS HC A02/MF A01

Two types of evacuated tubular solar collectors were operated in space heating, cooling, and domestic hot water heating systems in Colorado State University Solar House 1. A flat absorber plate inside a single walled glass tube is used in the Corning design, whereas heat is conducted through a single glass wall to an external heat exchanger plate in the Philips collector. The respective aperture areas are 50.0 sq m and 44.7 sq m. Since system designs and conditions of operation were not identical, efficiencies and energy deliveries of the two evacuated tubular collectors should not be compared without recognition of these factors. But in comparison with conventional flat plate collectors, both types show substantially reduced heat losses and improved efficiency. DOE

N80-25866# Argonne National Lab., Ill. Energy and Environmental Systems Div.

RELIABILITY AND MAINTAINABILITY EVALUATION OF SOLAR COLLECTOR AND MANIFOLD INTERCONNECTIONS

J. A. Mavec, R. Wolosewicz, A. Clark, P. Wang, and P. S. Chopra Mar. 1979 50 p refs
(Contract W-31-109-eng-38)
(SOLAR/0902-79/70; ANL/SDP/TM-79-4) Avail: NTIS HC A03/MF A01

The problem associated with the interconnection devices currently in use at demonstration sites were examined. The nature and causes of interconnection-related failures are presented, together with the corrective actions that were taken. Design criteria for interconnections in solar-energy systems were developed, and a number of guidelines are provided to assist designers in avoiding interconnection difficulties. DOE

N80-25867# Argonne National Lab., Ill.
TWO-TANK SEASONAL STORAGE CONCEPT FOR SOLAR SPACE HEATING OF BUILDINGS

B. K. Cha, D. W. Connor, and R. O. Mueller 1979 15 p refs
Presented at the APS Electron and Atomic Phys. Meeting,

Houston, Tex., 10-12 Dec. 1979
(Contract W-31-109-eng-38)

(CONF-791226-2) Avail: NTIS HC A02/MF A01

An analysis of a novel two tank water storage system is presented, consisting of a large primary water tank for seasonal storage of solar energy plus a much smaller secondary water tank for storage of solar energy collected during the heating season. The system offers the advantage of high collection efficiency during the early stages of the heating season, a period when the temperature of the primary tank is generally high. The resulting improvement in annual system efficiency through the addition of a small secondary tank is found to be substantial - for the site considered (Madison, Wisconsin), the relative percentage gain in annual performance is in the range of 10 to 20%. A simple computer model permits accurate hour-by-hour transient simulation of thermal performance over a yearly cycle. Results are presented of detailed simulations of collector and storage sizing and design tradeoffs for solar energy systems supplying 90 to 100% of annual heating load requirements. DOE

N80-25872# Argonne National Lab., Ill.
EVALUATION OF RELIABILITY OF OPERATIONAL SOLAR-ENERGY SYSTEMS

J. A. Mavec, E. Waite, and R. Wolosewicz 1979 8 p refs
Presented at Ann. Solar Heating and Cooling Systems Operational Results, Colorado Springs, Colo., 27 Nov. 1979
(Contract W-31-109-eng-38)

(CONF-791105-2) Avail: NTIS HC A02/MF A01

A reliability study of two solar heating systems using air as the heat transfer medium is presented. Failure modes and effects analysis were used to examine the controls of the systems for three operating modes. Principal components were identified for each mode, and a fault tree and reliability block diagram was constructed to structure the fault or failed sequence. Established failure rates were assigned to each component, and an exponential failure distribution was assumed. For components operating on demand at a given average frequency, the adjusted demand and normal operating failure rates were combined to reflect the total contribution. Representative operational times and component frequencies were found for each operating mode. A fault tree computer code was used to determine minimal outsets to the top event, remove redundant events, and perform necessary calculations. DOE

N80-25873# Alabama Univ. in Huntsville. Environmental Energy Center.

DATA HANDBOOK FOR THE NATIONAL SOLAR ENERGY DEMONSTRATION BOOK

David L. Christensen May 1979 87 p
(Contract EM-78-S-01-5216)

(DSE-5216-T4) Avail: NTIS HC A05/MF A01

Information is provided in a matrix format listing technical and programmatic data concerning the various project sites selected for the National Solar Energy Demonstration Program. The commercial, residential, and other demonstration projects which are now a part of the national program, are incorporated into one handbook, as a reference source for technical and research purposes on a state-by-state basis. DOE

N80-25875# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

CONCEPTUAL DESIGN OF ADVANCED CENTRAL RECEIVER POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 1: EXECUTIVE SUMMARY Final Report

Jun. 1979 64 p

(Contract EG-77-C-03-1483)

(SAN-1483-1/1; ESG-79-2-Vol-1)

Avail: NTIS HC A04/MF A01

The conceptual design of an advanced receiver power system using liquid sodium as a heat transport medium was completed. The technical and economic advantages of this concept were determined for commercial-scale power plants. Topics covered included: (1) review and analysis of preliminary specification;

(2) parametric analysis; (3) select commercial configuration; (4) commercial plant conceptual design; (5) assessment of commercial plant; (6) advanced central receiver power system development plan; (7) program plan; (8) reports and data; (9) program management; and (10) safety analysis. A programmatic overview of the accomplishments of this program is given. The 100 MW conceptual commercial plant, the 281 MW optimum plant, and the 10 MW pilot plant are described. DOE

N80-25876# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

CONCEPTUAL DESIGN OF ADVANCED CENTRAL RECEIVER POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 2, BOOK 1: COMMERCIAL PLANT CONCEPTUAL DESIGN Final Report

Mar. 1979 400 p refs

(Contract EG-77-C-03-1483)

(SAN-1483-1/2; ESG-79-2-Vol-2-BK-1)

Avail: NTIS

HC A17/MF A01

The conceptual design of the 100 MW solar tower focus commercial power plants is described in detail. Sodium is pumped up to the top of the tall tower where the receiver is located. The sodium is heated in the receiver and then flows down the tower, through a pressure reducing device, and into a large, hot storage tank made to meet a specific thermal energy storage capacity requirement. The sodium is pumped by a separate pump, through a system of sodium to water steam generators. The sodium flowing from the evaporator unit is piped to a cold

storage tank. From the cold storage tank, sodium is then pumped up to the tip of the tower to complete the cycle. The steam generated in the steam generators is fed to a conventional off-the-shelf, high-efficiency turbine. The steam loop operates in a conventional rankine cycle with the steam generators serving the same purpose as a conventional boiler and water being fed to the evaporator with conventional feedwater pumps. DOE

N80-25883# Department of Energy, Washington, D. C. Office of Solar Applications.

SOLAR ENERGY PROJECT: AN OVERVIEW

Jan. 1980 44 p refs

(DOE/CS-0124) Avail: NTIS HC A03/MF A01

The secondary school project is described which was developed by divisions of the University of the State of New York including the State Education Department, the University at Albany's Atmospheric Sciences Research Center and secondary schools represented by 80 participating science teachers. This cooperative effort of scientist and educator resulted in 43 classroom-tested activities suitable for infusion into five science curriculum areas, including junior high science, earth science, biology, chemistry and physics. These activities are also appropriate for the development of a separate solar energy course of study. National dissemination and pilot testing of this project will begin during the fall of 1978. DOE

N80-25886# Boston Univ., Mass. Dept. of Chemistry.
PHOTOCHEMICAL DETERMINANTS OF THE EFFICIENCY OF PHOTO GALVANIC CONVERSION OF SOLAR ENERGY
Morton Z. Hoffman and Norman N. Lichtin 1979 35 p refs
(Contract EY-76-S-02-2889)

(COO-2889-5) Avail: NTIS HC A03/MF A01

A photogalvanic cell is a battery in which the cell solution absorbs light directly to generate species which, upon back reaction through an external circuit with the aid of suitable electrodes, produces electric power; photoactivation of the electrodes is not involved. The charge-carrying species have storage capacity if they are long-lived and can be prevented from engaging in degradative back reactions in bulk solution. The efficiency of a photogalvanic cell for the conversion of photon energy into electrical energy is determined by photochemical and electrochemical factors. Among the latter are the choice of electrode materials and the kinetics of electron transfer at the heterogeneous surfaces. The photochemical determinants of the efficiency of photogalvanic cell operations are examined: the absorption spectral characteristics of the cell solution, the efficiency of formation of separated charge carriers, and the lifetimes of the carriers toward back electron transfer. Modulation of bulk solution dynamics can be

achieved by variation of the solution medium. The photochemical determinants are discussed with particular reference to the use of thionine or $\text{RU}(\text{bpy})_2/3(+)$ as the light absorbing species. DOE

N80-25903# SRI International Corp., Menlo Park, Calif.
LINE-FOCUS SOLAR CENTRAL POWER SYSTEMS PHASE 1 Topical Report, 29 Sep. 1978 - 30 Apr. 1979

A. J. Slemmons May 1979 115 p refs

(Contract EY-76-C-03-0015)

(SAN-0115-140-1) Avail: NTIS HC A06/MF A01

The subsystem and system parametric analysis for a 100 MW/sub e/ solar central power plant of the high temperature, line focus, cavity receiver type were completed. Annual leveled busbar energy costs of 55 mills/kWh are projected for the 80th plant. The conceptual design of the plant was initiated. DOE

N80-25905# California Univ., Livermore. Lawrence Livermore Lab.

SOLAR-ASSISTED HEAT PUMP-SWIMMING POOL SYNERGISTICS FOR DOMESTIC HEATING

T. R. Galloway Oct. 1979 11 p refs Presented at Systems Simulation and Econ. Analysis Conf., San Diego, Calif., 23 Jan. 1980

(Contract W-7405-eng-48)

(UCRL-83458; CONF-800101-1)

Avail: NTIS

HC A02/MF A01

A 150 cu m home, clear performance and economic advantages are shown for a solar assisted heat pump, providing domestic hot water and space heating and cooling. The pump uses a year round solar heated swimming pool as a large thermal energy reservoir. The pool cycles seasonably between 18 and 31 C, allowing year round swimming, and provides an excellent water source for the heat pump and low cost, low temperature plastic solar panels operating at their near optimum efficiency. The system was optimized by examining the performance and cost characteristics of different glazed and unglazed solar panel collector (areas from 28 to 150 cu m and orientation from horizontal to 60 deg tilt) for sites in San Francisco Bay Area and in San Joaquin Valley. DOE

N80-25906# Southern California Gas Co., Los Angeles.

SAGE, SOLAR ASSISTED GAS ENERGY Summary Report
S. J. Cunningham and J. Rice Sep. 1979 34 p

(Grant NSF PTP-75-03457)

(PB80-144363; NSF/RA-790330)

Avail: NTIS

HC A03/MF A01 CSCL 13A

A multidisciplinary effort to examine the problems of introducing solar energy into the United States building industry was conducted. The following were emphasized: (1) field installations and tests to evaluate new vs. retrofit installations; (2) market assessment of the potential for a SAGE water heating system in apartment buildings; and (3) policy analysis of strategies that would contribute to widespread utilization of SAGE water heating. Technical results of field installations and tests are described for two installations using the system configuration chosen from pilot plant analysis. GRA

N80-25907# Southern California Gas Co., Los Angeles.

SAGE, SOLAR ASSISTED GAS ENERGY Final Report

S. J. Cunningham Sep. 1979 225 p refs

(Grant NSF PTP-75-03457)

(PB80-153836; NSF/RA-790331)

Avail: NTIS

HC A10/MF A01 CSCL 13A

A technical and economic baseline for assessing the practical potential of solar water heating for apartments was developed. Several steps were involved in the development: (1) installing and testing two solar assisted gas energy (SAGE) water heating systems; (2) assessing the market potential for a SAGE water heating system and possible business arrangements; and (3) analyzing strategies that would contribute to wide-spread utilization of SAGE water heating. Project findings are reported with respect to technical results, cost analysis, system performance and maintenance results, market assessment and policy analysis. GRA

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N80-25982# Northrop Services, Inc., Huntsville, Ala.
SOLAR RADIATION DATA FORECAST AND INTERPOLATION ANALYSIS. FOLDER 1, PART 1: EXECUTIVE SUMMARY. PART 2: TECHNICAL ANALYSIS (TASKS 1 AND 2). PART 3: APPENDICES (TASKS 1 AND 2) Final Report

John Woo, Jr. Apr. 1979 184 p refs
(Contract EG-77-C-02-4494)
(COO-4494-1) Avail: NTIS HC A09/MF A01

Data were evaluated from the rehabilitated 52 station SOLMET solar radiation network. Techniques were established to transform radiation measurements taken on a horizontal surface to an inclined surface. A climatological cell statistics (CCS) method was developed to obtain the statistics of up to 24 variables occurring in combination with each other using surface meteorological data and to relate these statistics to the solar radiation measurements. A method to evaluate the differences between two insolation data sets, called the Wedge method, was developed to determine the representative area of a radiation measurement site. These methods were used to evaluate the capabilities of the NOAA solar radiation model to interpolate between measurement sites. Twenty-four methods of calculating solar radiation on inclined surfaces were investigated. All algorithms were rewritten in a common convention and nomenclature and the measurements required for each method were categorized.

DOE

N80-26075# Sandia Labs., Albuquerque, N. Mex.
COMPARISON BETWEEN RESULTS OF THE HELIOS AND MIRVAL COMPUTER CODES APPLIED TO CENTRAL RECEIVER SOLAR-ENERGY COLLECTION

Charles N. Vittitoe, Frank Biggs, and Patricia L. Leary (Sandia Labs., Livermore, Calif.) Jan. 1980 27 p refs
(Contract EY-76-C-04-0789)
(SAND-79-8266) Avail: NTIS HC A03/MF A01

The computer codes HELIOS and MIRVAL, developed to predict the optical performance of reflecting solar concentrators and to model power collection by central-receiver solar energy power plants are compared in regard to their performance predictions. HELIOS is an analytic code, whereas MIRVAL use Monte Carlo ray-tracing techniques. The sample problems for comparison consists of a rectangular target and alt-azimuth heliostats deployed in a north field. The results indicate that HELIOS and MIRVAL closely agree on prediction of field performance and of power density on the target plane. DOE

N80-26143# Cornell Univ., Ithaca, N. Y.
OPTICAL PROPERTIES OF METALLIC SURFACES, SMALL PARTICLES AND COMPOSITE COATINGS FOR SOLAR ENERGY CONVERSION APPLICATIONS Final Technical Report, 1 Apr. 1977 - 31 Aug. 1979

N. W. Ashcroft, R. A. Buhrman, A. J. Sievers, and J. W. Wilkins
Dec. 1979 26 p refs
(Contract EG-77-S-03-1456)
(DOE/ET-20413/1) Avail: NTIS HC A03/MF A01

A combined theoretical experimental-program to understand the optical properties of heterogeneous materials is described. The primary experimental quantity measured was the optical response from the visible to the far infrared. The production, structure and optical properties of composite metal-insulator cermet films were investigated. Using effective medium theories the optical properties were calculated and compared to experimental measurements. Studies of the design of spectrally selective solar energy absorbers using cermet films were made both experimentally and with computer simulation. Composite films were produced by controlled coevaporation of the metal and an insulator. The materials used include Ni, V, Fe, and Pt metals with dielectrics Al₂O₃, SiO₂, MgO and ZrO₂. Some preliminary results on amorphous aluminum are described. Crystalline aluminum has the disadvantage that its reflectance in the visible is smaller than those of some good free electron metals such as silver, which is unsuitable as a front surface reflector because of rapid corrosion. Interband transitions depress the reflectivity of aluminum in the solar spectrum. If these interband transitions could be eliminated and the free electron reflectance of aluminum obtained, a superior reflective coating would result.

DOE

N80-26182*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THE PLANAR MULTIJUNCTION CELL: A NEW SOLAR CELL FOR EARTH AND SPACE

John C. Evans, An-Ti Chai, and Chandra Goradia 1980 8 p refs Proposed for presentation at 15th Intern. Energy Conversion Engr. Conf., Seattle, Wash., 18-22 Aug. 1980; sponsored by AIAA, presented at 14th IEEE Photovoltaic Specialists Conf., San Diego, Calif., 7-10 Jan. 1980
(NASA-TM-81526) Avail: NTIS HC A02/MF A01 C SCL 20L

A family of high-voltage solar cells, called the planar multijunction (PMJ) cell is being developed. The new cells combine the attractive features of planar cells with conventional or interdigitated back contacts and the vertical multijunction solar cell. The PMJ solar cell is internally divided into many voltage-generating regions, called unit cells, which are internally connected in series. The key to obtaining reasonable performance from this device was the separation of top surface field regions over each active unit cell area. Using existing solar cell fabricating methods, output voltages in excess of 20 volts per linear centimeter are possible. Analysis of the new device is complex, and numerous geometries are being studied which should provide substantial benefits in both normal sunlight usage as well as with concentrators. Author

N80-26255# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

LA RECHERCHE AEROSPATIALE, BIMONTHLY BULLETIN NUMBER 1979-6

1979 92 p refs Transl. into ENGLISH of La Rech. Aérospatiale, Bull. Bimestriel (Paris), no. 1979-6, Nov. - Dec. 1979 p 346-409 Original French report available from ONERA, Paris FF 36 Prepared for ESA
(ESA-TT-632; ONERA-NT-1979-6) Avail: NTIS HC A05/MF A01

Topics include: instrumentation for Earth radiation budget measurements, a solar powered air turbine thermal power system, high stability quartz oscillators, plate equilibrium problems, numerical bracketing of the eigen frequencies of complex linear structures, and identification of the elastic characteristics of composite materials.

N80-26267# Office National d'Etudes et de Recherches Aérospatiales, Paris (France). Turbomachines Div.

AN OPEN CYCLE TURBINE SOLAR THERMAL POWER SYSTEM

Emile LeGrives In its La Rech. Aérospatiale, Bimonthly Bull. No. 1979-6 (ESA-TT-632) 1979 p 11-38 refs Transl. into ENGLISH Of La Rech. Aérospatiale, Bull. Bimestriel (Paris), No. 1979-6, Nov. - Dec. 1979 p 355-373 Original report in FRENCH previously announced as A80-19989

Avail: NTIS HC A05/MF A01

Solar electrical power generation using a heated air turbine in conjunction with a tower mounted central receiver and heliostat field was hybrid fossil fuel fired so as to avoid thermal storage problems. Using a regenerative gas turbine open cycle, no cooling system was required. It is shown that with a solar receiver concept allowing a fast thermal response to transient radiation situations, a turbine inlet temperature of 1100 to 1150 K can be reached with an overall efficiency (power available on turbine shaft/power radiated into receiver) of 25 percent, with a 2000 Sun concentration ratio. Solar receiver, turbocompressor and regenerator sizes are given for a thermal power input of 1 MW into the receiver. Author (ESA)

N80-26403# Dow Corning Corp., Midland, Mich.
DEVELOPMENT OF IMPROVED INSULATION MATERIALS Final Technical Report, 1 Sep. 1978 - 30 Sep. 1979

J. A. Rabe, S. Spells, G. R. Homan, D. M. Rasch, C. L. Lee, and R. C. Parmele Sep. 1979 168 p refs
(Contract EM-78-C-04-4295)
(ALO-4295-T2) Avail: NTIS HC A08/MF A01

Evaluations of three types of silicone foam, for use as insulation in flat plate solar collectors are presented. The three types of foam were: Type 1A: a two part, room temperature curing foam cross linked through identical with SiOSi identical with linkages; Type 1B: a one part, heat activated foam also crosslinked through identical with SiOSi identical with bonds; and Type 2: a two part, room temperature curing foam cross linked with = NCOS(CH₂)₃ identical with linkages. A composite, in which a thin layer of type 1A foam protects a secondary layer of less expensive but thermally unstable isocyanurate foam, is also evaluated. DOE

N80-26409*# Institute of Gas Technology, Chicago, Ill.
STUDIES OF THERMOCHEMICAL WATER-SPLITTING CYCLES Final Report

R. J. Remick and S. E. Foh May 1980 48 p refs
 (Contracts NAS7-100; JPL-955494)
 (NASA-CR-163029; JPL-9950-371) Avail: NTIS
 HC A03/MF A01 CSCL 07D

Higher temperatures and more isothermal heat profiles of solar heat sources are developed. The metal oxide metal sulfate class of cycles were suited for solar heat sources. Electrochemical oxidation of SO₂ and thermochemical reactions are presented. Electrolytic oxidation of sulfur dioxide in dilute sulfuric acid solutions were appropriate for metal oxide metal sulfate cycles. The cell voltage at workable current densities required for the oxidation of SO₂ was critical to the efficient operation of any metal oxide metal sulfate cycle. A sulfur dioxide depolarized electrolysis cell for the splitting of water via optimization of the anode reaction is discussed. Sulfuric acid concentrations of 30 to 35 weight percent are preferred. Platinized platinum or smooth platinum gave the best anode kinetics at a given potential of the five materials examined. B.D.

N80-26611# Mission Research Corp., Albuquerque, N. Mex.
TRANSIENT EFFECTS FROM LIGHTNING. VOLUME 1: TRANSIENT ELECTROMAGNETIC FIELDS FROM LIGHTNING DISCHARGES

H. Fowles, L. Scott, and J. Hamm Jan. 1980 184 p refs
 (Contract EY-76-C-04-0789)
 (SAND-79-7051-Vol-1) Avail: NTIS HC A09/MF A01

The effects of lightning on solar photovoltaic systems in the 100 kilowatt to 1 megawatt power range, and methods for protecting these systems from lightning are discussed. The statistics of lightning strokes is reviewed, and the model which predicts the electromagnetic fields and optical power density is summarized. Coupling of the electromagnetic fields to photovoltaic system elements is also discussed, and the experience of power and telephone companies with lightning transients is drawn upon. A theoretical model for predicting damage thresholds for modern terrestrial solar cells is presented. The thresholds are presented in the form of peak currents as a function of pulse width for two separate failure modes: melting of the deposited metal grid and burnout of the junction. Lightning protection techniques which are technically and economically feasible for photovoltaic systems are discussed. The techniques of shielding and terminal protection are discussed. DOE

N80-26766*# Travis-Braun and Associates, Inc., Dallas, Tex.
SOLAR ENERGY FACILITY AT NORTH HAMPTON RECREATION CENTER, DALLAS, TEXAS Final Report

May 1980 141 p
 (Contract EX-76-C-01-2543)
 (NASA-CR-161444) Avail: NTIS HC A07/MF A01 CSCL 10A

The solar energy facility located at the North Hampton Park Recreation and Health Center, Dallas, Texas is presented. The solar energy system is installed in a single story (two heights), 16,000 sq ft building enclosing a gymnasium, locker area, and health care clinic surrounded by a recreational area and athletic field. The solar energy system is designed to provide 80 percent of the annual space heating, 48 percent of the annual space cooling, and 90 percent of the domestic hot water requirements. The system's operation modes and performance data acquisition system are described. The system's performance during the months of June, July, August, September, and October of 1979 are presented and show a negative savings of energy. Experience

to date indicates however that the system concept has promise of acceptable performance. It is concluded that if proper control and sequencing components was maintained, then the system performance would improve to an acceptable level. R.E.S.

N80-26768*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOVOLTAIC RESIDENTIAL APPLICATIONS PROGRAM IMPLEMENTATION WORKSHOP PROCEEDINGS

R. H. Barbieri 15 May 1980 166 p Workshop held at Calif. Inst. of Tech., Pasadena, 12-13 Feb. 1980
 (Contract NAS7-100; EX-76-A-29-1012)
 (NASA-CR-163274; JPL-Pub-80-22) Avail: NTIS
 HC A08/MF A01 CSCL 10B

Two major aspects of the workshop are presented: (1) presentations on the Photovoltaic program and the National Solar Heating and Cooling Demonstration program, and (2) discussions on the issues pertinent to the Residential Application program. R.E.S.

N80-26770*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THERMAL POWER SYSTEMS (TPS); POINT-FOCUSING THERMAL AND ELECTRIC APPLICATIONS (PFTEA). VOLUME 2: DETAILED REPORT, FISCAL YEAR 1979

15 Jan. 1980 146 p refs
 (Contracts NAS7-100; Contract DE-AI01-79ET-20397)
 (NASA-CR-163023; DOE/JPL-1060/31-Vol-2;
 JPL-Pub-79-118-Vol-2) Avail: NTIS HC A07/MF A01 CSCL 10A

Progress in the development of systems which employ point focusing distributed receiver technology is reported. Emphasis is placed on the first engineering experiment, the Small Community Solar Thermal Power Experiment. Procurement activities for the Military Module Power Experiment the first of a series of experiments planned as part of the Isolated Load Series are included. J.M.S.

N80-26771*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

COST OF CZOCHRALSKI WAFERS AS A FUNCTION OF DIAMETER

M. H. Leipold, C. Radics, and A. Kachare 15 Feb. 1980 20 p
 (Contracts NAS7-100; EX-76-A-29-1012)
 (NASA-CR-163277; DOE/JPL-1012/37; JPL-Pub-80-25) Avail:
 NTIS HC A02/MF A01 CSCL 10A

The impact of diameter in the range of 10 to 15 cm on the cost of wafers sliced from Czochralski ingots was analyzed. Increasing silicon waste and decreasing ingot cost with increasing ingot size were estimated along with projected costs. Results indicate a small but continuous decrease in sheet cost with increasing ingot size in this size range. Sheet costs including silicon are projected to be \$50 to \$60/sq m (1980 \$) depending upon technique used. R.E.S.

N80-26776*# General Electric Co., Philadelphia, Pa.
DESIGN, FABRICATION, TEST, AND QUALIFICATION AND PRICE ANALYSIS OF THIRD GENERATION DESIGN SOLAR CELL MODULES

N. F. Shepard 31 Mar. 1980 113 p
 (Contract JPL-955401)
 (NASA-CR-163028; DOE/JPL-955401-80/1; JPL-9950-353)
 Avail: NTIS HC A06/MF A01 CSCL 10A

The Block 4 shingle type module makes it possible to apply a photovoltaic array to the sloping roof of a residential building by simply nailing the overlapping hexagon shaped shingles to the plywood roof sheathing. This third-generation shingle module design consists of nineteen series connected 100 mm diameter solar cells which are arranged in a closely packed hexagon configuration to provide in excess of 75 watts/sq m of exposed module area under standard operating conditions. The solar cells are individually bonded to the embossed underside of a 4.4 mm thick thermally tempered piece of glass. An experimental silicone pottant was used as the transparent bonding adhesive between the cells and glass. The semi-flexible portion of each shingle module is a composite laminate construction consisting of an outer layer of FLEXSEAL bonded to an inner core of closed cell polyethylene foam. Silaprene is used as the substrate laminating

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adhesive. The module design has satisfactorily survived qualification testing program which includes 50 thermal cycles between -40 and +90 C, a seven day temperature-humidity exposure test, and a wind resistance test. E.J.R.

N80-26777*# Sanders Associates, Inc., Nashua, N. H. Energy Systems Center.

DEVELOPMENT OF AN AIR BRAYTON SOLAR RECEIVER
[1980] 149 p
(Contract JPL-955120)
(NASA-CR-163027; JPL-9950-351) Avail: NTIS
HC A07/MF A01 CSCL 10A

Various receiver configurations and operating conditions were examined. The interface requirements between the receiver/concentrator/power module were addressed. Production cost estimates were obtained to determine the cost of the receiver during the 1980 timeframe. A conceptual design of an air Brayton solar receiver is presented based on the results. The following design goals were established: (1) peak thermal input power - 85 KWt; (2) receiver outlet air temperature - 1500 F; (3) receiver inlet air temperature - 1050 F; (4) design mass flow rate - 0.533 lb/sec; and (5) design receiver inlet pressure - 36.75 psia. J.M.S.

N80-26778*# IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR ELCAM TEMPE ARIZONA STATE UNIVERSITY, TEMPE, ARIZONA Progress Report, Jun. 1979 - Jan. 1980

May 1980 71 p refs Sponsored in part by DOE
(Contract NAS8-32036)
(NASA-CR-161466) Avail: NTIS HC A04/MF A01 CSCL 10A

The solar system, Elcam-Tempe, was designed by Elcam Incorporated, Santa Barbara, California, to supply commercial domestic hot water heating systems to the Agriculture Department residence at Arizona State University. The building is a single story residence located at the agriculture experiment farm of the Arizona State University. The energy system's four modes of operation are described. Electrical energy savings at the site was a net of 5.54 million Btu after the 0.17 million Btu of operating energy required to operate collector loop circulating pump were subtracted. The energy savings due to solar was less than the system's potential. On an average, twice as much hot water could have been used with significant solar energy contribution. The system corrosion and deposits caused by using dissimilar metals in the collector loop was the only problem noted with the Elcam-Tempe system. R.E.S.

N80-26781*# Bechtel National, Inc., San Francisco, Calif.
STUDY OF CURVED GLASS PHOTOVOLTAIC MODULE AND MODULE ELECTRICAL ISOLATION DESIGN REQUIREMENTS Final Report

Jun. 1980 182 p refs
(Contract JPL-954698)
(NASA-CR-163033; DOE/JPL-954698-80/2; JPL-9950-365)
Avail: NTIS HC A09/MF A01 CSCL 10A

The design of a 1.2 by 2.4 m curved glass superstrate and support clip assembly is presented, along with the results of finite element computer analysis and a glass industry survey conducted to assess the technical and economic feasibility of the concept. Installed costs for four curved glass module array configurations are estimated and compared with cost previously reported for comparable flat glass module configurations. Electrical properties of candidate module encapsulation systems are evaluated along with present industry practice for the design and testing of electrical insulation systems. Electric design requirements for module encapsulation systems are also discussed. R.E.S.

N80-26782*# Spectrolab, Inc., Sylmar, Calif.
HIGH RESOLUTION, LOW COST SOLAR CELL CONTACT DEVELOPMENT Final Report

N. Mardesich Dec. 1979 50 p
(Contracts NAS7-100; JPL-955298)
(NASA-CR-163289; DOE/JPL-955298-80/2; JPL-9950-368)
Avail: NTIS HC A03/MF A01 CSCL 10A

The experimental work demonstrating the feasibility of the MIDFILM process as a low cost means of applying solar cell collector metallization as reported. Cell efficiencies of above 14% (AMI, 28 C) were achieved with fritted silver metallization. Environmental tests suggest that the metallization is slightly humidity sensitive and degradation is observed on cells with high series resistance. The major yield loss in the fabrication of cells was due to discontinuous grid lines, resulting in high series resistance. Standard lead-tin solder plated interconnections do not appear compatible with the MIDFILM contact. Copper, nickel and molybdenum base powder were investigated as low cost metallization systems. The copper based powder degraded the cell response. The nickel and molybdenum base powders oxidized when sintered in the oxidizing atmosphere necessary to ash the photoresin. Author

N80-26792*# Technische Physische Dienst TNO-TH, Delft (Netherlands).

THE POTENTIAL FOR HEAT PRODUCTION WITH SOLAR WATER HEATERS IN THE NETHERLANDS CLIMATE [DE POTENTIELE WARMTEPRODUKTIE MET EEN ZONNE-BOILER IN HET NEDERLANDSE KLIMAAT]

C. denOuden In Central Tech. Inst. Lectures on Heat Technol. in the Netherlands 1977 p 51-57 refs In DUTCH

Avail: NTIS HC A04/MF A01; Central Tech. Inst., Apeldoorn, Netherlands FL 30

The technical aspects of the solar water heater are described, and various designs presented. The energy production during an average year in the Netherlands using different configurations is computed. An economic analysis based upon a system with a 4 sq m collector is given. Author (ESA)

N80-26793*# Technische Physische Dienst TNO-TH, Delft (Netherlands).

THE DESIGN OF A SOLAR HOME HEATING INSTALLATION, USING A MATHEMATICAL MODEL [HET ONTWERPEN VAN EEN ZONNEVERWARMINGS-INSTALLATIE VOOR EEN WONING MET BEHULP VAN EEN REKENMODEL]

E. vanGalen, A. J. T. M. Wijsman, and C. denOuden In Central Tech. Inst. Lectures on Heat Technol. in the Netherlands 1977 p 59-69 ref In DUTCH Sponsored by Netherlands Min. van Econ. Zaken

Avail: NTIS HC A04/MF A01; Central Tech. Inst., Apeldoorn, Netherlands FL 30

The model is capable of simulating a complete system, including the collector and the distribution system in the home. Efficiencies of various types of collectors are accommodated. Results of some runs are presented. Comparative cost data for solar and conventional systems are given. Solar systems are shown to be economical for home heating only in well-insulated buildings. Author (ESA)

N80-26797*# Research Triangle Inst., Research Triangle Park, N. C.

DEVELOPMENT OF HIGH EFFICIENCY STACKED MULTIPLE BANDGAP SOLAR CELLS Final Report, 1 Aug. 1978 - 30 Sep. 1979

S. M. Bedair, J. R. Hauser, M. F. Lamorte, S. Phatak, M. L. Timmons, J. E. Andrews, and M. Simmons Wright-Patterson AFB AFAPL Oct. 1979 102 p refs
(Contract F33615-78-C-2077)
(AD-A083092; RTI-41U-1678; AFAPL-TR-79-2116) Avail: NTIS HC A06/MF A01 CSCL 10/2

The objective of this research was to develop the technology required to fabricate two-junction, cascade solar cell assemblies having conversion efficiencies exceeding 25 percent when operating at 25 deg C under 1 sun, AM 0 conditions. The experimental effort has focused on several different III-V ternary and quaternary materials that show promise for use in fabricating

a cascade cell. These include GaAlAs, GaInAs, GaInP, GaAsSb, and GaAlAsSb. The work also includes theoretical calculations of cascade solar cell performance over a wide range of operating temperatures. GRA

N80-26801# Boeing Engineering and Construction, Seattle, Wash.

SOLAR CENTRAL RECEIVER PROTOTYPE HELIOSTAT. VOLUME 3: COST ESTIMATES

1 Jun. 1978 149 p

(Contract EG-77-C-03-1604)

(SAN-1604-3) Avail: NTIS HC A07/MF A01

The Boeing heliostat design was produced and installed for a capital cost of \$42 per square meter at high commercial plant quantities and rates. This is 14% less than the DOE cost target. Even at a low commercial plant production rate of 25,000 heliostats per year the capital cost of \$48 per square meter 2% less than the cost goal established by the DOE. Projected capital cost and 30 year maintenance costs for three scenarios of production and installation are presented: (1) commercial rate production of 25,000, 25,000 and 1,000,000 heliostats per year; (2) a one-time only production of 25,000 heliostats per year with each plant (25,000 heliostats) installed at widely dispersed sites throughout the southwestern United States. These three scenarios for solar plant locations and the manufacturing/installation processes are fully described, and detailed cost breakdowns for the three scenarios are provided. DOE

N80-26802# Jalar Associates, San Francisco, Calif.
INDUSTRIAL COMPRESSED AIR APPLICATIONS FOR SOLAR ENERGY CONVERSION/STORAGE DEVICES Final Report

Laurence B. McEwen, Jr. and John W. Swain, Jr. Jan. 1980 162 p refs Prepared for Sandia Labs., Albuquerque

(Contract EY-76-C-04-0789)

(SAND-79-7077) Avail: NTIS HC A08/MF A01

A survey was made of industrial compressed air installations in this country with emphasis on air usage patterns, types of equipment, and energy/power requirements. This was followed by an investigation into the technical feasibility of utilizing solar energy conversion systems to power representative industrial compressed air systems. The final task was to evaluate the economic merits of three diverse scenarios of conceptual industrial compressed-air installation. None of the three were found to be economically attractive until approximately 10 years after completion of construction with one of the primary reasons being the high capitalized cost of the associated solar powered air compression systems. A proper combination of technological improvements in solar energy conversion systems, reduced capital costs, accelerated rises in utility rates, and continued uncertainty in fossil fuel availability is regarded as necessary before further pursuit of this concept is warranted. DOE

N80-26811# Boeing Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION FOR ZIEN MECHANICAL CONTRACTORS-1 SINGLE FAMILY RESIDENCE, MILWAUKEE, WISCONSIN

D. Beers 5 Feb. 1980 48 p

(Contract EX-76-A-29-1020)

(SOLAR/1057-79/50-Pt-1) Avail: NTIS HC A03/MF A01

The Zien Mechanical site is a single family residence located in Milwaukee, Wisconsin. The home has two separate solar energy systems: an air system for space heating and cooling; a liquid system to preheat the potable hot water. The space heating and cooling system design and operation modes are described. The space heating system is designed to apply approximately 44 percent of the space heating requirements for the 1388 square foot residence. Engineering drawings are provided and the performance evaluation instrumentation is described. R.E.S.

N80-26812# Boeing Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION FOR ALPHA CONSTRUCTION COMPANY'S SINGLE FAMILY RESIDENCE, CANTON, OHIO

D. Beers 21 Sep. 1979 53 p

(Contract EX-76-A-29-1020)

(SOLAR/1034-79/50) Avail: NTIS HC A04/MF A01

The solar energy system for a new single family detached residence in Canton, Ohio, preheats domestic hot water and supplements heating energy for 2460 square feet of occupied space. The solar energy system is designed to provide approximately 50 percent of the space heating and 70 percent of the hot water energy requirements for the home. The system design and operation modes are described. Engineering drawings are provided and the performance evaluation instrumentation is described. R.E.S.

N80-26813# Boeing Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION FOR STEWART-TEELE-MITCHELL SINGLE FAMILY RESIDENCE, MALTA, N.Y.

D. Beers 5 Dec. 1979 51 p

(Contract EX-76-A-29-1020)

(SOLAR/1018-79/50) Avail: NTIS HC A04/MF A01

The Stewart-Teele-Mitchell solar energy system is installed in a 1900 square-foot, single family dwelling located in Malta, New York. The system is designed to provide solar energy for space heating, and domestic hot water heating. The system design and operation modes are described. Engineering drawings are provided and the performance evaluation instrumentation is described. R.E.S.

N80-26814# Boeing Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION FOR WASHINGTON NATURAL GAS COMPANY'S SINGLE FAMILY RESIDENCE, KIRKLAND, WASHINGTON

D. Beers 12 Sep. 1979 48 p

(Contract EX-76-A-29-1020)

(SOLAR/1001-79/50) Avail: NTIS HC A03/MF A01

The solar energy system for a new single family detached residence in Kirkland, Washington, preheats domestic hot water and heats 2607 square feet of occupied space. The system design and operation modes are described. Engineering drawings are provided and the performance evaluation instrumentation is described. R.E.S.

N80-26815# Boeing Co., Seattle, Wash.
SOLAR PROJECT DESCRIPTION FOR ZIEN MECHANICAL 2 SINGLE FAMILY RESIDENCE, MILWAUKEE, WISCONSIN

5 Feb. 1980 44 p

(Contracts EX-76-A-29-1020; H-2372)

(SOLAR/1057-79/50-Pt-2) Avail: NTIS HC A03/MF A01

Zien Mechanical Contractors No. 2 is a single-family residence in Milwaukee, Wisconsin. The home has approximately 1304 square feet of conditioned space. The solar energy system consists of two independently controlled systems: one system is used for domestic hot water preheating, the other is used for space heating and cooling. The domestic hot water system design and operation modes are described. Engineering drawings are provided and the performance evaluation instrumentation is described. R.E.S.

N80-26816# Burt, Hill, Kosar, Rittleman, and Associates, Butler, Pa.

SOLAR-ASSISTED LOW ENERGY DWELLINGS Final Report

Torben V. Esbensen Feb. 1980 113 p refs

(Contract EY-76-S-05-4908)

(DOE/CS-0145; CCMS-93) Avail: NTIS HC A06/MF A01

The Zero Energy House Group was formed as a subproject of the CCMS Solar Energy Pilot Study in 1974 by seven participating countries experimenting with solar-assisted low-energy dwellings for temperate and northern European climatic conditions. A Zero Energy House is one in which solar energy is used to meet the reduced energy needs of buildings incorporating various thermal energy conservation features. This is the final report of the Zero Energy House Group. It includes brief descriptions of 13 major low-energy dwellings in the participating CCMS countries. An overall assessment of the state-of-the-art in solar-assisted low-energy dwellings is given. DOE

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N80-26818# Mississippi State Univ., Mississippi State. Engineering and Industrial Research Station.

ADDITION OF INEXPENSIVE SOLAR AIR-HEATERS TO A PRE-ENGINEERED METAL BUILDING Final Report, 25 Sep. 1977 - 25 Mar. 1979

Richard E. Forbes and Ronald W. McClendon May 1979 52 p refs

(Contracts EG-77-G-04-4086; EG-77-C-29-0001)

(ALO-4086-1) Avail: NTIS HC A03/MF A01

The use of site built solar collectors for heating air in poultry houses was studied in order to design and test a functional air heater solar collector which would be inexpensive to construct and acceptable to poultry producers. The results reported are an extension of the original concept. The basic concept is to use a pre-engineered metal building for the structure and incorporate the solar air heaters as an integral part of the south facing wall of the building. The outer skin of the building is used as the absorber plate for the collectors. Construction and testing of the solar collectors and heat storage systems are discussed, and the performance characteristics of the site built solar collectors are described. DOE

N80-26819# Rockwell International Corp., Thousand Oaks, Calif. Electronics Research Center.

DEVELOPMENT OF POLYCRYSTAL GaAs SOLAR CELLS Quarterly Technical Progress Report, 1 Aug. - 30 Oct. 1979

D. L. Miller, Marshall J. Cohen, J. S. Harris, Jr., Joseph Ballantyne (Cornell Univ., Ithaca, N.Y.), and Elias Stefanakos (N.C. A and T State Univ., Greensboro) Dec. 1979 49 p

(Contract EG-77-C-01-4042)

(DSE-4042-T28; QTPR-3) Avail: NTIS HC A03/MF A01

Progress on the development of thin film polycrystal GaAs solar cells with 10% conversion efficiency is described. Highlights include the growth of Ge on Fe substrates and the investigation of various grain boundary passivation schemes. DOE

N80-26820# Midwest Research Inst., Golden, Colo.

SERI SOLAR ENERGY STORAGE PROGRAM

Robert J. Copeland, John D. Wright, and Charles E. Wyman Feb. 1980 12 p refs Presented at the Thermal Energy Storage Review Meeting, Tysons Corner, Va., 3 Dec. 1979

(Contract EG-77-C-01-4042)

(SERI/TP-333-497; CONF-791232-1) Avail: NTIS HC A02/MF A01

Research on advanced technologies, system analyses, and assessments of thermal energy storage for solar applications in support of the Thermal and Chemical Energy Storage program are presented. Currently, research is in progress on direct contact latent heat storage and thermochemical energy storage and transport. Systems analyses are being performed of thermal energy storage for solar thermal applications, and surveys and assessments are being prepared of thermal energy storage in solar applications. DOE

N80-26822# Stanford Linear Accelerator Center, Calif.

MORE ON DUAL PURPOSE SOLAR-ELECTRIC POWER PLANTS

F. F. Hall Feb. 1980 17 p refs Presented at the 2nd Miami Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10 Dec. 1979

(Contract EY-76-C-03-0515)

(SLAC-PUB-2477; CONF-791204-33) Avail: NTIS HC A02/MF A01

Dual purpose solar-electric plants are discussed. The rationale for such plants is reviewed and plant elements are listed. Heat extraction, energy storage, and plant costs are discussed. DOE

N80-26823# Trident Engineering Associates, Inc., Annapolis, Md.

SURVEY AND EVALUATION OF CURRENT DESIGN OF EVACUATED COLLECTORS Final Technical Report

B. J. Graham 30 Sep. 1979 192 p refs

(Contract EM-78-C-04-5350)

(ALO-5350-1) Avail: NTIS HC A09/MF A01

The general development of evacuated collectors is described. A table summarizing all of the available collectors, along with

their characteristics, is presented. There are four evacuated collectors which have been tested, used in demonstration sites, and developed for the market. These collectors are described in detail, and they are compared in performance and cost with a well engineered, double glazed, selectively coated, flat plate collector. A rather simple model system of about 2000 sq ft of collector area for each of the four evacuated collectors and the flat plate collector is described, along with the support structure and the piping for each. Details of the cost are presented in order to compare collector costs with component costs. All of the available efficiency curves of collectors were plotted for comparison with the efficiency curve of a good, flat plate collector. DOE

N80-26824# Argonne National Lab., Ill. Energy and Environmental Systems Div.

RELIABILITY AND MATERIALS PERFORMANCE OF SOLAR HEATING AND COOLING SYSTEMS

P. S. Chopra Jun. 1979 24 p refs

(Contract W-31-109-eng-38)

(SOLAR/0906-79/70; ANL/SDP-TM-79-8) Avail: NTIS HC A02/MF A01

The reliability field information collected to date from the solar heating and cooling systems sponsored by the US Department of Energy and the evaluation of four system-reliability problems freezing, leaks, controls, and collectors are summarized. An example of a reliability analysis for a hot water preheating system is presented using data on component failures obtained primarily from nonsolar sources. The status of material assessment activities is discussed along with the results of initial studies of the properties of heat transfer fluids and the scaling caused by the fluids. DOE

N80-26826# California Univ., Berkeley. Lawrence Berkeley Lab. Energy Analysis Program.

ASSESSMENT OF SOLAR ENERGY WITHIN A COMMUNITY: SUMMARY OF THREE COMMUNITY-LEVEL STUDIES Summary Report

Ronald L. Ritschard Oct. 1979 37 p refs Sponsored by DOE

(DOE/EV-0054) Avail: NTIS HC A03/MF A01

An analysis of the potential health, environmental, and social/economic consequences of large-scale (national in scope) commercialization of solar technologies is discussed. A summary of three studies concentrating on the potential community-level impacts of such commercialization is given. The results of these studies provide enrichment of the national-level project by identifying for policymakers specific community-level issues that may arise as a result of federal policy. The three studies are: (1) community-level environmental impacts of decentralized solar technologies; (2) community impediments to implementation of solar energy; and (3) three solar urban futures: characterizations of a future community under three energy supply scenarios. DOE

N80-26828# Exxon Research and Engineering Co., Linden, N.J. Advanced Energy Systems Labs.

THIN FILM POLYCRYSTALLINE SILICON SOLAR CELLS Quarterly Report, 1 Jul. - 30 Sep. 1979

Amal K. Ghosh, Tom Feng, and H. Paul Maruska 1979 30 p refs

(Contract DE-AC03-79ET-23047)

(DOE/SF/23047-3; QR-3) Avail: NTIS HC A03/MF A01

The details of the fabrication procedures for making SnO₂/n-Si, ITO/n-Si, and metal insulated semiconductors solar cells are given. A low cost and highly reproducible spray deposition process for tin oxide and indium tin oxide (ITO) was used to make SnO₂/n-Si and ITO/n-Si solar cells with power conversion efficiencies of 10 and 13% for polycrystalline and single crystal silicon, respectively. Continued improvements in the efficiencies of diffused p-n junction cells were made: efficiencies of 10.3 and 9% were obtained for polysilicon cells of 1- and 20-cu cm sizes, respectively. The effects of grain boundaries on the generation of photocurrent were studied. The Hall mobility of polysilicon in the dark and under illumination, developed a served resistivity and mobility results. A comparison of the spectral response curves

of SnO₂/n-Si heterojunction and diffused p/n junction cells indicates a lower diffusion length in the diffused cells. The stability studies of the SnO₂/n-Si cells were continued. DOE

N80-26830# General Electric Co., Philadelphia, Pa. Space Div.

CONCENTRATING ARRAY PRODUCTION PROCESS DESIGN, VOLUME 1: STUDY SUMMARY, VOLUME 2: STUDY RESULTS Final Report

Ronald C. Hodge, A. Koeing, A. Hetzel, J. Nichols, A. Zucker, M. McCullough, R. Fogaroli, R. McCarthy, R. Drummond, and J. Dougherty Mar. 1980 213 p refs Prepared for Sandia Labs, Albuquerque, N.M.

(Contract EY-76-C-04-0789)

(SAND-78-7072-Vol-1/2) Avail: NTIS HC A10/MF A01

Existing P/V concentrator designs are evaluated in terms of their performance and low production and life cycle cost potential. Alternate designs and modifications are defined that will be potentially less costly to produce in large scale production. Manufacturing processes commensurate with four levels of production are defined for a prime array design. Manufacturing and life cycle costs are determined as a function of production level, category, and salient design features, e.g., optical type.

DOE

N80-26835# Los Alamos Scientific Lab., N. Mex. **VALIDATION OF SOLAR SYSTEM SIMULATION CODER BY THE INTERNATIONAL ENERGY AGENCY**

James C. Hedstrom and Thomas L. Freeman (Atlas Corp., Santa Cruz, Calif.) 1980 7 p refs Presented at 2nd Ann. Systems Stimulation and Econ. Analysis Conf., San Diego, Calif., 23-25 Jan. 1980

(Contract W-7405-eng-36)

(LA-UR-80-387; CONF-800101-18)

Avail: NTIS

HC A02/MF A01

Validation of active solar energy system simulation codes by the International Energy Agency using data from the Los Alamos Study Center is described. Two rounds of comparisons of predicted to measure performance were completed. In the first round, all participants were given detailed system description data and a period of measured hourly weather and loads data with the corresponding measured hourly performance data. In the second round, the participants were given minor changes to the system description and a second period of measured hourly performance. In the first round, each of the participants was able to predict the results provided. However, this required an undocumented series of adjustments to the user input and the models and comparisons of measured and predicted results. Agreement of measured and predicted results were nearly as good in the second round except for two codes that predicted significantly erroneous results. As a result of this exercise, errors and shortcomings were found and corrected in most of the codes and confidence in the ability of all codes to model real systems has been increased. However, the questions of a workable methodology for validation and the means of dealing with user error remain unanswered.

DOE

N80-26836# Department of Energy, Washington, D. C. Office of Energy Research.

PRELIMINARY ENVIRONMENTAL ASSESSMENT FOR THE SATELLITE POWER SYSTEM (SPS), REVISION 1, VOLUME 2: DETAILED ASSESSMENT

Jan. 1980 205 p refs

(DOE/ER-00362-Vol-2) Avail: NTIS HC A10/MF A01

The satellite power system (SPS) collects solar energy through a system of satellites in space and transfers this energy to Earth. A reference system is described that converts the energy to microwaves and transmit the microwave energy via directive antennas to large receiving/rectifying antennas (rectennas) located on the Earth. At the rectennas, the microwave energy is converted into electricity. The key environmental issues associated with the SPS which concern human health and safety, ecosystems, climate, and electromagnetic systems interactions are addressed. Microwave-radiation health and ecological effects; nonmicrowave health and ecological effects; atmospheric effects; effects on communication systems due to ionospheric disturbance, and electromagnetic compatibility are among the factors discussed.

DOE

N80-26837# New Mexico Univ., Albuquerque. Dept. of Physics and Astronomy.

DEMONSTRATION SALT GRADIENT SOLAR POND Ph.D. Thesis

Federica Zangrando and H. C. Bryant 10 Jul. 1979 149 p refs

(Contract EG-77-S-04-3977)

(ALO-3977-T1; SAPR-4) Avail: NTIS HC A07/MF A01

A thorough account is given of a solar pond study underway at the University of New Mexico since 1975. This report consists of the Ph.D. dissertation of Federica Zangrando entitled *Observation and Analysis of a Full-Scale Experimental Salt Gradient Solar Pond*. The stability condition for a nonconstant gradient, doubly-diffusive system is derived and a prescription for the routine detection of potential instabilities is presented. Techniques for handling unstable regions are described. Conclusions so far strongly support the viability of the solar pond concept. Salt gradient ponds appear to have a very definite niche in the ecology of energy production.

DOE

N80-26839# Arizona Public Service Co., Phoenix.

AIRPORT SOLAR PHOTOVOLTAIC CONCENTRATOR PROJECT, PHASE 1 Final Report, 1 Jun. 1978 - 28 Feb. 1979

Dec. 1979 347 p Prepared in cooperation with Motorola, Inc., Scottsdale, Ariz.

(Contract ET-78-C-04-5317)

(DOE/CS-05317/1) Avail: NTIS HC A15/MF A01

The system design, analysis, and specification, site preparation, and operation and evaluation plan for a 500 kWe photovoltaic power supply to be located at the Phoenix Sky Harbor International Airport in Phoenix, Arizona, are presented. The solar cell arrays are concentrator silicon solar cells with tracking 70X Cassegrain-type concentrators. The power conditioning system, tracking system, and control systems are described. Environmental impact studies are described. Component specifications and drawings are included.

DOE

N80-26841# Battelle Columbus Labs., Ohio.

DEVELOPMENT OF A LOW-TEMPERATURE, LOW-COST, BLACK LIQUID SOLAR COLLECTOR, PHASE 2 Semiannual Report, 1 Sep. 1979 - 29 Feb. 1980

D. K. Landstrom, S. G. Talbert, and V. D. McGinniss 20 Mar. 1980 24 p refs

(Contract DE-AC04-79CS-30171)

(ALO-30171-1) Avail: NTIS HC A02/MF A01

The long-term durability of various plastic materials and solar collector designs was evaluated and sufficient outdoor performance data to design a full-scale demonstration of a black-liquid solar collector for a commercial application were obtained. Besides conducting indoor weathering tests of various plastic materials, two outdoor automated test facilities were built. One unit was in use for about two winter months in Columbus, Ohio, and the other unit is ready for testing in Phoenix, Arizona. Extruded polycarbonate panels and extruded acrylic panel designs were investigated.

DOE

N80-26842# Department of Energy, Washington, D. C. Office of Solar Applications for Buildings.

SOLAR FEDERAL BUILDINGS PROGRAM PLAN

Feb. 1980 27 p

(DOE/CS-0147A) Avail: NTIS HC A03/MF A01

The Solar Federal Buildings Program (SFBP) is a multi-year program designed to stimulate the growth and improve the efficiency of the solar industry by providing funds to Federal agencies for the design, acquisition, construction, and installation of commercially applicable solar hot water, heating, cooling, and process systems in new and existing Federal buildings. The program plan to be used in implementing this major solar commercialization effort is outlined.

DOE

N80-26844# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.

LOW-COST SOLAR ANTIREFLECTION COATINGS Annual Report, 24 Jul. 1978 - 24 Sep. 1979

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R. J. H. Lin, J. C. Lee, and P. B. Zimmer Oct. 1979 99 p refs
(Contracts EM-78-C-04-5300; DE-AC04-78CS-35300)
(ALO-5300-T2) Avail: NTIS HC A05/MF A01

The etched antireflection (AR) coating process was scaled up to etch full size glass panes but the chemical control of the etching solution remains a problem. Analytical methods including high pressure liquid chromatography (HPLC), flame excited atomic absorption, infrared spectroscopy, Coulter counter techniques, and liquid index of refraction measurements were examined for application to this process monitor and control problem. A phenomenological model for the key reaction species in the etching process is presented along with a monitor control scheme using refractive index measurements to set the initial reactant concentrations and HPLC to track in process concentrations. The environmental durability of the organic AR coating of fused FEP-120 Teflon dispersion was improved by the use of a hydrofluoric acid etch/silane coupling agent pretreatment. Improved coating processing technique were developed culminating in the demonstration of scale up feasibility for glass panels up to 1 ft by 1 ft with good batch sample to sample repeatability. DOE

N80-26845# EIC, Inc., Newton, Mass.
CORROSION PROTECTION OF SOLAR-COLLECTOR HEAT EXCHANGERS WITH ELECTROCHEMICALLY DEPOSITED FILMS Semiannual Report, 1 Dec. 1978 - 31 May 1979
S. B. Brummer, V. R. Koch, and G. H. Schnaper Jul. 1979 44 p refs
(Contract EM-78-C-04-4297)
(COO-4297-2; SAR-2) Avail: NTIS HC A03/MF A01

A novel corrosion protection technique was demonstrated for the common solar collector metals Al, Cu, and Fe as mild steel. This involves the potentiostatic electrochemical deposition of thin, adherent polymer films on the interior of heat exchanger tubes by application of a current in the presence of a suitable organic monomer. Polyphenylene oxide (PPO) films were anodically deposited onto Al, Cu and Fe coupons from methanolic media. However, defects in these films afforded poor corrosion protection. Suitably functionalized PPO films have been crosslinked via Schiff base formation in a subsequent chemical step. While these chemically modified PPO films were demonstrably more resistant to ethylene glyco H₂O media at elevated temperatures, they too were undetermined by the thermal transfer medium. Cinnamaldehyde, a styrene type monomer, has been successfully electrodeposited onto Al coupons. This process involved a constant, albeit unreference potential technique in which the Al is made the negative electrode. DOE

N80-26846# International Business Machines Corp., Huntsville, Ala. Federal Systems Div.
COLLECTOR ARRAY PERFORMANCE REPORT FOR SITES OF THE NATIONAL SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
Jul. 1979 146 p
(Contract EG-77-C-01-4049)
(SOLAR/0021-79/07) Avail: NTIS HC A07/MF A01

The following data are given: (1) single-panel instantaneous efficiency curve coefficients; (2) current month instantaneous efficiency curve coefficients; (3) cumulative (through current month) instantaneous efficiency curve coefficients; (4) cumulative (through current month) second order curve coefficients; (5) daily energy gain comparisons for the current month; (6) properties of the collector transport fluid; (7) array flow rate (average for the month); (8) single panel flow rate; (9) array temperature gain (average for the month); and (10) monthly energy gain comparisons for the most recent 12 months. DOE

N80-26847# Los Alamos Scientific Lab., N. Mex.
ADDITIONAL SOLAR/LOAD RATIO CORRELATIONS FOR DIRECT GAIN BUILDINGS
William O. Wray 1980 6 p refs Presented at the Ann. Meeting of the Am. Sect. of ISES, Phoenix, Ariz., 2-6 Jun. 1980

(Contract W-7405-eng-36)
(LA-UR-80-854; CONF-800604-2) Avail: NTIS
HC A02/MF A01

Solar/load ratio (SLR) correlations were developed for two new reference direct gain designs. The new reference designs are identical to the originals except that the glazing air gap has been increased from 1/4 in. to 1/2 in. and a vector average of the local hourly windspeed was used in the thermal network calculations rather than an assumed average value of 15 mph. Both of these modifications are realistic and enhance the predicted performance of direct gain buildings. A comprehensive set of mass sensitivity calculations was performed in order to provide information needed to select an appropriate set of parameters for new lightweight direct gain designs for which additional SLR correlations will be developed. DOE

N80-26848# Northrop Services, Inc., Huntsville, Ala.
EVALUATION OF HEAT TRANSFER ENHANCEMENT IN AIR-HEATING COLLECTORS Final Report
Donald L. Mattox Jun. 1979 187 p refs
(Contracts EM-78-C-04-5352; DE-AC04-78CS-05352)
(ALO-5352-T1) Avail: NTIS HC A09/MF A01

Increasing the thermal efficiency of air heating solar collectors through identification and development of optimum design and operation criteria for solar absorber to air heat exchangers is reported. A transient heat transfer analysis of a complete solar air heating collector was used to demonstrate that an optimum absorber to air heat exchanger design could be provided with several interrupted fin configurations. Additional analyses were performed to establish that the maximum solar collector thermal performance to required pumping power was realized for a Reynolds number range of 1000 to 2000. This Reynolds number range was used to establish a theoretical design limit curve for maximum thermal performance versus required pumping power for all interrupted fin designs as published in the open literature. Heat and momentum transfer empirical relationships were defined for scaling the state of the art high conductance fin designs identified from a compact configuration for the less compact designs needed for solar collectors. DOE

N80-26849# Midwest Research Inst., Golden, Colo.
END-USE MATCHING FOR SOLAR INDUSTRIAL PROCESS HEAT Final Report
Kenneth C. Brown, Douglas W. Hooker, Ari Rabi, Shirley A. Stadjuhar, and Ronald E. West Jan. 1980 235 p refs
(Contract EG-77-C-01-4042)
(SERI/TR-34-091) Avail: NTIS HC A11/MF A01

Because of the large energy demand of industry (37% of US demand) and the wide spectrum of temperatures at which heat is required, the industrial sector appears to be very suitable for the matching of solar thermal technology with industrial process heat (IPH) requirements. A methodology for end-use matching was devised, complete with required data bases and an evaluation program PROSYS/ECONMAT. Six cities in the United States were selected for an analysis of solar applications to IPH. Typical process heat requirements for 70% of the industrial plants in each city were identified and evaluated in conjunction with meteorological and economic data for each site to determine lowest cost solar systems for each application. The flexibility and scope of PROSYS/ECONMAT is shown in a variety of sensitivity studies that expand the results of the six city analysis. Case studies of two industrial plants were performed to evaluate the end use matching procedure, these results are reported. DOE

N80-26851# Tennessee Technological Univ., Cookeville.
WIND EFFECTS ON COLLECTORS Final Report, 1 Oct. 1978 - 1 Oct. 1979
Hudy C. Hewitt, Jr. and Edwin I. Griggs 1 Nov. 1979 113 p refs
(Contract EM-78-C-04-5364)
(DOE/CS-35364/T1) Avail: NTIS HC A06/MF A01

Consideration was given to modeling wind speed data and to a scheme for correlating data between two separate stations. A sensor system was developed to measure the effect of wind on collector performance. The specifications for the sensor are presented, and a discussion of the calibration of the sensor is

given. Four experiments were performed to determine wind flow patterns around buildings. The velocity profile over an actual collector was also measured as a function of free stream velocity. A mathematical model for a solar collector and three experimental efforts to measure the effect of wind on collector performance are reported. DOE

N80-26855# Toronto Univ. (Ontario). Dept. of Mechanical Engineering.
DESIGN OF ANNUAL STORAGE SOLAR SPACE HEATING SYSTEMS

F. C. Hooper and J. D. Cook Nov. 1979 13 p refs Presented at the 72nd Ann. AICHE Meeting, San Francisco, 25-29 Nov. 1979 Submitted for publication
(Contract EY-76-C-02-2939)
(DOE/CS-32939/10; CONF-791108-20) Avail: NTIS HC A02/MF A01

A simulation model for the performance of such systems is described, and a method of classifying system configurations is proposed. It is shown that annual systems sized for unconstrained performance, with no unused collector or storage capacity, and no rejected heat, minimize solar acquisition costs. The optimal performance corresponds to the condition where the marginal storage-to-collector sizing ratio is equal to the corresponding marginal cost ratio. DOE

N80-26863# Brookhaven National Lab., Upton, N. Y.
DEVELOPMENT OF HARDWARE SIMULATORS FOR TESTS OF SOLAR COOLING/HEATING SUBSYSTEMS AND SYSTEMS. PHASE 1: RESIDENTIAL SUBSYSTEM HARDWARE SIMULATOR AND STEADY STATE SIMULATION

Paul C. Auh Sep. 1979 29 p refs
(Contract EY-79-C-02-0016)
(BNL-51120) Avail: NTIS HC A03/MF A01

The proposed hardware simulator was successfully built and has been operational since its construction. The hardware simulator has the following unique features: it has been incorporated with a measurement double checking system, it is a totally closed loop system, it employs three separate energy storage tanks, and it has been automated to perform instantaneous data collection and reduction. With the external energy storage, all the external test conditions can be easily set up for any steady state or transient run. The simulator is described in detail with schematics and actual photographs. The steady state testing of Arkla's Solaire 36 absorption chiller has been performed. The test dealt primarily with chiller capacity or coefficient of performance as a function of generator hot water inlet temperature (1) with condenser cooling water inlet temperature as parameter, and (2) with evaporator chilled water outlet temperature as parameter. DOE

N80-26866# Research Triangle Inst., Research Triangle Park, N. C.

APPLICATION ANALYSIS AND PHOTOVOLTAIC SYSTEM CONCEPTUAL DESIGN FOR SERVICE/COMMERCIAL/ INSTITUTIONAL AND INDUSTRIAL SECTORS. VOLUME 2: TECHNICAL REPORT Final Report

R. A. Whisnant, C. B. Morrison, N. G. Staffa, and R. D. Alberts Dec. 1979 219 p refs
(Contract EY-76-C-04-0789)
(SAND-79-7020-Vol-2) Avail: NTIS HC A10/MF A01

Data on the attributes of the applications that are germane to solar photovoltaic systems application were identified and acquired, and the figure of merit, utilizing the collected data, that indicates the relative photovoltaic potential for displacement of conventionally generated electricity of the various of applications were devised and applied. The expected profitability of photovoltaic application was determined from the discounted future costs of conventional energy sources, capital costs, and projected operating and maintenance costs over the life of the system. This was combined with the energy consumption of the application to obtain an estimate of the energy market potential. The application ranking and subjective evaluations of market size diversity, and public exposure were used to select five applications and their locations for design of a suitable photovoltaic system. For each

of the selected applications, the various relevant characteristics are identified, potential photovoltaic system configurations are identified, and performance and economic models are used to design a representative system. DOE

N80-26867# Oak Ridge National Lab., Tenn. Solar and Special Studies Div.

PHOTOVOLTAIC APPLICATIONS: PAST AND FUTURE

Stephen I. Kaplan 1980 6 p Presented at the 14th Photovoltaics Specialists Conf., San Diego, Calif., 7 Jan. 1980
(Contract W-7405-eng-26)
(CONF-800106-4) Avail: NTIS HC A02/MF A01

Three planned or proposed photovoltaic projects are described. The 240 kW system at Mississippi County Community College consists of an array of 270 106 unit strings of single crystal Si cells mounted at the focus of 40x concentrating parabolic troughs. The system is expected to be complete in the spring of 1980. The four 50 kWp photovoltaic systems planned for Northwest Mississippi Junior College consist of different types of solar cells using different types of concentrators. The system is expected to go into operation in the summer of 1980. The proposed system for Georgetown University has not reached the hardware grant stage. DOE

N80-26868# Midwest Research Inst., Golden, Colo.

ANALYSIS METHODS FOR PHOTOVOLTAIC APPLICATIONS

[1980] 7 p
(Contract EG-77-C-01-4042)
(SERI/SP-35-230) Avail: NTIS HC A02/MF A01

Brief descriptions of a variety of photovoltaic power systems simulation models and design tools are given. Services available through photovoltaic module manufacturers are outlined, and computer codes for systems analysis are described. DOE

N80-26869# Lincoln Lab., Mass. Inst. of Tech., Lexington.

PHASE 2 EXPERIMENT TEST PLAN: SOLAR PHOTOVOLTAIC/THERMAL RESIDENTIAL EXPERIMENT

Duncan B. Sheldon 23 Jan. 1980 27 p refs
(Contract EY-76-C-02-4094)
(COO-4094-65) Avail: NTIS HC A03/MF A01

The Solar Photovoltaic/Thermal Energy Project requires a Phase 2 test plan for its Solar Energy Research (SERF). This Phase 2 test plan is provided. The purpose of the research being conducted at the SERF is reviewed, and references describing Phase 1 work are listed. DOE

N80-26870# Los Alamos Scientific Lab., N. Mex.

PASSIVE SOLAR DESIGN HANDBOOK. VOLUME 2 OF TWO VOLUMES: PASSIVE SOLAR DESIGN

J. Douglas Balcomb, Dennis Barley, Robert McFarland, Joseph Perry, Jr., William O. Wray, and Scott Noll Jan. 1980 230 p
(Contract W-7405-eng-48)
(DOE/CS-0127/2) Avail: NTIS HC A11/MF A01

A manual for the design and performance evaluation and analysis of passive solar heating systems is presented. Two passive solar building types are analyzed: direct gain and thermal storage walls. Rules of thumb for the schematic design phase and simplified procedure for the design development phase are described. Analysis methods for the construction documents phase are given. The design procedure for fan-forced rock beds for hybrid systems is presented. Economic analysis methods for passive solar buildings are described. Tables of monthly average solar radiation, temperature and degree days for various locations in the US and southern Canada are included. DOE

N80-26871# Midwest Research Inst., Golden, Colo.

ANALYSIS METHODS FOR SOLAR HEATING AND COOLING APPLICATIONS: PASSIVE AND ACTIVE SYSTEMS, THE SECOND EDITION

Jan. 1980 19 p refs
(Contract EG-77-C-01-4042)
(SERI/SP-35-232R) Avail: NTIS HC A02/MF A01

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Brief descriptions of analysis methods and design tools which are valuable in performing parametric studies of candidate designs are presented. The methods included range from rules-of-thumb for builders to the simulation packages used by researchers.

DOE

N80-26873# Department of Housing and Urban Development, Washington, D. C. Office of Policy Development and Research.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM: A DESCRIPTIVE SUMMARY OF HUD CYCLE 4 AND 4A SOLAR RESIDENTIAL PROJECTS

Jul. 1979 167 p

(Contract EX-76-A-29-1020)

(HUD-PDR-455) Avail: NTIS HC A08/MF A01

The US Department of Housing and Urban Development (HUD) has awarded nearly \$8.5 million in grants for the purchase and installation of solar energy equipment in 6,851 residences. This cycle is fourth in a series of five cycles of residential demonstration projects with solar heating and cooling systems sponsored by HUD in a national effort to demonstrate widespread use of solar energy. Each project is summarized. The grantee and the location and size of the project are described. A rendering of the unit is given along with a description of energy system.

DOE

N80-26876# Entwicklungs- und Forschungslabor, Lorrach (West Germany).

WATER HEATING BY SOLAR ENERGY WITH PLASTIC COLLECTORS Final Report

Juergen Kleinwaecher Bonn Bundesmin. fuer Forsch. u. Technol. Sep. 1979 163 p refs In GERMAN; ENGLISH summary

Sponsored by Bundesmin. fuer Forsch. u. Technol. (BMFT-FB-T-79-29) Avail: NTIS HC A08/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 34

A low price, high efficiency, light weight, and easy to transport solar collector was developed using a plastic monotube with transparent top and dark bottom. Various synthetic materials were examined with regard to their optical and thermal properties and their durability. Prototype installations for swimming pool heating, domestic hot water and house heating in combination with a heat pump are described.

Author (ESA)

N80-26877# Grammer (Willibald), Amberg (West Germany). Abteilung Solar-Klima-Technik.

SOLAR COLLECTOR SYSTEM USING AIR COLLECTORS FOR A PRE-DRYING FACILITY IN A GRASS DRYING PLANT Final Report

Herrmann Barthel Bonn Bundesmin. fuer Forsch. u. Technol. Sep. 1979 19 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.

(SKT-Teil-1; BMFT-FB-T-79-30) Avail: NTIS HC A02/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 3.60

The design, construction, and installation of a solar collector system for the drying of grass with hot air is described. The collector surface measures 1456 square meters. Measurements were taken during field tests and their results are reported. Water removal is about 18%.

Author (ESA)

N80-26879# Austrian Solar and Space Agency, Vienna.

COLLECTOR TEST METHODS: ANALYSIS OF TEST METHODS FOR THE DETERMINATION OF THE THERMAL EFFICIENCY OF FLAT-PLATE COLLECTORS

Manfred Bruck, Walter Heindl, Harald Koch, Gottfried Schaffar (Technische Univ., Vienna), and Peter Varga Sep. 1979 236 p refs Sponsored by Austrian Federal Ministry of Science and Research

(ASSA-FA-10; ISBN-3-7041-0050-1) Avail: NTIS HC A11/MF A01

Test methods were evaluated for the determination of the thermal efficiency of flat-plate solar collectors with a liquid as the transfer fluid by means of a mathematical simulation. A comparison of experimental results obtained from tests conducted by the National Bureau of Standards (NBS) and by the International Energy Agency (IEA) with the results of the theoretical analysis shows that the observed scatter of data is primarily caused by

systematic errors when conducting the test. However, the scatter is also caused by production-dependent changes of the collector properties and by the fact that ambient conditions were not sufficiently considered. The analysis of the test methods by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and by the Bundesverband fuer Solarenergie (BSE) showed that the BSE standard yields better results - particularly for the climatic conditions in Central Europe - than the ASHRAE standard. A simple correction of the systematic deviations observed in BSE tests, caused by the fact that the temperature of the absorber is lower than of the transfer fluid, is suggested.

Author (ESA)

N80-26983# Toronto Univ. (Ontario). Dept. of Mechanical Engineering.

A MODEL FOR THE ANGULAR DISTRIBUTION OF SKY RADIANCE

F. C. Hooper and A. P. Brunger Aug. 1979 7 p refs Presented at Joint ASME/AICHE 18th Natl. Heat Transfer Conf., San Diego, Calif., 6-8 Aug. 1979

(Contract EY-76-C-02-2939)

(DOE-CS-32939-9; CONF-790808-23)

Avail: NTIS

HC A02/MF A01

A flexible mathematical model is introduced which describes the radiance of the dome of the sky under various conditions. This three component continuous distribution (TCCD) model is compounded by the superposition of three separate terms, the isotropic, circumsolar and horizon brightening terms, each representing the contribution of a particular sky characteristic. In use a particular sky condition is characterized by the values of the coefficients of each of these three terms, defining the distribution of the total diffuse component. The TCCD model was demonstrated to fit both the normalized clear sky data and the normalized overcast sky data with an RMS error of about ten percent of the mean overall sky radiance. By extension the model could describe variable or partly clouded sky conditions. The model can aid in improving the prediction of solar collector performance.

DOE

N80-27219*# National Aeronautics and Space Administration, Washington, D. C.

LESSONS OF THE NASA TECH HOUSE

Howard Allaway 1980 41 p Original contains color illustrations

(NASA-SP-442; LC-80-607024) Avail: NTIS MF A01; SOD HC \$3.00 CSCL 13B

The performance and effectiveness of the various systems incorporated into the NASA Technology House are described and evaluated in relation to the HUD reference house. The various aerospace technologies used (advanced electronics, solar energy utilization, water recycling, fire retardant materials) are discussed as well as the improved materials, design configurations, and construction techniques developed under other government programs and by industry. Tabular data show the consumption and conservation of electrical energy and water for each month over one full weather cycle, during which time a family of four was in residence.

A.R.H.

N80-27800*# Lutz-Sotire Partnership, Stamford, Conn.

SOLAR HEATING SYSTEM INSTALLED AT STAMFORD, CONNECTICUT Final Report

Sep. 1979 83 p Sponsored in part by DOE

(Contract EX-76-C-01-2377)

(NASA-CR-161436) Avail: NTIS HC A05/MF A01 CSCL 10A

The solar heating system installed at the Lutz-Sotire Partnership Executive East Office Building, Stamford, Connecticut is described. The Executive East Office Building is of moderate size with 25,000 sq ft of heated space in 2 1/2 stories. The solar system was designed to provide approximately 50 percent of the heating requirements. The system components are described. Appended data includes: the system design acceptance test, the operation and maintenance manual, and as-built drawings and photographs.

R.E.S.

N80-27802*# IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR CONTEMPORARY-MANCHESTER, MANCHESTER, NEW HAMPSHIRE
Progress Report, Mar. 1979 - Feb. 1980
 30 Jul. 1980 80 p Sponsored in part by DOE
 (Contract NAS8-32036)
 (NASA-CR-161471) Avail: NTIS HC A05/MF A01 CSCL 10A

The operational and thermal performance of the solar energy system, Contemporary-Manchester, is described. The system was designed by Contemporary Systems Incorporated to provide space heating and domestic hot water preheating for a three story dwelling located on the New Hampshire Vocational Technical College campus, Manchester, New Hampshire. The net fossil energy savings for the period from March, 1979 to February, 1980 was 14.52 million Btu. However, the performance of the system must be degraded due to the fact that the building was unoccupied throughout the data assessment and analysis period. The unoccupied status prevented the normal adjustment of heating and ventilating controls for maintenance of comfort levels within the building. This lack of occupancy also prevented the typical family hot water usage, which would have allowed for more realistic evaluation of the hot water subsystem. R.E.S.

N80-27806*# IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION-SEASONAL REPORT FOR ELCAM SAN DIEGO, SAN DIEGO, CALIFORNIA
Progress Report, Mar. - Sep. 1979
 May 1980 71 p refs Sponsored in part by DOE
 (Contract NAS8-32036)
 (NASA-CR-161481) Avail: NTIS HC A04/MF A01 CSCL 10A

The solar energy system, Elcam San Diego, was designed to supply domestic hot water heating for a single family residence located in Encinitas, California. System description, performance assessment, operating energy, energy savings, maintenance, and conclusions are presented. The system is a 'Sunspot' two tank cascade type, where solar energy is supplied to either a 66 gallon preheat tank (solar storage) or a 40 gallon domestic hot water tank. Water is pumped directly from one of the two tanks, through the 65 square feet collector array and back into the same tank. Freeze protection is provided by automatically circulating hot water from the hot water tank through the collectors and exposed plumbing when freezing conditions exist. Auxiliary energy is supplied by natural gas. Analysis is based on instrumented system data monitored and collected for one full season of operation. L.F.M.

N80-27807*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
ASHMET: A COMPUTER CODE FOR ESTIMATING INSOLATION INCIDENT ON TILTED SURFACES
 Robert F. Elkin and Ronald G. Toelle May 1980 44 p refs
 Sponsored in part by DOE
 (NASA-TM-78286) Avail: NTIS HC A03/MF A01 CSCL 10A

A computer code, ASHMET, was developed by MSFC to estimate the amount of solar insolation incident on the surfaces of solar collectors. Both tracking and fixed-position collectors were included. Climatological data for 248 U. S. locations are built into the code. The basic methodology used by ASHMET is the ASHRAE clear-day insolation relationships modified by a clearness index derived from SOLMET-measured solar radiation data to a horizontal surface. L.F.M.

N80-27813*# Boeing Aerospace Co., Seattle, Wash.
SOLAR POWER SATELLITE SYSTEM DEFINITION STUDY. VOLUME 5: SPACE TRANSPORTATION ANALYSIS, PHASE 3
Final Report, Dec. 1979 - May 1980
 Jun. 1980 153 p refs 5 Vol.
 (Contract NAS9-15636)
 (NASA-CR-160748; D180-25969-5-Vol-5) Avail: NTIS HC A08/MF A01 CSCL 10A

A small Heavy Lift Launch Vehicle (HLLV) for the Solar Power Satellites (SPS) System was analyzed. It is recommended that the small HLLV with a payload of 120 metric tons be adopted as the SPS launch vehicle. The reference HLLV, a shuttle-derived option with a payload of 400 metric tons, should serve as a backup and be examined further after initial flight experience. The electric orbit transfer vehicle should be retained as the reference orbit-to-orbit cargo system. L.F.M.

N80-27821# SRI International Corp., Menlo Park, Calif.
COMMUNITY IMPEDIMENTS TO IMPLEMENTATION OF SOLAR ENERGY
 M. D. Armstrong and J. E. Armstrong Nov. 1979 112 p refs
 (Contract W-7405-eng-48)
 (DOE/EV-0059) Avail: NTIS HC A06/MF A01

The complete array of institutional problems expected to emerge when solar technology is implemented on a national scale is assembled. The findings of the study are presented in two formats. First, the results are organized by the time frames of delays in solar implementation caused by the inherent difficulties a national energy policy would encounter in changing the way a given institution responds to specific solar technologies. Delay categories of 10 years or more, 6 to 8 years, and 3 to 5 years were selected; all were assigned under the assumption that a strong national policy promoting adoption of solar technologies would be in effect. The second format constitutes a description of the difficulties at the community level, associated with implementing each solar technology. DOE

N80-27822# Midwest Research Inst., Golden, Colo.
HETEROJUNCTION SOLAR CELLS
 S. Wagner 1978 17 p refs Presented at Royal Soc. Discussion Meeting on Solar Energy, London, 15 Nov. 1978
 (Contract EG-77-C-01-4042)
 (SERI/TP-32-134; CONF-7811142-1) Avail: NTIS HC A02/MF A01

A qualitative description of semiconductor/semiconductor heterojunction solar cells is given. The two groups of heterojunctions of greatest economic potential, very highly efficient cells for concentrator applications and moderately efficient thin film cells for flat plates, are described with examples. These examples illustrate the role of heterojunctions in surface passivation, monolithic multijunction devices, devices with semiconductors of only one conductivity type, and low-temperature fabrication techniques. DOE

N80-27823# National Technical Information Service, Springfield, Va.

SOLAR PROCESS HEAT. CITATIONS FROM THE NTIS DATA BASE
Progress Report, 1964 - Mar. 1980
 Audrey S. Hundemann Apr. 1980 67 p
 (PB80-807936) Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10A

Feasibility, design, cost, and economic potential of solar process heat are discussed. Potential applications to industries using hot water or steam and to heat used for dehydration processes in agriculture are covered. Contains 60 abstracts. GRA

N80-27827# National Bureau of Standards, Washington, D.C. National Engineering Lab.
ANALYSIS OF CODE RELATED RESPONSES FROM THE SOLAR DEMONSTRATION PROGRAM
Final Report
 Jan. 1980 156 p Sponsored in part by HUD and DOE
 (PB80-153968; NBSIR-79-1957) Avail: NTIS HC A08/MF A01 CSCL 10A

The building regulatory information gathered during the course of the Residential Solar Demonstration Program from inception of the program through September 30, 1978 is documented. It is concluded that existing codes do not present a barrier to the installation and acceptance of solar systems; however, code officials need additional training and better back-up material to properly evaluate solar systems. GRA

N80-27828# New Mexico Energy Inst., Albuquerque.
DEVELOPMENT OF A LOW-COST NON-TRACKING HEAT

02 SOLAR ENERGY

PIPE CONCENTRATING COLLECTOR Final Report, 1 Jul. 1978 - 30 Jun. 1979

K. T. Feldman, Jr. and Darryl Lee Noreen Jul. 1979 182 p refs Sponsored in part by New Mexico Energy and Minerals Dept. (PB80-160443; NMEI-23) Avail: NTIS HC A09/MF A01 CSCL 13A

A solar water heater which uses a multi-heat-pipe energy absorber is discussed. In the absorber configuration, wickless heat pipes which rely on only gravity and a puddle-flow mechanism are used. In order to design an energy absorber with sufficient heat transfer capability, the performance of a puddle-flow gravity-assisted heat pipe is theoretically investigated. The maximum heat transport capability of methanol, water, and Freon-11 heat pipes was studied. The relationship between various heat pipe parameters and axial heat transport capability is discussed. GRA

N80-27829# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.

AN INVESTIGATION OF WIND LOADS ON SOLAR COLLECTORS. APPENDIX 2: NET PRESSURE COEFFICIENTS Final Report

H. W. Tieleman, R. E. Akins, and P. R. Sparks Jan. 1980 170 p

(Contract EO-A01-78-3605)

(PB80-158769; VPI-E-80-1-App-2) Avail: NTIS HC A08/MF A01 CSCL 10A

A wind tunnel study of a series of model solar collector installations (flat-plate collectors) immersed in a thick turbulent shear layer was undertaken in order to determine design wind loads on such installations. Wind tunnel measurements were made of the mean and fluctuating pressures on a model of a single flat plate collector which was a component of different multipanel installations. The pressures were spatially integrated over the top and bottom of the single collector separately. GRA

N80-27843# California Univ., Berkeley. Energy and Environment Div.

LAND USE AND ENVIRONMENTAL IMPACTS OF DECENTRALIZED SOLAR ENERGY USE

Robert H. Twiss, Patricia L. Smith, Allen E. Gatzke, and Scott T. McCreary Jan. 1980 206 p refs

(Contract W-7405-eng-48)

(DOE/EV-0067) Avail: NTIS HC A10/MF A01

The physical, spatial and land-use impacts of decentralized solar technologies applied at the community level by the year 2000 are examined. The results are intended to provide a basis for evaluating the way in which a shift toward reliance on decentralized energy technologies may eventually alter community form. Six land-use types representative of those found in most US cities are analyzed according to solar penetration levels identified in the maximum solar scenario for the year 2000. The scenario is translated into shares of end use demand in the residential, commercial and industrial sectors. These proportions become the scenario goals to be met by the use of decentralized solar energy systems. The percentage of total energy demand is assumed to be 36.5 percent, 18.8 percent and 22.6 percent in the residential, commercial and industrial sectors respectively. The community level scenario stipulated that a certain percentage of the total demand be met by on-site solar collection, i.e. photovoltaic and thermal collectors, and by passive design. This on-site solar goal is 31.9 percent (residential), 16.8 percent (commercial) and 13.1 percent (industrial). DOE

03 HYDROGEN

Includes hydrogen production, storage, and distribution.

A80-33406 Biological solar energy conversion - Hydrogen production and nitrogen fixation by marine blue-green algae. A. Mitsui, E. Duerr, S. Kumazawa, E. Philips, and H. Skjoldal (Miami University, Miami, Fla.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 31-35. 8 refs. NSF Grants No. PFR-77-11545-A01; No. PFR-76-17159.

Experiments have been conducted with a view to developing intact cell marine blue-green algal systems capable of producing hydrogen and fixing nitrogen. Numerous strains of photosynthetic microorganisms with these capabilities have been isolated in tropical and subtropical Atlantic environments. One of these species, a tropical blue-green alga, has demonstrated the capability for sustained periods of hydrogen production at high rates (1 ml H₂/ml algal suspension/3 day). Biochemical studies have shown that the high yield is due to the absence of uptake hydrogenase activity in this strain. Further research with these or similar organisms could lead to the development of biological solar energy technologies.

V.L.

A80-33407 H₂ production from water - Use of natural and synthetic catalysts for the bioconversion of solar energy. K. K. Rao, M. W. W. Adams, P. Morris, D. O. Hall (Kings' College, London, England), E. C. Hatchikian, J. Le Gall (CNRS, Laboratoire de Chimie Bacterienne, Marseille, France), K. Schneider, and H. G. Schlegel (Göttingen, Universität, Göttingen, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 36-40. 31 refs. Research supported by the Science Research Council of England and Commission of the European Communities.

An in vitro system containing chloroplasts, ferredoxin and hydrogenase evolves H₂ on illumination. The duration of H₂ production depends on the light and oxygen sensitivity of the components of the system. Some of the biological constituents of the system are replaceable by synthetic analogues. Attempts are also made to stabilize the chloroplasts and enzymes by immobilization on solid supports. Optimal rates of 50 micromole of H₂ per mg chlorophyll per h, continuous for four to six hours, are obtained at present.

(Author)

A80-33410 Light-dependent hydrogen production by *C. reinhardi*. S. Lien (Solar Energy Research Institute, Golden, Colo.), C. McBride, R. Togasaki, and A. San Pietro (Indiana University, Bloomington, Ind.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1.

Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 51-55. 13 refs. NSF Grants No. BMS-75-03415; No. AER-75-16962; Contract No. EG-77-C-0104-042.

The activity of hydrogenase in nonsynchronous, photoheterotrophically grown cells of *C. reinhardi* is a function of culture age. Rapidly growing cultures (exponential phase) exhibit lower hydrogenase activity than early stationary phase cultures. During prolonged dark anaerobic incubation the hydrogenase activity attains a maximal value in two to five hours. The activity declines rapidly after three to four hours of anaerobic incubation unless the pH of the suspending medium is maintained above 6.0. In *C. reinhardi* the source of electrons for hydrogen photoproduction appears to be

derived mainly from water oxidation. However, when the water-splitting complex of photosystem II is impaired by a mutational block, the organism can utilize intracellular organic reductants as substrate for H₂ production in a light-dependent reaction involving both PSII and PSI. When photosynthetic electron transport is uncoupled from phosphorylation, a rate of 174 micromoles of hydrogen evolved per mg cells per hour is observed. This rate of hydrogen photoproduction corresponds to 76% of the reductant generating capacity of PSII under steady-state photosynthesis.

(Author)

A80-35189 Hydrogen production using fusion energy and thermochemical cycles. V. D. Dang and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). *International Journal of Hydrogen Energy*, vol. 5, no. 2, 1980, p. 119-129. 21 refs. Contract No. EY-76-C-02-0016.

Thermochemical cycles for the production of synthetic fuels would be especially suited for operation in conjunction with controlled thermonuclear fusion reactors because of very high temperature energy which such reactors could supply. Several high-temperature, two step thermochemical cycles for the production of hydrogen are examined. A thermodynamic analysis of the Fe₃O₄-FeO, CrCl₃-CrCl₂, and UCl₄-UCl₃ pairs reveals the feasibility of the processes. A more detailed process analysis is given for the Fe₃O₄-FeO system using steam as the heat transfer medium for decomposing the higher valent metal oxide for oxygen production, and hydrolyzing the lower oxide for hydrogen production. The steam could be heated to high temperatures by refractory materials absorbing the 14 MeV neutrons in the blanket region of a fusion reactor. Process heat transfer and recovery could be accomplished by regenerative reactors. Proposed operating conditions, the energy balance, and the energy efficiency of water decomposition process are presented. With a fusion blanket temperature of 2500 K, thermal efficiencies for hydrogen production (HHV) of 74.4% may be obtained.

(Author)

A80-35190 The reaction of sulphur dioxide with water and a halogen: The case of iodine - Reaction in presence of organic solvents. G. De Beni, G. Pierini, and B. Spelta (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerche, Ispra, Italy). *International Journal of Hydrogen Energy*, vol. 5, no. 2, 1980, p. 141-149. 12 refs.

Experimental work on the reaction of SO₂, H₂O and I₂ is described in this paper. This reaction gives rise to separation problems which may be overcome by the use of a large excess of SO₂ and/or by the addition of suitable organic solvents. The results obtained with SO₂ only and with addition of diethylether and TBP are discussed, also in view of application of this reaction in possible thermochemical cycles.

(Author)

A80-35192 Application of magnesium rich rare-earth alloys to hydrogen storage. B. Darriet, M. Pezat, A. Hbika, and P. Hagenmuller (Bordeaux I, Université, Talence, Gironde, France). *International Journal of Hydrogen Energy*, vol. 5, no. 2, 1980, p. 173-178. 12 refs. Research supported by the Délégation Générale à la Recherche Scientifique et Technique.

The hydriding behavior of the LnMg₁₂, Ln₂Mg₁₇ and Ln₅Mg₁ alloys (Ln equals La, Ce or mischmetal) has been investigated. They decompose during hydriding to give magnesium hydride and the corresponding rare-earth hydride. The study of absorption-desorption hydriding cycles at different temperatures and various pressures shows that such alloys could be used as high performance hydrogen storage materials.

(Author)

A80-35193 Comment on 'The impracticability of large-scale generation of hydrogen from water photolysis by utilization of solar radiation'. W. J. D. Escher (Escher Technology Associates, St. Johns, Mich.). *International Journal of Hydrogen Energy*, vol. 5, no. 2, 1980, p. 205, 206. 5 refs.

03 HYDROGEN

A80-36653 Hydrogen in metals - Notable properties and examples for their utilization. I (Wasserstoff in Metallen - Herausragende Eigenschaften und Beispiele für deren Nutzung. I). H. Wenzl (Kernforschungsanlage Jülich GmbH, Institut für Festkörperforschung, Jülich, West Germany). *Metall*, vol. 34, May 1980, p. 407-412. In German.

A80-37330 Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979, and Supplement. Symposium sponsored by the Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979. Proceedings, 443 p.; Supplement, 171 p. \$39.14.

The Symposium emphasizes future oil prospects, experience with gaseous hydrogen pipeline systems, hydrogen fueled turbofan engines, liquid hydrogen airport requirements, and a liquid hydrogen experimental airline project. Papers were given on the impacts of fossil fuel on the environment, alternate fuels for aircraft, production of hydrogen by coal gasification, production of hydrogen from solar energy and water, handling of hydrogen, liquid hydrogen fueled aircraft, turbofan engine and fuel system for liquid hydrogen use, liquid hydrogen engines, and design concept for LH2 airport facilities. A.T.

A80-37333 # Hydrogen from fossil fuels. D. P. Gregory and P. B. Tarman (Institute of Gas Technology, Chicago, Ill.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 7.1-7.29. 7 refs.

Hydrogen is manufactured on an industrial scale by steam reforming of natural gas, partial oxidation of heavy oil, and coal gasification. As hydrogen becomes less available and more expensive, a reassessment of processes is necessary to evaluate hydrogen production. This paper contains descriptions of existing processes for the production of hydrogen from gas, oil, and coal by electrolysis. Emphasis is given to the Steam-Iron Process because it represents a novel method of producing pure hydrogen, which might be well adapted to liquid hydrogen production for aircraft fuel use. Estimates of hydrogen costs for each process are compared on an economic basis, and the effects of changes in the major cost factors, such as feedstock costs and by-product credits, are evaluated. The principal by-products are sulfur, oxygen in the case of electrolysis, and electric power in the case of the Steam-Iron Process. In some situations, a combined steam-iron/electrolysis process appears attractive. (Author)

A80-37334 # Description of processes for producing hydrogen by coal gasification. H. U. Karwat (Linde AG, Munich, West Germany). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 8.1-8.35. 6 refs.

Commercial installations for coal gasification, now producing ammonia, methanol and (town) gas production, are based on the reaction of steam and oxygen with coal and are potential hydrogen producers. Besides the processes which obtain their heat supply by burning coal, those concepts which utilize process heat from nuclear reactors are of interest. Raw gas treating is similar to the proven techniques of ammonia manufacture. The envisaged production of 800 to 1500 t/d of hydrogen requires gas generator and gas treating plants 4 to 7 times larger than those installed for a 1000 t/d coal based ammonia plant. (Author)

A80-37335 # Description of processes for producing hydrogen by advanced electrolysis. M. Braun. In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979.

Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 9.1-9.18.

A review of water electrolysis technology is presented. Electrolysis is not inferior to thermochemical methods for producing hydrogen from nonfossil heat sources on a large scale since the efficiency of both processes is limited to the same value by the second law of thermodynamics. The two types of electrolysis systems, aqueous alkaline electrolysis at elevated temperatures and pressure and the use of a cation exchange membrane, offer the possibility of reaching a cell voltage of about 1.7 V at the plant investment cost of about 100 dollars/kw within the next 8 years.

A.T.

A80-37336 * # Future production of hydrogen from solar energy and water - A summary and assessment of U.S. developments. J. A. Hanson (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and W. J. D. Escher (Escher-Foster Technology Associates, Inc., St. Johns, Mich.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979.

Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 11.1-11.28. 31 refs. Research sponsored by the U.S. Department of Energy.

The paper examines technologies of hydrogen production. Its delivery, distribution, and end-use systems are reviewed, and a classification of solar energy and hydrogen production methods is suggested. The operation of photoelectric processes, biophotolysis, photocatalysis, photoelectrolysis, and of photovoltaic systems are reviewed, with comments on their possible hydrogen production potential. It is concluded that solar hydrogen derived from wind energy, photovoltaic technology, solar thermal electric technology, and hydropower could supply some of the hydrogen for air transport by the middle of the next century. A.T.

A80-37337 # Safe handling of hydrogen in large quantities. M. Müller (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 13.1-13.29.

Safe handling of hydrogen which is used as a propellant in rocket engines is examined. The supply system consisting of vehicles of 1000 to 6000 l capacities for transport of liquid hydrogen is described; the hydrogen is released to a storage tank of 10,000 l capacity. The test facility has a high pressure capability of the propellant feed system, and it enables the development and optimization of the combustion system without the use of the rocket's pumping and turbine unit. Safety measures require that the materials in contact with hydrogen must have a sufficient low temperature ductility or must be resistant to embrittlement which occurs when in contact with pressurized gas at ambient temperatures. For normal stress, a conventional stainless steel 1.4541 (German standard) was used, while for a higher stress, as in tubes and tanks, a nitrogen alloyed austenitic steel 1.4429 is utilized. Finally, several accidents involving a hydrogen leak, explosions, and failures of electronic equipment leading to accidents were described. A.T.

A80-37338 # Hydrogen as an alternative fuel - An intermediate report on research and development funding by the Federal Ministry for Research and Technology. D. Frenzel (Bundesministerium für Forschung und Technologie, Bonn, West Germany). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 14.1-14.17.

The paper considers hydrogen as an alternative fuel suitable for balanced, integrated transportation to meet the interests of users, operators, and the environment. The alternative fuel is required to be economical, safe, toxicologically acceptable, environmentally safe, and producible from readily available materials. The main problem in applying hydrogen in the elementary state is storage which can be

handled by using gas cylinders, cryotanks, and metal hydride storage devices, noting that the hydride storage device is best for use in motor vehicles. The spinoff applications from hydrogen storage research such as air conditioning and auxiliary heating of vehicle interiors are discussed. These hydrogen investigations are intended to analyze and evaluate the entire energy chain, including production, distribution, storage, the application in vehicles taking into consideration various operating conditions. A.T.

A80-37339 # Surface transportation systems using hydrogen energy. W. J. D. Escher and R. W. Foster (Escher-Foster Technology Associates, Inc., St. Johns, Mich.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 15.1-15.13; Appendixes, 20 p. 31 refs.

Application of hydrogen energy to surface transportation systems is considered from today's limited research and demonstration projects standpoint, and from tomorrow's prospective uses. Emphasis is on providing substantial supporting theoretical and experimental background, both on hydrogen's comparative fuel characteristics and on internal combustion engines fueled with hydrogen. Aspects of hydrogen, as an alternative fuel for conventional diesel-powered rail motive power systems, are related from the viewpoint of an ongoing effort in alternative fuels for medium speed diesel engines. From this case-in-point experience, some suggestions are offered toward the successful promotion of hydrogen for other transportation sectors, including air. (Author)

A80-37340 # Characteristics of liquid hydrogen-fueled aircraft. G. D. Brewer (Lockheed-California Co., Burbank, Calif.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 16.1-16.24. 17 refs.

A summary of the effect of liquid hydrogen on long range quality and performance of liquid-hydrogen fueled aircraft is presented. It shows that the use of liquid hydrogen will reduce the wing dimensions, require larger fuselage, and reduce the gross weight. It will also reduce engine noise; diminish hydrocarbon, CO, SO, and NO pollution; lower life cycle energy; and produce cost reductions by increasing engine life, and will improve safety. It is concluded that there are considerable benefits to be gained by using LH₂, but there are also reasons to continue kerosene-type fuel as long as it is available on an economic basis. A.T.

A80-37341 # Safety of liquid hydrogen in air transportation. F. J. Edeskuty (California, University, Los Alamos, N. Mex.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 18.1-18.17. 29 refs. Research sponsored by the U.S. Department of Energy.

Safety in the use of liquid hydrogen in air transportation is discussed. The use of cryogenic hydrogen involves the hazards from low temperatures and from combustibles. The hydrogen properties and their effect on airline operation are considered, showing that several safety problems require additional experimentation. The storage and refueling system should be automated, and buildings in the vicinity of aircraft and fueling systems should be kept at a positive pressure. Hydrogen spills and dispersion are discussed in terms of models which include the rate and size of spill, and which can predict the dispersion and distribution of hydrogen as a function of time and distance from the spill point. It is concluded that the safety record of producing and handling LH₂ has been good and it will require a continued effort in safety engineering. A.T.

A80-37342 * # Preliminary studies of a turbofan engine and fuel system for use with liquid hydrogen. C. F. Baerst and J. C. Riple

(AirResearch Manufacturing Company of Arizona, Phoenix, Ariz.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979.

Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 19.1-19.25. 9 refs. NASA-sponsored research.

A study of design concepts for the application of the properties of LH₂ in a turbofan engine for air transport is presented. The study showed the benefits from the reduction of aircraft direct operating cost. Design concepts for the engine fuel delivery and control system, including the engine high pressure fuel pump, were developed and general concept feasibility was demonstrated. Recommendations were made for the advanced development required for design application for both the engine, the fuel delivery, and the control system. A.T.

A80-37343 # Liquid hydrogen engines. R. C. Mulready (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 21.1-21.43.

The paper discusses the development of liquid hydrogen engines. The 500 lb/day hydrogen liquefaction plant, the hydrogen tube trailers, and the test stand structures constructed to dissipate any hydrogen which may leak are described. The tests of valves, seals, heat exchangers, and pumps are discussed; the pumps which produced the design pressure rise of 1100 psi at 25,000 rpm are considered. The hydrogen expander cycle called the 304 was selected for the Sutan engine to take advantage of hydrogen's properties as a turbine working fluid. In this engine, hydrogen alone was used in the turbine at the inlet temperature of 1335 F producing the 12,000 HP to drive the fan at a sea level. A larger 60,000 lb/day hydrogen plant which employed expanders in the refrigeration cycle was operated in 1958, and a rocket engine was designed with hydrogen as the working fluid. The hydrogen turbopump has launched most of the large communication satellites and deep space missions, including the Voyager series. A.T.

A80-37344 # Design concept for LH₂ airport facilities. J. G. Hoyt (Ralph M. Parsons Co., Pasadena, Calif.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 22.1-22.39.

A study of impact on airports of converting a portion of the air transport system to the use of liquid hydrogen (LH₂) as a fuel is presented. Studies assumed that gaseous hydrogen (GH₂) would be available at the boundary of the airport; this paper summarizes one prototypical system for the distribution and transfer of the cryogenic fuel, and outlines the requirements for the liquefaction and a storage facility. The system uses four liquefier modules, five vacuum perlite-insulated storage dewars, and a pump-fed, two pipe distribution loop system serving hydrants at conventional gas positions. Fuel transfer is by a 'cherry picker' assembly, providing insulated connections from the hydrant to aircraft fuel-inlet and vent-access points and carrying all systems for purification, transfer, inerting, and operational safety. The paper concludes with a summary of costs from these studies and indicates that there is no problem with adapting airports to the LH₂ service. A.T.

A80-37345 # A proposed liquid hydrogen development program for aircraft. G. D. Brewer (Lockheed-California Co., Burbank, Calif.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979, p. 24.1-24.22. 9 refs.

On the basis of theoretical considerations liquid hydrogen has been shown to be a very attractive candidate fuel for transport aircraft. It is superior in all of the criteria considered to be of primary importance: global availability, safety, pollution, and level of noise generated around airports. To provide experimental data

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based on practical experience a comprehensive technology development plan which includes operation of LH₂-fueled transport aircraft in international commercial cargo service is suggested. The proposed program will provide the technology base needed to intelligently evaluate LH₂ when the ultimate decision must be made to select a fuel for future transport aircraft. (Author)

A80-37346 # Hydrogen production from water by use of nuclear energy. R. Schulten and H. Barnert (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979, Supplement. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979. 24 p. 21 refs.

The paper discusses future prospects regarding the production of hydrogen from water as well as other secondary energy carriers on the basis of nuclear energy converted into heat energy in a high-temperature reactor (HTR). The discussion covers the following: (1) aspects of future energy supply relative to energy demand and nuclear contribution, the heat market and high-quality secondary energy carriers; (2) fission energy conversion and conservation in terms of the HTR in competition with other reactors as well as conservation of uranium and nonproliferation; (3) high temperature heat production; (4) high-temperature heat conversion processes; and (5) R&D for HTR applications and international cooperation on HTR. S.D.

A80-37347 * # Analysis and design of insulation systems for LH₂-fueled aircraft. G. R. Cunningham, Jr. (Lockheed Research Laboratories, Palo Alto, Calif.). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979, Supplement. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979. 27 p. 22 refs. Contract No. NAS1-14614.

An analytical program was conducted to evaluate the performance of 15 potential insulations for the fuel tanks of a subsonic LH₂-fueled transport aircraft intended for airline service in the 1990-1995 time period. As a result, two candidate insulation systems are proposed for subsonic transport aircraft applications. Both candidates are judged to be the optimum available and should meet the design requirements. However, because of the long-life cyclic nature of the application and the cost sensitivity of airline operations, an experimental tank/insulation development or proof-of-concept program is recommended. This program should be carried out with a nearly full-scale system which would be subjected to the cyclic thermal and mechanical inputs anticipated in aircraft service. S.D.

A80-37348 # Hydrogen fueled high bypass turbofans in subsonic aircraft. R. J. Payzer and S. W. Renninger (General Electric Co., Cincinnati, Ohio). In: Hydrogen in air transportation; Proceedings of the International Symposium, Stuttgart, West Germany, September 11-14, 1979, Supplement. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979. 34 p.

Some results are presented from a study conducted to evaluate the potential payoff of hydrogen fuel in high bypass turbofan engines suitable for application in long range subsonic logistic aircraft. The discussion focuses on engine cycle configurations, cycle comparison, evaluation model, evaluation of basic cycles, composite cycle evaluation, and composite cycle design factors. It is shown that for the basic turbofan cycle, there is a definite thermodynamic benefit in switching from JP to hydrogen fuel due to the difference in fuel properties. However, the additional complexity associated with use of hydrogen in composite cycles does not appear to be justified. These cycles provide little or no benefit in terms of improved aircraft performance over and above the basic hydrogen turbofan cycle and represent high risk approaches. S.D.

A80-37349 # Hydrogen liquefaction, storage and transfer on an airport site. J. J. Thibault (L'Air Liquide, Sassenage, Isère, France). In: Hydrogen in air transportation; Proceedings of the

International Symposium, Stuttgart, West Germany, September 11-14, 1979, Supplement. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1979. 24 p. 8 refs.

The paper deals only with cryogenic problems. A number of exploratory studies were conducted for evaluating the feasibility and cost impact of the use of LH₂ as a fuel on an airport site. Once LH₂ is produced and stored, it must be delivered to the planes through cryogenic transfer lines, a few kilometers long, and cryogenic fueling systems between the lines and the planes. The liquefaction, storage and transfer components are reviewed and their size and complexity compared with those of existing equipment. Some research and technology development fields are stressed. S.D.

A80-37987 Electrolytic hydrogen production and its potential utilization for ship propulsion. C. A. Schmidt (Comisión Chilena de Energía Nuclear, Santiago, Chile). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2. New York, Pergamon Press, Inc., 1980, p. 1094-1108.

12 refs.

The electrolytic hydrogen technology available today, and the one expected to be developed within the next 20 years, is examined from a technical and the economical point of view. Light Water Reactors (LWR) for the near term and Liquid Metal Fast Breeder Reactors (LMFBR) as primary energy sources are used to produce electrolytic hydrogen. Potential utilization of hydrogen as a fuel for ships, is examined with some practical examples in WSEV. (Author)

A80-38117 The use of an unsteady wave chemical reactor as a key element in the production of H₂ for use in synthetic fuel production. E. L. Klosterman, R. T. Taussig, T. S. Vaidyanathan, P. Cassidy, L. Steinhauer, and M. Shirazian (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: Shock tubes and waves; Proceedings of the Twelfth International Symposium, Jerusalem, Israel, July 16-19, 1979. Jerusalem, Magnes Press, 1980, p. 446-456. 22 refs. Contract No. ET-78-C-06-1095.

The gas dynamics aspects of applying an unsteady chemical wave reactor to CO/H₂ production have been investigated. It is shown that multiple wave processes minimize flow velocities and therefore friction losses. Similarly, significant amounts of helium diluent (30 to 60 percent) are necessary to minimize the same losses while retaining high CO/H₂ yields. Efficient freezing of the chemical reaction products at the high peak temperatures would be possible with predicted CO yields of 13 percent. Overall cycle efficiencies of 34 percent appear possible with a 90 percent reactor performance efficiency. V.L.

A80-40970 The significance of hydrogen as a future environmentally sound secondary energy source in energy and propulsion technology (Die Bedeutung von Wasserstoff als zukünftiger umweltfreundlicher Sekundärenergieträger in der Energie- und Antriebstechnik). W. Peschka (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Technische Physik, Stuttgart, West Germany). *DFVLR-Nachrichten*, June 1980, p. 24-28. In German.

Hydrogen as a rocket fuel is an important secondary energy source in space flight. In recent years, the potential use of hydrogen as a secondary energy source next to electricity has been examined. Attention is given to the ecological aspects of hydrogen production, storage of secondary energy by means of hydrogen, hydrogen and solar energy, and hydrogen as an alternate fuel. M.E.P.

A80-42459 Photoelectrochemistry. I - Photoelectrolysis. II - The photogalvanic cell. A. F. Janzen (Western Ontario, University, London, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 905-921, 923-937. 27 refs.

The physical and chemical processes involved in photoelectrolysis are outlined. The restrictions for hydrogen production by

photoelectrolysis are discussed, and an estimate of maximum efficiency for energy storage is given. Examples of photogalvanic cells, recent developments, and critical processes are presented. Iron-thionine, methylene blue-iron, and azura-A-iron systems are considered. An estimate of the maximum conversion efficiency of photogalvanic cells is made. V.T.

A80-43772 Mössbauer surface studies on TiFe hydrogen storage material. A. Bläsius and U. Gonser (Saarland, Universität, Saarbrücken, West Germany). *Applied Physics*, vol. 22, July 1980, p. 331, 332. 6 refs. Research supported by the Deutsche Forschungsgemeinschaft.

By means of Conversion Electron Mössbauer Spectroscopy (CEMS) Fe clusters have been found on the surface of activated TiFe specimens. The magnetic moments of the Fe precipitates order ferromagnetically with a field of 328 kOe and are aligned parallel to the surface. The Fe precipitates are produced by the thermal treatment under hydrogen atmosphere and can be regarded as catalysts for the dissociation of the H₂ molecules. (Author)

N80-23478# Brookhaven National Lab., Upton, N. Y. **HYDROGEN STORAGE MATERIALS RESEARCH AND DEVELOPMENT WORK AT BROOKHAVEN NATIONAL LABORATORY**

John R. Johnson 1979 4 p refs Presented at the DOE Chem. Energy Storage and Hydrogen Energy Systems Contracts Rev. Meeting, Reston, Va., 12 Nov. 1979 (Contract EY-76-C-02-0016) (BNL-26813; CONF-791127-2) Avail: NTIS HC A02/MF QA01

The utilization of TiCr₂ intermetallics (parent compounds or substituted systems) as energy storage media or for nonmechanical compression/liquefaction applications is discussed. Preliminary research into the feasibility of hydrogen separation from mixed gas streams, using intermetallic compounds, is briefly reported. DOE

N80-23797# Sandia Labs., Livermore, Calif. Energy Systems Study Div. **FIXED SITE HYDROGEN STORAGE. 1: APPLICATIONS IMPACT**

J. J. Iannucci and S. L. Robinson 1979 11 p refs Presented at the 2nd Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10 Dec. 1979 (Contract EY-76-C-04-0789) (SAND-79-8647; CONF-791204-10) Avail: NTIS HC A02/MF A01

The potential applications and requirements for fixed site storage in a scenario of wide spread hydrogen use are examined, and quantified. An envisioned hydrogen production/distribution/end-use cycle is scrutinized to identify the storage needs for both continuous and intermittent sources including solar. The most pressing need for storage is found to be at the distribution point, in concurrence with current natural gas practice. Caverns and similar underground storage techniques are shown to be the most promising modes due to their low cost relative to all other options examined. Since a large volume of natural gas storage is presently in service, a pressing need to develop fixed site hydrogen storage technology (beyond the conversion of this underground storage to hydrogen) has not been identified. DOE

N80-23865# European Space Agency, Paris (France). **PHOTOLYTIC DECOMPOSITION OF WATER INTO OXYGEN AND HYDROGEN AS AN ALTERNATIVE ENERGY UTILIZATION OF HOUSEHOLDS AND SMALL CONSUMERS**

Wolfgang U. Wendekamm Nov. 1979 54 p refs Transl. into ENGLISH of "Photolytisches Zersetzung von Wasser zu Wasserstoff und Wasserstoff als Alternative Energieversorgung von Haushalten und Kleinverbrauchern". Rept. DFVLR-FB-78-77 DFVLR, Trauen, West Germany, Jan. 1978 Original report in GERMAN previously announced as N79-30836 Original German report available from ZLDI, Munich DM 19.90 (ESA-TT-582; DFVLR-FB-78-17) Avail: NTIS HC A04/MF A01

The photolytic decomposition of water into oxygen and hydrogen is one of the possible alternatives for the transformation of solar energy into storable secondary energy for practical utilization by households and small consumers. After a survey of the possible cycles of water decomposition, the chemical and physical fundamentals of the photolytic decomposition of water using inorganic catalysts and sensitizers are described. Finally, a total house energy supply system is presented as one illustration of the application possibilities. Author (ESA)

N80-24477# Midwest Research Inst., Golden, Colo. **PHOTOBIOLOGICAL HYDROGEN PRODUCTION** M. Seibert, S. Lien, and P. F. Weaver 1979 20 p refs Presented at the US/USSR Joint Working Group in Microbiol., Riga, 2-5 Oct. 1979

(Contract EG-77-C-01-4042) (SERI/TP-33-410) Avail: NTIS HC A02/MF A01

Hydrogen production by phototrophic organisms, which has been known since the 1930's, occurs at the expense of light energy and electron-donating substrates. Three classes of organisms, namely, photosynthetic bacteria cyanobacteria, and algae carry out this function. The primary hydrogen-producing enzyme systems, hydrogenase and nitrogenase, are discussed along with the manner in which they couple to light-driven electron transport. In addition, the feasibility of using in vivo and in vitro photobiological hydrogen producing systems in future solar energy conversion applications are examined. DOE

N80-24483# Brookhaven National Lab., Upton, N. Y. Energy Storage and Conversion Div.

BULK HYDROGEN STORAGE USING METAL HYDRIDES G. Strickland and M. J. Russo, Jr. Dec. 1979 10 p refs Presented at the 2nd Miami Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10-13 Dec. 1979 (Contract EY-76-C-02-0016)

(BNL-27093; CONF-791204-14) Avail: NTIS HC A02/MF A01

The considerations involved in design and use of a process unit, or reservoir, for storing bulk quantities of hydrogen via solid particles of titanium-iron-manganese are described along with several applications. One style of reservoir having improved design features, and the service system in which it was installed for testing are discussed. The reservoir has a nominal storage capacity of 50 lb (23 kg) of hydrogen and is rated for hydrogen charging and discharging times in the 5 to 10 hour range. DOE

N80-25464# Scientific Design Co., Inc., New York. **EVALUATION OF THE TEXACO SYNTHESIS GAS GENERATION PROCESS FOR THE PRODUCTION OF HYDROGEN FROM SRC-2 RESIDUE**

T. Y. Chang and Allan S. West Dec. 1979 87 p (Contract W-7405-eng-28) (ORNL/Sub-7240/6) Avail: NTIS HC A05/MF A01

The results are presented of an evaluation of the Texaco Synthesis Gas Generation Process for the production of hydrogen from SRC-II vacuum bottoms residue. Preliminary process designs for a gasification facility for a commercial scale coal liquefaction plant were prepared. A number of studies were performed to establish a near-optimal operating pressure and method of acid gas removal. Plant investment and operating cost estimates are included. It is concluded that the gasifier is well suited for the efficient production of hydrogen from SRC-II residue and only minimal developmental work is needed prior to commercializations. Because of the short duration of the test runs, refractory and burner lives are a point of concern. Based on the current state of oxygen compression technology the gasifier should be designed to operate at about 800 psig. DOE

N80-25467# Los Alamos Scientific Lab., N. Mex. **LIQUID HYDROGEN-FUELED VEHICLE PROJECT**

Walter F. Stewart 1979 16 p refs Presented at the Automotive Technol. Develop. Contractor's Coord. Meeting, Dearborn, Mich., 23-25 Oct. 1979 (Contract W-7405-eng-36)

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(LA-UR-79-2883; CONF-791082-1) Avail: NTIS
HC A02/MF A01

A cooperative evaluation and state-of-the-art demonstration project for liquid hydrogen vehicle onboard storage and refueling techniques is discussed. Safety, economic, and energy assessments for liquid hydrogen as a fuel are also included. A baseline system is provided representing present capabilities in engine conversion, liquid hydrogen storage, and liquid hydrogen refueling. DOE

N80-28538# Los Alamos Scientific Lab., N. Mex.
UTILIZATION OF SOLAR THERMAL SOURCES FOR THERMOCHEMICAL HYDROGEN PRODUCTION

Melvin G. Bowman 1980 6 p refs Presented at the Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980 Submitted for publication
(Contract W-7405-eng-36)

(LA-UR-80-837; CONF-800604-3) Avail: NTIS
HC A02/MF A01

The utilization of high temperature solar heat for the production of electricity and/or fuels is considered. Solar concentrator systems are discussed in terms of cost and practicality. Conversion efficiency and energy storage requirements are also considered. DOE

N80-27816# Defense Intelligence Agency, Washington, D.C.
HYDROGEN TECHNOLOGY: FOREIGN, CHANGE 1 Report for period ending Feb. 1980

James D. Busi and Phillip Greenbaum 14 Apr. 1980 66 p
(AD-A083665; DIA-DST-1860S-522-78-CHG-1) Avail: NTIS
HC A04/MF A01 CSCL 10/2

Hydrogen is both a promising medium for the efficient storage and transmission of energy and a potential alternate fuel. Hydrogen is not a primary energy source, however, since its production is dependent upon other energy sources (thermal, electrical, and radiant). To be practicable as a fuel, hydrogen must be produced in bulk quantities with a standardized purity that will satisfy consumer specifications. In addition, improved distribution systems must make hydrogen widely available to military, industrial, and domestic consumers if the successful evolution of a hydrogen economy is to occur. The greatest potential military impact of hydrogen lies in its use as an aviation fuel. Because of its high specific energy (124 kJ/kg--2.7 times greater than conventional aviation fuels), hydrogen has potential use as a fuel for subsonic transports, supersonic aircraft, and helicopters; however, safety measures, logistics, and storage and handling systems must be developed and standardized before this capability can be achieved. Initial experimental use of hydrogen in military aircraft may occur in the 1980s. A followup conversion and modification of aircraft and airports to hydrogen will require an additional 10 to 15 years. Secondary military interests include the use of hydrogen fuel cells for portable and transportable power generation, and its use as a propellant in aerospace applications. GRA

FUELS AND OTHER SOURCES OF ENERGY

Includes fossil fuels, nuclear fuels, geothermal and ocean thermal energy, tidal energy, and wind energy.

A80-32857 # Fusion - An energy source for synthetic fuels. J. A. Fillo, J. Powell, and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). *American Institute of Aeronautics and Astronautics, International Meeting and Technical Display on Global Technology 2000, Baltimore, Md., May 6-8, 1980, Paper 80-0844.* 10 p. 23 refs. Research sponsored by the U.S. Department of Energy.

An important first step in the synthesis of liquid and gaseous fuels is the production of hydrogen. Thermonuclear fusion offers an inexhaustible source of energy for the production of hydrogen from water. Depending on design, electric generation efficiencies of 40 to 60% and hydrogen production efficiencies by high temperature electrolysis of 50 to 70% are projected for fusion reactors using high temperature blankets. Fusion/coal symbiotic systems appear economically promising for the first generation of commercial fusion synfuels plants. In the long term, there could be a gradual transition to an inexhaustible energy system based solely on fusion. (Author)

A80-32930 The influence of Tidal Generating Force on windflow - A preliminary study. V. Sutton-Vane. *Wind Engineering*, vol. 3, no. 4, 1979, p. 263-268. 5 refs.

The correlation between Tidal Generating Force (the cyclically varying resultant effect of lunar and solar gravitational forces and their directions) and windflow has been investigated and a close relationship appears to exist. For observing windflow behavior and evaluation of TGF, mean windflow figures for central London and daily predictions of high water at London Bridge for 1979 were used. From the preliminary study it is suggested that TGF affects the atmosphere in a similar way to the sea, leading to the concept of the existence of a Tidal Atmosphere with spring and neap tides coinciding with periods of greater and lesser wind activity. Further study is required for more substantial conclusions and if the concept appears to be correct it would become possible to realize long term predictions of periods of maximum and minimum wind activity and reduce the unpredictability of wind when used as a source of power. From the results already obtained, it should be possible to predict periods of higher or lower than average windflow, a year or more ahead with an approximate accuracy of plus or minus two and a half days. O.L.

A80-33126 Recycling the nutrients in residues from methane digesters of aquatic macrophytes for new biomass production. M. D. Hanisak, L. D. Williams (Harbor Branch Foundation, Inc., Fort Pierce, Fla.), and J. H. Ryther (Woods Hole Oceanographic Institution, Woods Hole, Mass.). *Resource Recovery and Conservation*, vol. 4, Apr. 1980, p. 313-323. 16 refs. Contract No. EY-76-S-02-2948.

The floating freshwater macrophyte *Eichhornia crassipes* (water hyacinth) was fermented anaerobically to produce 0.4 l of biogas/g volatile solids at 60% methane with a bioconversion efficiency of 47%. Both the liquid and solid digester residues were a rich source of nutrients that were recycled to produce additional biomass. An approximate balance of the nitrogen recycled through the culture-digester-culture system indicated that nitrogen was conserved within the digester. All of the nitrogen originally added to the digester in the form of shredded water hyacinths could be found in the liquid (48%) and solid (52%) residues; 65.5% of the nitrogen in these residues could be reassimilated by cultures of water hyacinths. This study indicated the potential of bioconversion of aquatic macrophytes to methane as a possible means of both producing and conserving energy. (Author)

A80-33127 Solid fossil-fuel recovery by electrical induction heating in situ - A proposal. S. Fisher (F.T. Fisher's Sons, Ltd., Montreal, Canada). *Resource Recovery and Conservation*, vol. 4, Apr. 1980, p. 363-368. 5 refs.

A technique, termed electrical induction heating, is proposed for in situ processes of energy production from solid fossil fuels, such as bitumen production from underground distillation of oil sand; oil by underground distillation of oil shale; petroleum from heavy oil by underground mobilization of heavy oil, from either residues of conventional liquid petroleum deposits or new deposits of viscous oil; methane and coal tar from lignite and coal deposits by underground distillation of coal; and generation of electricity by surface combustion of low calorific-value gas from underground coke gasification by combustion of the organic residue left from the underground distillation of coal by induction heating. A method of surface distillation of mined coking coal by induction heating to produce coke, methane, and coal tar is also proposed. V.P.

A80-33409 Microalgal biomass systems for fuels, chemicals, and fertilizers. J. R. Benemann (Ecoenergetics, Inc., Richmond, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 46-50. 20 refs.

A80-33411 Conversion processes for liquid fuels from biomass. J. M. Radovich, C. F. Pomeroy, S. S. Sofer, and C. M. Slipecevic (Oklahoma University, Norman, Okla.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 58-62. 10 refs. Research supported by the Electric Power Research Institute.

Several conversion processes for producing liquid fuels from biomass are evaluated in terms of net thermal efficiency, energy benefit ratio, and liquid fuel recovery. The evaluated processes are based on four basic routes for converting biomass to liquid fuels: production of 'pyrolytic oil' via pyrolysis and direct hydrogenation; production of syngas for conversion to methanol or Fischer-Tropsch liquids; production of SNG by anaerobic digestion with subsequent conversion of SNG to methanol or Fischer-Tropsch liquids; and production of alcohol by fermentation. It is shown that the most efficient processes are those involving biomass gasification followed by liquid fuel synthesis, and biochemical conversion. V.L.

A80-33412 Liquid fuel production from biomass. J. E. Sanderson, D. V. Garcia-Martinez, J. J. Dillon, G. S. George, and D. L. Wise (Dynatech R/D Co., Cambridge, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 63-67. Contract No. EG-77-C-002-4368.

Previous work on the production of methane via nonsterile anaerobic fermentation has been expanded by the modification of the process to produce longer-chain aliphatic hydrocarbons instead of methane. This product may be used without further modification as a fuel for diesel engines or as a substitute feedstock for the production of gasoline. The work to date uses marine algae as the primary substrate, but work is currently in progress to adapt the process for use with other aquatic and terrestrial forms of biomass. In the modified fermentation, the approach has been to suppress methane formation and to extract the organic acids from the fermentation broth for electrolytic oxidation (Kolbe electrolysis) to aliphatic hydrocarbons. Preliminary economic analysis based on a 1000 ton/day plant design and assumed biomass costs indicates that this process is capable of producing liquid fuels at a cost competitive with the most optimistic forecasts for alternative processes. (Author)

A80-33413 Economics of energy recovery from biomass using fluidized-bed combustion. J. W. Stallings (Energy, Inc., Idaho Falls, Idaho). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 73-77. 7 refs.

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A system is presented which utilizes fluidized-bed combustion to recover low-pressure steam from wood chips which have been harvested expressly for that purpose. Using published values for the cost of wood chips delivered to a central site, the economics of the \$1.3 million steam-generating system are analyzed. In a sample calculation using \$10/ton as the cost of as-received chips, a steam price of \$3.02 per thousand pounds is derived. (Author)

A80-33414 Pellets of immobilized yeast cells as biocatalysts for transforming biomass. R. Villet (Solar Energy Research Institute, Golden, Colo.), J. Dillon, and G. Manderson (Massey University, Palmerston North, New Zealand). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 78-82. 14 refs. Contract No. EG-77-C-01-4042.

There is scope for improving the efficiency of biotechnological processes for converting sugars to ethanol. One aspect of this is to develop novel bioreactors as an alternative to conventional fermentation systems. Experiments were performed on immobilized yeast cells in the form of biocatalyst pellets. Optimal conditions were determined for the encapsulation of *Kluyveromyces fragilis* in polyacrylamide gels. Rates of production of ethanol from lactose were measured in batch fermentations, comparing immobilized with free cells. Kinetic parameters which can be utilized in the design of continuous fermentation systems were determined. The long-term stability of the biocatalyst pellets was assessed. Some experiments were performed also with immobilized *Saccharomyces cerevisiae*. (Author)

A80-33415 A modular system for bio-gas production using farm waste. J. Keable and C. Dodson (Helix Multi Professional Services, Reading, Berks., England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 83-87. 7 refs.

A80-33416 Development and characterization of ethanol tolerance in *Clostridium thermocellum*. A. A. Herrero, R. F. Gomez, and D. I. C. Wang (MIT, Cambridge, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 88-92. 8 refs. Contract No. EG-77-S-02-4198.

Clostridium thermocellum, an anaerobic and thermophilic bacterium, is able to degrade cellulosic materials and use them as sole carbon sources. The conversion of cellulose to ethanol by *C. thermocellum* is limited by its low resistance to ethanol. Through a selection procedure, *C. thermocellum* derivatives have been adapted to grow at higher ethanol concentrations than the wild type. One of the mutants (C-9) is able to grow in the presence of 25g of ethanol per liter. The effect that increasing concentrations of acetate, lactate and ethanol, has on the fermentation profiles of cellobiose, by *C. thermocellum* and its C-9 derivative, was investigated. It was determined that, in both microorganisms, lactate and acetate shifted the catabolic pathway towards ethanol. This is presumably due to a regulatory effect exerted by acetate and lactate on their own formation, thus diverting carbon and reduced pyridine nucleotide towards ethanol. (Author)

A80-33417 Xylose recovery from hemicellulose by selective acid hydrolysis. M. L. Limbaugh, R. P. Chambers, C. Kallianpur, and Y. Y. Lee (Auburn University, Auburn, Ala.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 93-96. 8 refs. Contract No. DE-AS01-79ET-2305.

Hemicellulose in oak hardwood was hydrolyzed at temperatures ranging from 140 C to 180 C and H₂SO₄ acid catalyst concentrations ranging from 0.0% to 0.40%. A maximum xylose yield of 83% was obtained at 150 C and 0.20% H₂SO₄ by weight. The hemicellulose hydrolysis reaction at these operating conditions was found to have a high degree of selectivity since the cellulose

hydrolysis to glucose was only 17% and the hemicellulose conversion to furfural, a decomposition product of xylose, was only 8%. Substantial yields of carbohydrate polysaccharides were observed at 0.05% acid catalyst concentration and the lower temperature range. (Author)

A80-33750 The potential of crop residues as a fuel for power generation. N. Bhagat, H. Davitian, and R. Pouder (Brookhaven National Laboratory, Upton, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2025-2029. 13 refs.

Crop residues, the portions of extractable plant material remaining after crop harvest, could serve as an alternative energy source for electric power generation in agricultural regions of the United States. Current estimates indicate that the U.S. annual production of residues has an energy value of about 5 quads, but, in practice it may be possible to collect only a fraction of this for use as an energy resource. Cost estimates for preparation of residues as fuel indicate they are approximately competitive with conventional fuels with costs ranging from \$0.70 to \$1.25 per million Btu depending on crop type. Two 3-5 kW farm power systems and one 8 MW regional power generator were assessed as to market potential and breakeven capital costs. In some cases, these generators were found to be economically competitive at electricity prices slightly higher than current prices. (Author)

A80-33753 The energy-food interface - An economic analysis of Brazil's alcohol plan. N. Rask (Ohio State University, Columbus, Ohio) and R. I. Adams (Rio Grande do Sul, Universidade, Porto Alegre, Brazil). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p.

2111-2115.

A vertically integrated and regionally competitive linear programming model is used to determine potential adjustments in energy crop production in the agricultural sector. Several agricultural regions are studied. Under present world petroleum prices, alcohol cannot be produced competitively. However, alcohol production is competitive within the energy price policy parameters now existing in Brazil and within present price estimates for other alternatives to petroleum (coal liquefaction, shale oil, etc.). Within the agricultural sector, regional production centers, labor surplus areas and alternative source crops are all competitive with centrally located major sugar production. While increased energy prices reduce agricultural income through increased input costs, energy crop production more than offsets this loss resulting in a net aggregate gain for agricultural income especially in non-mechanized areas. Employment in agriculture also shows net gains with energy crop production. (Author)

A80-33769 Simulation of correlated wind speeds for sites and arrays. R. B. Corotis (Northwestern University, Evanston, Ill.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2257-2261. 11 refs. Contract No. EY-76-S-06-2342.

The horizontal wind speed components at a site are often modelled as independent, identically distributed, zero-mean, Gaussian random variables. The effects of unequal variances and of correlated components are investigated and seem to not substantially alter the basic Rayleigh form of the speed distribution. Temporal correlation and array considerations are discussed briefly. Data with various averaging times and sampling rates are used to compare wind characteristics with those found from National Weather Service data. Specifically, sampling rate does not significantly affect variances and autocorrelations, while the latter is very sensitive to averaging time. (Author)

A80-33771 A new approach of wind speed characterization for wind energy studies. T. N. Goh and G. K. Nathan (University of Singapore, Singapore). In: Sun II; Proceedings of the Silver Jubilee

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Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2267-2271.

The paper describes an investigation of wind speeds recorded at six meteorological stations in Singapore, an island situated at approximately 1 deg 15 min N, 105 deg 45 min E. The study illustrates the analysis of information from wind data through the use of appropriate methods of time series analysis and modelling. The models provide an understanding of the dynamics of wind data in the area through characterizations in the time domain. (Author)

A80-33772 **Redesign of windmill towers - A cost reduction study.** L. J. Cubitt and L. J. McGrath (Ballarat College of Advanced Education, Ballarat, Australia). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2272-2276. 8 refs.

In the case of wind energy there are three major difficulties in obtaining the energy in a useful form. These difficulties are the intermittent nature of the wind, the low energy density of the wind (i.e. energy/unit volume) compared with thermal power station, and the high capital cost of windmills. In this paper, a brief analysis is given to explain the decline of the use of windmills in Australia, along with a redesign of the most expensive element of the windmill system, viz. the tower. The criteria for the design are intended to reduce the cost of wind mill system, and for the new tower to have the same or better life expectancy than the present system. It is shown that guyed steel poles and reinforced concrete poles are significantly cheaper than the commonly used 4 or 3 posted tower. S.D.

A80-34019 # **Establishment of a computer data base on geothermal properties of aqueous NaCl, KCl and CaCl₂ solutions.** J. A. Fair and S. L. Phillips (California, University, Berkeley, Calif.). *CODATA Bulletin*, no. 23, May 1977, p. 15-21; Discussion, p. 21, 22. 13 refs. ERDA-supported research.

A National Geothermal Information Resource (GRID) has been established with the objective to compile and disseminate evaluated data on geothermal science and technology, including the physical chemistry category. The data base for aqueous solutions includes enthalpy, heat capacity, activity coefficient, osmotic coefficient, PVTX, viscosity, thermal conductivity, and electrical conductivity. A bibliography of references to this data, which currently contains 1100 citations, is annotated and stored on magnetic tape for quick retrieval. The bibliography covers the properties of aqueous solutions of NaCl, KCl, and CaCl₂ from 1965 to January 1976. The citations are input into a hierarchically structured computerized data base. Typical examples of brine data are presented. V.L.

A80-34531 **A process concept for the production of benzene-ethylene-SNG from coal using flash hydrolysis technology.** M. I. Greene, C. J. Ladelfa, and S. J. Bivacca (Cities Service R & D Co., Cranbury, N.J.). (*American Chemical Society, EIC Symposium, Anaheim, Calif., Mar. 12-17, 1978.*) *Fuel Processing Technology*, vol. 3, May 1980, p. 75-99. 23 refs.

Flash hydrolysis (FHP) of coal is an emerging technology for the direct production of methane, ethane and BTX in a single-stage, high throughput reactor. The FHP technique involves the short residence time (1-2 seconds), rapid heatup of coal in a dilute-phase, transport reactor. When integrated into an overall, grass-roots conversion complex, the FHP technique can be utilized to generate a product consisting of SNG, ethylene/propylene, benzene and Fischer-Tropsch-based alcohols. This paper summarizes the process engineering and economics of conceptualized facility based on an FHP reactor operation with a lignitic coal. The plant is hypothetically sited near the extensive lignite fields located in the Texas region of the United States. Utilizing utility-financing methods for the costing of SNG, and selling the chemicals cogenerated at petrochemical market prices, the 20-year average SNG cost has been computed to vary between \$3-4/MM Btu, depending upon the coal

costs, interest rates, debt/equity ratio, coproduct chemicals prices, etc. (Author)

A80-34532 **Chemical nature of coal hydrogenation oils. I - The effect of catalysts.** J. R. Kershaw, G. Barrass, and D. Gray (Fuel Research Institute of South Africa, Pretoria, Republic of South Africa). *Fuel Processing Technology*, vol. 3, May 1980, p. 115-129. 33 refs.

Hydrogenation of the same coal was carried out with no catalyst and with 1, 5, 10 and 15% stannous, zinc and ferrous chloride catalysts. The oils (hexane soluble portion) were fractionated by silica gel chromatography and by extraction with acid and base. The oils and fractions derived from them were investigated by C-13 and H-1-nuclear magnetic resonance, infrared, ultraviolet, fluorescence and phosphorescence spectroscopy. Increasing the amount of catalyst used decreased the percentage of polar compounds in the oil while the gross hydrocarbon structure showed little change with catalyst concentration. The decrease in the percentage of polar compounds in the oil results in a reduction in the viscosity of the oil due to decreased hydrogen bonding, which was shown by infrared and nuclear magnetic resonance studies. (Author)

A80-34533 **Chemical nature of coal hydrogenation oils. II - The effect of temperature.** J. R. Kershaw, G. Barrass, I. C. Du Preez, and D. Gray (Fuel Research Institute of South Africa, Pretoria, Republic of South Africa). *Fuel Processing Technology*, vol. 3, May 1980, p. 131-140. 14 refs.

Hydrogenation of the same coal was carried out at 400, 450, 500, 550, 600, 650 and 700 C. H-1-nuclear magnetic resonance spectra of the oils (hexane soluble portion) showed an increase in the percentage of aromatic protons and a decrease in the percentage of aliphatic protons as the temperature increases, while the percentage of benzylic protons remained constant. The aromaticity of the oils as calculated by the Brown-Ladner equation increases with the reactor temperature. C-13-nuclear magnetic resonance spectra of the oils indicates that the long aliphatic chains present decrease in both number and length as the reactor temperature increases. The molecular weight and viscosity of the oil as well as the percentage of polar compounds in the oil decrease with increasing temperature. (Author)

A80-34534 **Vehicle gas producers.** E. E. Donath. *Fuel Processing Technology*, vol. 3, May 1980, p. 141-153. 8 refs.

The present petroleum supply situation with the possibility of unscheduled interruptions and the definite expectation of continued price increases calls for an investigation of the use of solid fuels for the propulsion of vehicles. The paper reviews the use of solid fuel gas producers with high thermal efficiency on motor vehicles, especially trucks and buses. Some economic comparisons are presented for pre-World War II conditions. Suggestions are made for possible future development of vehicle gas producers. The types of producers are described, along with their performance, special problems, and the importance of fuel properties. S.D.

A80-34539 **Oil shales and carbon dioxide.** E. T. Sundquist (U.S. Geological Survey, Reston, Va.) and G. A. Miller (U.S. Geological Survey, Grand Junction, Colo.). *Science*, vol. 208, May 16, 1980, p. 740, 741. 13 refs.

During retorting of oil shales in the western United States, carbonate minerals are calcined, releasing significant amounts of carbon dioxide. Residual organic matter in the shales may also be burned, adding more carbon dioxide to the atmosphere. The amount of carbon dioxide produced depends on the retort process and the grade and mineralogy of the shale. Preliminary calculations suggest that retorting of oil shales from the Green River Formation and burning of the product oil could release one and one-half to five times more carbon dioxide than burning of conventional oil to obtain the same amount of usable energy. The largest carbon dioxide releases are associated with retorting processes that operate at temperatures greater than about 600 C. (Author)

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A80-34859 Windpower principles - Their application on the small scale. N. G. Calvert (Liverpool, University, Liverpool, England). New York, Halsted Press, 1979. 122 p. 16 refs. \$17.50.

The book provides a theoretical treatment of the small-scale applications and technology of wind-powered machines, with particular emphasis on the sail mill windmill. The background, fluid mechanics and component characteristics of wind-powered machines are reviewed, and the aerodynamics and possible geometries of the airfoil are considered. Sails, sail mills and vertical axis mills are examined, and windmill control and performance testing and wind measurement are discussed. The calculation of the power available from various types of windmills in various sites is treated, and the construction of a small pilot wind power plant is discussed, with attention given to an evaluation of possible construction materials. Consideration is also given to windmills at sea and free-spinning, high-speed windmills, and to various means of energy storage.

A.L.W.

A80-35172 Hydro-power - The use of water as an alternative source of energy. C. Simeons. Oxford, Pergamon Press, Ltd., 1980. 556 p. 64 refs. \$75.

The discussion covers such areas as wave power, tidal power, hydrogen power, energy storage, hydroelectric power, and national hydropower programs. Emphasis is on technical characteristics and specific energy schemes.

B.J.

A80-35716 Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979. Proceedings. Conference and Workshop sponsored by the U.S. Department of Energy and American Meteorological Society; Contract No. EY-76-C-06-1830. Boston, Mass., American Meteorological Society, 1979. 486 p. \$25.

Wind characteristics for design and performance, wind characteristics for operations, wind energy resource assessment, and wind energy siting methodologies are the specific topics discussed. Particular papers are presented on such topics as wind turbine dynamic blade loads due to wind gusts and wind direction changes, the potential impact of automated wind guidance on wind energy conversion operations, agricultural applications of wind resource assessments, and remote sensing applications to wind power facility siting.

B.J.

A80-35719 * # Modified power law equations for vertical wind profiles. D. A. Spera and T. R. Richards (NASA, Lewis Research Center, Cleveland, Ohio). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 47-56; Discussion, p. 57, 58, 14 refs.

In an investigation of windpower plant siting, equations are presented and evaluated for a wind profile model which incorporates both roughness and wind speed effects, while retaining the basic simplicity of the Hellman power law. These equations recognize the statistical nature of wind profiles and are compatible with existing analytical models and recent wind profile data. Predictions of energy output based on the proposed profile equations are 10% to 20% higher than those made with the 1/7 power law. In addition, correlation between calculated and observed blade loads is significantly better at higher wind speeds when the proposed wind profile model is used than when a constant power model is used.

B.J.

A80-35720 # A model for the probability structure of atmospheric turbulence. J. A. Dutton and J. Hojstrup (Riso National Laboratory, Roskilde, Denmark). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 59-67, 69. Research supported by the U.S. Department of Energy and Universität Karlsruhe.

A Gaussian patch model is developed for the investigation of

turbulence in the atmospheric boundary layer. The theoretical basis is that the quantities of interest can be calculated if the joint distribution of turbulent velocities $u(t)$ and $u(t + \Delta t)$ is known for various Δt . A theoretical model for these joint distributions is proposed, and it is demonstrated with calculations based on two samples of data that the model is worthy of further study.

B.J.

A80-35721 # Wind fluctuations described as discrete events. D. C. Powell (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 71-79.

A wind fluctuation description that is expressed as the frequency occurrence of some specifically defined class of turbulence events is presented. This frequency of occurrence could be called the frequency of occurrence of discrete gusts if a technical definition of gusts is given which includes any series of discrete events that may be defined from a turbulence time series according to some rule of utility. Two definitions of discrete gusts are discussed, and the concept is illustrated by the analysis of anemometer data. The approach may be useful in calculating the frequency of occurrence of events harmful to wind energy machines.

B.J.

A80-35722 # Wind statistics at the Boulder Atmospheric Observatory tower. J. C. Kaimal (NOAA, Wave Propagation Laboratory, Boulder, Colo.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 81-90. 5 refs. Contract No. DE-AI06-79ET-23115.

Recent analyses of wind fluctuation data obtained from the 300-m tower of the Boulder Atmospheric Observatory (BAO) are described; the analyses are part of an effort to provide turbulence statistics for use in the design of wind turbine generators. The BAO data are well suited to provide information on factors which affect the performance and life of large rotor blades; these factors include the vertical gradient of the horizontal wind velocity, wind direction variability with time, and gust distribution over the plane of the blades. A preliminary survey of 1978 data concerning the effects of irregular terrain on boundary layer structure and the evolution of the daytime convective boundary layer is presented.

B.J.

A80-35723 # Effect of complex terrain on wind fluctuations. H. A. Panofsky, J. M. Vilardo, H. N. Shirer, R. C. Lipschutz, and D. E. Larko (Pennsylvania State University, University Park, Pa.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 91-100; Discussion, p. 101. 12 refs.

In an effort to investigate the effects of variances on wind power machines, the paper describes techniques which make possible the estimation of certain statistics of the natural wind from easily accessible meteorological and terrain variables, with emphasis on strong winds and complex terrain. The statistics investigated are variances and spectra of the three wind components; variances affect wind power machines in a number of ways; for example, the stronger the variances, the greater is the likelihood that strong winds will cause the machine to fail. It is shown that it is not sufficient to study variances; the spectral composition is also needed in order that the variances over proper frequency bands can be found.

B.J.

A80-35728 # Wind direction variations in strong winds. J. C. Doran (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 151-159. Contract No. EY-76-C-06-1830.

Fluctuations in both the magnitude and direction of the wind may be an important factor in the design and performance of wind

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turbines. This paper describes some measurements of wind direction fluctuations and presents a means of interpreting them that may be useful to designers. The method of interpretation is based on probability distributions of observed angular values; it is shown that significant differences exist between angular fluctuations experienced at a fixed point, averaged over a disk of rotation, and those experienced by a blade element rotating about a horizontal axis. The static and dynamic descriptions of these fluctuations are an important aspect in design considerations and in the development of tracking strategies. B.J.

A80-35729 # A method for estimating the impact of WECS on utility operating reserve requirements. M. Goldenblatt (JBF Scientific Corp., Wilmington, Mass.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 169-177.

By statistically combining the uncertainty in predicting the next day's loads with the uncertainty in predicting the next day's WECS power output levels, a total uncertainty in predicting available equipment requirements can be determined when WECSs are added to the utility generating equipment. The difference between the required operating reserve resulting from this total uncertainty in available capacity requirements and operating reserve required without WECS is defined as the WECS operating reserve and is the amount of additional operating reserve necessitated by the presence of WECS. It is shown that the amount of additional operating reserve is directly related to the accuracy of the available WECS power predictions. V.L.

A80-35731 # The potential impact of automated wind guidance on wind energy conversion operations. G. M. Carter and D. B. Gilhousen (NOAA, Techniques Development Laboratory, Camp Springs, Md.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 191-203, 205. 15 refs.

Numerical-statistical forecasts of surface winds based on the model output statistics (MOS) technique and intended primarily as guidance for aviation and public weather forecasters, are discussed with reference to their accuracy and the use of the MOS approach for future energy-related applications. It is shown how the MOS technique is currently used to produce several types of reliable, fully-automated wind forecasts which are as accurate as, or better than, comparable subjective forecasts. The MOS guidance is also superior to the forecasts based on climatology or persistence. With some limitations, the MOS approach is shown to be well suited to the prediction of hourly winds for power estimation. V.L.

A80-35732 # Pacific Northwest regional assessment. W. R. Barchet and D. L. Elliott (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 213-226; Discussion, p. 227. Contract No. EY-76-C-06-1830.

Techniques used in the assessment of the wind energy potential of the Northwest region are outlined. The techniques are based on a maximum use of the available wind data and various indirect indicators of wind energy, such as supplemental information on regional climatology, meteorology, topography, vegetation, and eolian landforms. The wind data and qualitative indicators of wind power were combined to analyze the geographical distribution of wind energy in the region. The final phase in the assessment was to prepare a Northwest wind-energy atlas with maps and graphs for describing the geographical distribution of the wind resource on a regional and state scale and for detailing wind characteristics for selected stations. V.L.

A80-35733 # Wind energy resource development in California. M. Ginosar, C. Cook, and D. Waco (California Energy

Commission, Sacramento, Calif.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 229-239, 241.

A80-35734 # Alaskan wind power study - A large area wind characteristics survey. T. Wentink, Jr. (Alaska University, Fairbanks, Alaska). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 243-251, 10 refs. Contract No. EY-76-S-06-2229. DOE Task 12.

A80-35735 # Wind energy potential in the northern part of Germany. G. Tetzlaff and R. Beyer (Hannover, Universität, Hanover, West Germany). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 253-257, 259. 6 refs.

A80-35736 # Wind energy resource assessment of New Zealand. N. J. Cherry (Lincoln College, Canterbury, New Zealand). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 261-271. 7 refs.

A80-35737 # Meteorological and topographical indicators of wind energy for regional assessments. D. L. Elliott (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 273-283. Contract No. EY-76-C-06-1830.

Weather patterns and topographical influences associated with high or low wind energy are discussed with a view to a better understanding of the geographical distribution of wind energy. In the Northwest regional analysis, some of the meteorological and topographical features indicative of high wind energy areas are corridors in areas of frequent strong pressure gradients, long valleys parallel to prevailing wind direction and extending down from mountain ranges, and high elevation plains and plateaus in areas of strong geostrophic winds. Low wind power areas (less than 100 W/sq m at 10 m) are associated with valleys perpendicular to the prevailing wind condition aloft, sheltered basins, short or narrow valleys and canyons, and areas of high surface roughness. V.L.

A80-35741 # Statistical reliability of wind power assessments. R. B. Corotis (Northwestern University, Evanston, Ill.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 311-321; Discussion, p. 323, 324. 12 refs. Contract No. EY-76-S-06-2342.

General principles of wind data analysis in the development of site and regional wind power assessments are outlined. Particular consideration is given to the statistical confidence that can be assigned to certain observed quantities as a function of record length, and to the probability models which can be used to derive some quantities in terms of other, more readily available or more easily analyzable ones. The models for the probability density function of hourly wind speed and for the probability distribution of wind speed persistence above and below fixed reference speeds are examined and found appropriate for initial site assessment. V.L.

A80-35743 # Boundary layer wind shear. R. C. Heald (Oregon State University, Corvallis, Ore.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 343-351. 8 refs.

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Statistics on boundary layer wind shear and its diurnal variation across a layer corresponding to the region swept out by the blades of a modern horizontal-axis wind turbine, the NASA MOD-2, are presented. Wind measurements were performed at several locations over nearly level terrain and relatively homogeneous surface conditions at heights of from 10 to 100 m, and the shear direction components parallel and perpendicular to a wind turbine axis aligned with the mean wind at hub height are computed. Frequency distributions of the total shear and shear components within the layer and day and night average wind speed profiles and total shear are presented. Shear in the wind turbine layer is shown to be appreciably larger at night, due to deceleration below the generator layer and low-level-jet-associated acceleration above it, and may lead to increased machine fatigue as well as significantly greater wind power. Smaller directional changes are observed at night, usually clockwise in the Northern Hemisphere, and may make the design of a turnable wind turbine advantageous. A.L.W.

A80-35744 # Application of power laws for wind energy assessment. D. L. Sisterson and B. B. Hicks (Argonne National Laboratory, Argonne, Ill.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 353-359; Discussion, p. 361. 9 refs.

Variations in the exponent in the power law relating height to wind velocity are investigated for a series of measurements of nocturnal low-level winds in northern Illinois in order to determine the applicability of power laws in estimates of attainable wind power. Hourly, seasonal and annual frequency distributions of power law exponents representing the best fit to wind profiles obtained between heights of 5 and 50 m are presented which reveal that the exponents exceed 0.4, indicative of the decoupling of faster-moving upper air from a ground-based, stable inversion, on 50% of summer nights and 15% of winter nights. It is shown that under these conditions, wind energies estimated from low-level wind data and the standard 1/7 power law are 40% less than those derived from actual wind data. The stresses on wind turbine blades caused by these greater wind shears are also shown to be greater than anticipated. It is concluded that a simple power law cannot accurately describe a wind profile, particularly in stable conditions, however, it may be used as a simple estimate of wind energy and shear once the power law exponent distribution has been determined. A.L.W.

A80-35745 # Trees as an indicator of wind power potential. J. E. Wade and E. W. Hewson (Oregon State University, Corvallis, Ore.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 363-372; Discussion, p. 373. 5 refs.

Techniques for using tree deformation as an indicator of wind power potential are presented and their limitations are discussed. Consideration is given to the Griggs-Putnam index of wind deformation, which is based on the degree of permanent bending of coniferous tree needles, twigs, branches and trunk, the deformation ratio, which represents the amount of wind-induced crown asymmetry and trunk deflection, and the compression ratio, which measures wind influence on reaction wood formation. Calibrations of these indices with mean annual wind speed for Douglas fir on ponderosa pine trees are presented and results of prediction error determinations estimating an average error for the three indices of 18% and the greatest accuracy of the Griggs-Putnam index are indicated. It is cautioned that these wind speed indices should be used only as rough estimates of mean annual wind speed and may not be applicable where strong winds come from three or more directions or where afternoon winds may be strong but decrease considerably at night. It is concluded, however, that estimates of mean annual wind speed based on wind-deformed trees are a simple, quick and inexpensive criterion in the preliminary ranking of potential wind power sites. A.L.W.

A80-35746 # Remote sensing applications to wind power facility siting. C. L. Rosenfeld and P. A. Maule (Oregon State University, Corvallis, Ore.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 375-379.

The application of remote sensing techniques to the assessment of potential wind power sites according to various indicators is discussed. The key wind-power indicators are grouped as vegetation, snow covers, eolian features and topographic indicators, and each group is matched with appropriate sensing platforms and parameters to be used in regional assessment, area evaluation and specific site selection. Procedures for initial regional-scale screening based on regional wind field data and satellite imagery and high-altitude aerial photographs and for medium-scale evaluation based on vertical aerial photography supplied by various agencies and unconventional photointerpretation techniques such as vegetation deformation and electronic image processing are examined. Aerial or field reconnaissance efforts are then presented as appropriate means for the verification of specific candidate sites for wind instrumentation. A.L.W.

A80-35747 # The utility and verification of mathematical windfield models for wind energy regional screening and site selection. R. M. Traci, G. T. Phillips, and K. C. Rock (Science Applications, Inc., La Jolla, Calif.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 381-391. 5 refs.

A80-35749 # Wind energy assessment of the San Geronimo Pass Region. S. N. Walker and T. G. Zambrano (Aerovironment, Inc., Pasadena, Calif.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 405-415. 5 refs.

A80-35800 Automotive fuels from coal (Motorkraftstoffe aus Kohle). K. H. Eisenlohr and H. Gaensslen (Lurgi Kohle und Mineralöltechnik GmbH, Frankfurt am Main, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 33, May 1980, p. 201-207. In German.

The paper surveys present technical methods for transforming coal into automotive fuels. Consideration is given to the overall thermal efficiency as an important economic criterion in the evaluation of the different processes. Further, capital investment and production costs are determined and compared with each other. Finally, an analysis is made of the influence of the selling price of gaseous byproducts on the cost of automotive fuels. M.E.P.

A80-35898 * # The impact of fuels on aircraft technology through the year 2000. J. Grobman and G. M. Reck (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, International Meeting and Technical Display on Global Technology 2000, Baltimore, Md., May 6-8, 1980, Paper 80-0896*. 24 p. 29 refs.

In the future, it may be necessary to use jet fuels with a broader range of properties in order to insure a more flexible and reliable supply and to minimize energy consumption and processing costs at the refinery. This paper describes research being conducted to (1) determine the potential range of properties for future jet fuels, (2) establish a data base of fuel property effects on propulsion system components, (3) evolve and evaluate advanced component technology that would permit the use of broader property fuels and (4) identify technical and economic trade-offs within the overall fuel production-air transportation system associated with variations in fuel properties. (Author)

A80-36051 Closed cycle osmotic power plants for electric power production. M. Reali (Ente Nazionale per l'Energia Elettrica,

Milan, Italy). *Energy* (UK), vol. 5, Apr. 1980, p. 325-329. 19 refs.

The paper deals with closed-cycle osmotic power plants (CCOPPs), which are not meant for the exploitation of natural salinity gradients but, rather, for the exploitation of those abundant heat sources having temperatures slightly higher than ambient temperature, e.g., geothermal fields, ocean temperature gradients, waste heat from power plants, and solar energy. The paper gives a general description of the CCOPP, along with some indications of its potential for energy generation. The concept of the CCOPP lies in producing electric power by means of the osmotic flows of suitable solvents and subsequently in separating them again from their solutes by means of thermal energy obtained from any available heat source. The discussion covers osmotic phenomena and the CCOPP, as well as important features of the CCOPP. S.D.

A80-36314 How clean gas is made from coal. R. M. Felder, R. M. Kelly, J. K. Ferrell, and R. W. Rousseau (North Carolina State University, Raleigh, N.C.). *Environmental Science and Technology*, vol. 14, June 1980, p. 658-666. U.S. Environmental Protection Agency Grant No. R-804811-02.

Currently, many processes to gasify coal exist, but the technology of synthesis gas cleanup is not as well developed. The present paper deals with the operating experience and some preliminary results from a fluidized-bed pilot plant built with the objective to characterize completely the gaseous and condensed-phase emissions from the gasification-gas-cleaning process and to determine how emission rates of various pollutants and methanation catalyst poisons depend on adjustable process parameters. V.P.

A80-36424 On the vertical extrapolation of mean wind power density. L. Sedefian (New York State, Dept. of Environmental Conservation, Div. of Air Resources, Albany, N.Y.). *Journal of Applied Meteorology*, vol. 19, Apr. 1980, p. 488-493. 19 refs.

With the onset of the energy crisis, research has turned to wind power as a possible source of energy. In this paper, a simple method is proposed for determining the height variation of the mean wind power density. A limited data base is used to assess this method and compare it to previously suggested methods. The results show that the proposed method gives the most accurate estimate of the extrapolated mean wind power densities. In conclusion, the proposed method is capable of estimating the mean wind power density at aerogenerator hub heights. S.D.

A80-36625 # Geothermal energy - Extracting heat from hot dry rock masses. S. Nemat-Nasser (Northwestern University, Evanston, Ill.). In: *Midwestern Mechanics Conference, 16th, Manhattan, Kan., September 19-21, 1979, Proceedings*.

Manhattan, Kan., Kansas State University of Agriculture and Applied Science, 1979, p. 285-297. 26 refs. NSF Grant No. ENG-77-22155.

In this lecture the exploitation of geothermal energy for commercial use is briefly examined. Attention is focused on the extraction of heat from hot dry rock masses, a concept which has recently been developed and implemented at the Los Alamos Scientific Laboratory, New Mexico. Recent work by the author and his associates on the thermomechanics of fluid flow and heat transfer, and thermally induced tension cracks in rocks, is summarized. Particular attention is paid to the theory of stability of a system of interacting tension cracks, and its application to other fields. New results in this area by the author and coworkers are briefly summarized. (Author)

A80-36983 The urban bus and liquefied casinghead gas /Evaluation of a preliminary experiment/ (L'autobus urbain et le gaz de pétrole liquéfié /Bilan d'une première expérimentation/). G. Canal (Régie Autonome des Transports Parisiens, Paris, France). (*Association pour la Prévention de la Pollution Atmosphérique, Ministère de l'Environnement et du Cadre de Vie, Ministère de la Santé, Ministère de l'Industrie, and Ministère des Transports, Journées Scientifiques sur l'Automobile: Economies d'Énergie et Pollution Atmosphérique, Paris, France, Dec. 6, 7, 1979.*) *Pollution Atmosphérique*, vol. 22,

Jan.-Mar. 1980, p. 138-148. In French.

Results obtained from the experimental operation of the first French urban bus integrally powered by liquefied casinghead gas (LCG) are presented. Following a review of the various types of fuel in use in the French urban bus fleet since the turn of the century and the availability of LCG, the LCG bus experiment is described, with attention given to the fitting of an ordinary diesel engine bus to run on LCG, qualification tests, and the performance of the experimental bus on a city bus line. Operational experience indicates that the LCG bus consumes more fuel than a conventional diesel bus while being less reliable, in part due to its experimental nature. Advantages to the LCG bus are observed in its lower noise and emission levels. An economic analysis indicates substantial operating cost penalties in the utilization of buses fueled by liquefied casinghead gas. It is thus concluded that the application of LCG buses for selected urban uses would require government support, and areas for future development of the system are indicated. A.L.W.

A80-37504 # Bioconversion. C. Schnell and L. Hoffmann. *Dormier-Post* (English Edition), no. 1, 1980, p. 26-29.

The paper examines biotechnology and materials research by the Dormier System. The System has evaluated the current status and future possibilities of alternative biological-technical energy supply systems and possible uses of plant wastes by chemical industry. The System also estimated potential of the production of ethanol from plant products as a fuel substitute showing that the possibilities for energy and raw material savings for the industrialized countries are limited, but the economic contribution can be made in some fields by additional development work. It is concluded that future problems can be investigated in the fields of thermal balance, material selection, analysis and testing, and the use of alternative sources of energy relating to bioconversion. A.T.

A80-37617 Hydration enhanced sulfation of limestone and dolomite in the fluidized-bed combustion of coal. J. A. Shearer, G. W. Smith, K. M. Myles, and I. Johnson (Argonne National Laboratory, Argonne, Ill.). *Air Pollution Control Association, Journal*, vol. 30, June 1980, p. 684-688. 9 refs. Research sponsored by the U.S. Department of Energy and U.S. Environmental Protection Agency.

A80-37676 Engineering kinetics of short residence time coal liquefaction processes. R. K. Traeger (Sandia Laboratories, Albuquerque, N. Mex.). (*American Institute of Chemical Engineers, National Meeting, Houston, Tex., Apr. 2, 1978.*) *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 19, June 1980, p. 143-146. 15 refs. Contract No. DE-AC04-76DP-00789.

Conversion of coal to liquid products occurs rapidly at temperatures over 350 C and can be significant in preheaters or short residence time reactors. The extent of conversion can have an effect on the operation of preheaters or effectiveness of subsequent reactors. To obtain process information, Illinois No. 6 coal in SRC II heavy distillate was reacted at 13.8 MPa, temperatures of 400, 425, and 450 C, and at slurry space velocities of 3200-96,000 kg/h-cu m. Product compositions and viscosities were measured. High concentrations of preasphaltenes occur in early reactions resulting in a high viscosity product, but subsequent reactions to asphaltenes and oils are less rapid. (Author)

A80-37678 # Fischer-Tropsch processes investigated at the Pittsburgh Energy Technology Center since 1944. M. J. Baird (U.S. Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, Pa.; Ashland Oil, Inc., Catlettsburg, Ky.), R. R. Schehl, W. P. Haynes (U.S. Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, Pa.), and J. T. Cobb, Jr. (Pittsburgh University, Pittsburgh, Pa.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 19, June 1980, p. 175-191. 75 refs.

A discussion of Fischer-Tropsch investigations conducted by the

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Pittsburgh Energy Technology Center of the DOE since 1944 is presented. Attention is given to iron catalysts used in the oil circulation, slurry, fluidized-bed, and hot-gas-recycle reactors and most recently in the tube wall reactor. A brief historical background is given of the Fischer-Tropsch process, and each reactor system is described along with some of the important experimental results.

M.E.P.

A80-37679 Utilization of cellulosic feedstock in the production of fuel grade ethanol. J. Yu (Bechtel National, Inc., San Francisco, Calif.) and S. F. Miller (Bechtel National, Inc., San Francisco; Cutter Laboratories, Inc., Berkeley, Calif.). (*American Chemical Society and Chemical Society of Japan, Chemical Congress, Honolulu, Hawaii, Apr. 1-6, 1979.*) *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 19, June 1980, p. 237-241. 9 refs.

A80-37986 Ethanol, a clean burning bio-solar fuel - Its production and utilization. H. B. Mathur (Indian Institute of Technology, New Delhi, India). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.* New York, Pergamon Press, Inc., 1980, p. 1075-1093. 5 refs.

The production of ethanol from various substances is considered, and the use of ethanol as an automotive fuel is discussed. Extensive experimental tests and theoretical investigations have shown that ethanol can be used in existing automotive engines in the form of ethanol gasoline blends. Further, future ethanol engines can be developed for total ethanol operation with consequent high specific output and 10-15% higher thermal efficiency as compared to present-day engines. The use of ethanol to meet the transportation energy needs of a developing country like India is noted.

B.J.

A80-38016 End use energy in Brazil and the solar technologies. I. C. Macedo (Campinas, Universidade Estadual, Campinas, São Paulo, Brazil). In: *Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.* New York, Pergamon Press, Inc., 1980, p. 1928-1936. 5 refs.

Energy consumption by end-users, the contribution made by each generating sector, and the temperature spectrum of energy used, are estimated in order to assess the possibilities of solar technologies, including thermal conversion and bioconversion. Of the total of 99 MTEP (million metric tons, oil equivalent) energy used in Brazil in 1976, 44% was derived from petroleum or natural gas, 24% was hydroelectric, and about 29% was contributed by bioconversion of solar energy (wood, sugar cane, and bagasse). Energy consumption analysis indicates that even without the need for space heating, there is a significant amount of thermal energy used at low temperatures (below 100 C), e.g. water and air heating, and preheating for higher temperature systems. The use of solar collectors would be the most obvious way to reduce fuel consumption. Another program is the production of coal from planted forests (eucalyptus and pinus) and ethanol production from sugar cane.

V.L.

A80-38221 # NIIIEFA research and design in the field of inertial fusion using relativistic electron beams and laser radiation. V. A. Burtsev (Nauchno-Issledovatel'skii Institut Elektrofizicheskoi Apparatury, Leningrad, USSR). In: *Advances in inertial confinement systems; Proceedings of the Meeting, Osaka, Japan, October 29-November 1, 1979.* Suita, Japan, Osaka University, 1980, p. 227-256. 26 refs.

A80-38300 Fuel gases from coal gasification for the gas/steam turbine process (Brenngase durch Kohlevergasung für den Gas-/Dampfturbinen-Prozess). K. Tippmer (Carl Still GmbH und Co., Recklinghausen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, May 1980, p. 203-212. 14 refs. In German.

The basic principles of gasification are surveyed and various

gasification methods are detailed. Attention is given to the principle structure of the methods as well as individual procedure steps, such as coal-preparation, coal introduction, gasification, and dealing with harmful materials. Emphasis is given to such gasification methods which supply fuel gases for combined gas/steam processes. Finally, by means of a model investigation, various methods are compared with respect to fuel gas production, waste water treatment, desulfurization and their economic value.

M.E.P.

A80-38801 # Contribution of remote sensing to the geological problems of the country (Contributo del telerilevamento ai problemi geologici del paese). R. Cassinis (Società Italiana per il Telerilevamento, Milan, Italy). In: *Applications of remote sensing and ranging systems from space; International Scientific Conference on Space, 20th, Rome, Italy, March 11-13, 1980, Proceedings.* Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1980, p. 191-198. 19 refs. In Italian.

The relationship between data observed by remote sensing and by other methods is considered with regard to geological exploration. Geological objectives of remote sensing include the study of geodynamic problems, structures favoring the accumulation of hydrocarbons, and the search for minerals and subterranean water. The application of remote sensing to geological problems in Italy has resulted in the relocation of historical epicenters of earthquakes and the definition of active seismic lines; and remote sensing is also used to search for geothermal energy and active volcanoes. Attention is given to the study of seismicity in Italy and the exploration for surface thermal inertia within the HCMM experiment.

J.P.B.

A80-39304 Gaseous fuels for airship propulsion. E. Mowforth (Airfloat Transport, Ltd.; Surrey, University, Guildford, England). In: *Economics and technology of airships; International Symposium, Paris, France, March 28-30, 1979, Proceedings. Volume 2.* Paris, Association d'Etude et de Recherche sur les Aéronefs Allégés, 1979, p. 365-372.

The rising costs of oil fuels make the alternative use of gaseous fuels increasingly attractive, and the airship is inherently better suited to the adoption of such fuels in vapor form than is any other form of aircraft owing to the relative ease with which it may carry large volumes of gas. This paper examines some of the advantages and difficulties in using gaseous fuels (i.e., hydrogen, methane, and propane) and outlines possible airship propulsion systems using gaseous fuels alone or in combination with oil fuel. Particular attention is given to the occasionally conflicting requirements of safety, aerodynamic and structural compatibility, and ease of refueling.

B.J.

A80-39419 Coal liquefaction catalysts. J. F. Patzer, II and A. A. Montagna (Gulf Research and Development Co., Pittsburgh, Pa.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 19, July 1980, p. 382-386. 9 refs.

A simple coal liquid hydrogenation catalyst evaluation technique is described for the screening of potential coal liquefaction catalysts. Eleven catalysts are evaluated by this technique. Three of the catalysts are also evaluated in actual coal liquefaction service. A correspondence between hydrogenation activity as measured by the coal liquid evaluation and hydrogenation activity in coal liquefaction service is noted. Also, a potential relation between denitrogenation activity in the coal liquid evaluation and hydrocracking in coal liquefaction is posited.

(Author)

A80-39420 Coal liquefaction catalysis by zinc chloride melts in combination with organic solvents. E. A. Grens, II, F. Hershkowitz, R. R. Holten, J. H. Shinn, and T. Vermeulen (California, University, Berkeley, Calif.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 19, July 1980, p. 396-401. 15 refs. Contract No. W-7405-eng-48.

A80-39421 Nonisothermal determination of the intrinsic kinetics of oil generation from oil shale. S. M. Shih and H. Y. Sohn

(Utah, University, Salt Lake City, Utah). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 19, July 1980, p. 420-426. 8 refs. Contract No. DE-AS03-78ET-13095.

A nonisothermal technique using various heating rates has been applied to the determination of the intrinsic kinetics of oil generation from oil shale. From an engineering standpoint the rate of oil generation can adequately be described by overall first-order kinetics with a constant activation energy of 199 kJ/mol. Various methods are applied to the determination of the kinetics parameters. The relative merits of these methods are discussed. The results are compared with data reported in the literature. The nonisothermal technique has the advantages of short experimental time and the elimination of difficulties due to the initial heat-up period accompanying the isothermal experiments. (Author)

A80-39422 **Absorption of microwave energy by oil shale - Effects of shale richness, packing factor, and frequency.** A. Judzis, Jr., R. E. Hiatt, B. Williams, and A. Judzis (Michigan, University, Ann Arbor, Mich.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 19, July 1980, p. 465-469. 10 refs.

A80-39630 # **An approach to determining the economic feasibility of refuse-derived fuel and materials recovery processing.** H. W. Gershman (Gordian Associates, Inc., Washington, D.C.). *ASME, Transactions, Journal of Energy Resources Technology*, vol. 102, June 1980, p. 77-81. 8 refs.

An approach for determining the economic feasibility of refuse-derived fuel production and the recovery of materials is presented. This information is based on data developed for the metropolitan Washington, D.C. area as input for the consideration of a regional resource recovery program which would eventually encompass 4000 t/day of municipal solid waste; it is designed to recover refuse-derived fuel (RDF), ferrous and nonferrous metals, flint and color-mixed glass cullet, color-mixed glass fines, and waste newspapers. The planning process requires estimates of recovery product revenues and of process feasibility; since materials revenues can be predicted with a greater degree of certainty than RDF revenues, it becomes necessary to determine what revenues will be required from the sale of RDF so that predicted economics can be the same as the alternative disposal practice. A technique is described which will assist the decisionmaker in evaluating the economic feasibility of the proposed project by determining the RDF 'Indifference Value'. (A.T.)

A80-39762 # **Stabilizing in situ oil shale retorts with injected grout.** *Energy and Technology Review*, Mar. 1980, p. 9-15. 9 refs.

A retort grouting process has been developed which would solve certain problems associated with in situ recovery of crude oil by retorting oil shale, such as surface subsidence, disturbance of groundwater flow, and accumulation of spent shale at the surface. Essentially, the process consists of using the spent shale to make a grout that can be injected into the retort after processing is completed. Bench-scale experiments using a high-temperature process show that grout can be prepared with sufficient strength, mobility, and permeability to stabilize processed in situ oil shale retorts. By reducing the need for surface disposal of spent shale and by increasing the quantity of shale that can be retorted in a given area, the grouting method should significantly improve the economics of the oil recovery process while also offering environmental advantages over surface processing of the shale. (V.L.)

A80-39765 # **Hoe Creek No. 3 - First long-term underground coal gasification experiment with oxygen-steam injection.** *Energy and Technology Review*, May 1980, p. 17-25. 7 refs.

The paper describes the first long-term underground coal gasification experiment with oxygen-steam injection. In the Hoe Creek No. 3 underground experiment, linkage paths were established between the injection and production wells by drilling a horizontal borehole between them near the bottom of the coal seam. The drilled linkage hole was enlarged by reverse burning, and then the

forward gasification process was started - first with air injection for one week, then with oxygen-steam injection for the remainder of the experiment. During the oxygen-steam injection period, about 3900 tons of coal were gasified in 47 days, at an average rate of 83 tons per day. The heating value of the dry product gas averaged 218 Btu/scf, suitable for input to a processing plant for upgrading to pipeline quality, which is about 900 Btu/scf. (A.T.)

A80-40336 **RMA engineering applications to Fossil Energy projects.** J. R. Sims, D. Q. Bellinger, and E. E. Halili (TRW Energy Systems, McLean, Va.). In: *Annual Reliability and Maintainability Symposium*, San Francisco, Calif., January 22-24, 1980, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 259-267. 8 refs.

The paper provides information on RMA applications to Fossil Energy (FE) projects. It gives an overview of the DOE FE programs including the expansion of domestic production of coal, oil, and gas, conversion of coal to synthetic liquids and gas, and the improvement of the efficiency and economics of fossil fuel use by 1990. The RMA applications involved the preparation of a 'Contractual Specification Guide', and 'FE Project Manager's Manual' and the 'Fossil Energy Equipment Data System Procedures' for failure reporting. The current RMA activities include analyses of failure modes and recommendations for additions of spare pumps, the use of emergency bypass devices, and a provision for redundant transformers. Finally, the development of the RMA standards and failure/discrepancy reporting and corrective action systems are described, concluding that FE must also develop methodology of its own to achieve more effective RMA programs. (A.T.)

A80-40525 **In-situ gasification and liquefaction show promise.** J. T. Miskell. *Energy*, vol. 5, Spring 1980, p. 10, 11, 16.

Recent progress in the development of in-situ coal gasification and shale liquefaction is discussed. The presence of potentially gasifiable subbituminous, bituminous and lignite coal reserves in the United States amounting to 1800 billion tons, compared with minable coal reserves of 430 billion tons, is pointed out as a major motivation for the development of in-situ extraction techniques, which are estimated to be some of the least expensive potential sources of synthetic natural gas. The successful test of an underground gasification unit operating for 35 days in a 23-ft thick coal seam dipping at 63 deg to produce low-Btu fuel gas and nitrogen-free synthesis gas that can be converted to hydrocarbons is presented, and operational, geological, environmental and economic constraints on the operation of such a unit are considered. In-situ extraction of kerosen from shale using conventional or RF methods is presented as the most promising means for utilizing the great reserves of shale in the United States, requiring little water and causing least disturbance to the environment, and it is noted that the RF process will probably become available by the mid-1980s. (A.L.W.)

A80-40753 **Fundamental aspects of catalysed coal char gasification.** S. K. Gangwal and R. S. Truesdale (Research Triangle Institute, Research Triangle Park, N.C.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 113-126. 69 refs. Research supported by the U.S. Environmental Protection Agency.

A brief review of the basic aspects of catalysed coal char gasification is presented. Kinetics and mechanisms of catalysed and uncatalysed gasification reactions of coal char with steam, carbon dioxide and hydrogen are discussed. Mass transport effects and internal structure of coals are shown to be important in determining rates of these reactions. The importance of the type of catalyst used is also discussed. Such factors as catalyst cations and anions, the method by which the catalyst is contacted with the coal char, and physical and chemical states of the catalyst both prior to and during reaction are shown to be important in the gasification process. Finally, research instruments and equipment used recently for studies in catalysed gasification are reviewed. These include various types of reactor systems for following the course of these reactions and analytical instruments for assessing the physical and/or chemical

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state of the catalysts and/or coal char both prior to and during the gasification reactions. (Author)

A80-40754 Coal gasification development and commercialization of the Texaco coal gasification process. W. G. Schlinger (Texaco Montebello Research Laboratory, Montebello, Calif.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 127-136. 8 refs.

The development of the Texaco coal gasification process which uses an entrained bed downflow slagging gasifier is reviewed. The advantages of the process include its simplicity and lack of formation of environmentally unacceptable and undesirable byproducts. The treatment of the crude gasification product gas to produce a clean gas for use as fuel or as a feedstock for chemical manufacture is discussed, and the status of the commercialization of the process is considered. B.J.

A80-40755 Catalytic coal gasification for SNG manufacture. J. E. Gallagher, Jr. and C. A. Euker, Jr. (Exxon Research and Engineering Co., Linden, N.J.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 137-147. Contracts No. E(49-18)-2369; No. ET-78-C-01-2777.

The predevelopment phase of research on the Exxon catalytic coal gasification (CCG) process was completed in early 1978 and included bench-scale research on catalyst recovery and kinetics, the operation of a 6 in. diameter times 30 ft long fluid bed gasifier, and supporting engineering studies. As part of the engineering program, a conceptual design has been developed for a pioneer commercial CCG plant producing SNG from Illinois No. 6 bituminous coal. This paper reviews the status of research and development on the CCG program and describes the conceptual design and economics for the commercial scale CCG plant. B.J.

A80-40756 The U-GAS process. J. G. Patel (Institute of Gas Technology, Chicago, Ill.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 149-165. Research sponsored by the U.S. Department of Energy, American Gas Association, and Memphis Light, Gas and Water Co.

The U-GAS process has been developed by the Institute of Gas Technology to produce a low to medium Btu fuel gas from coal in an environmentally acceptable manner. The process accomplishes de-caking, devolatilization, and gasification of coal in addition to separation of ash in a single-stage fluidized bed reactor. A 24 ton per day pilot plant has been successfully operated on a variety of feedstocks including a high-sulfur, caking Illinois basin bituminous coal. Recent operation of the pilot plant has established process feasibility, and safe and reliable operation, and provided a strong data base for the preliminary design of a demonstration plant in Memphis. B.J.

A80-40757 The zinc chloride process for the hydrocracking of coal. F. E. Biasca, C. R. Greene (Shell Development Co., Houston, Tex.), W. E. Clark, and R. T. Struck (Conoco Coal Development Co., Library, Pa.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 167-171. Contract No. EX-76-C-01-1743.

The molten zinc chloride process is a hydrocracking system that converts coal to gasoline in a single step. An economically attractive process is currently under development at the one ton per day process development unit scale. The design and economics of a plant for the production of 53,000 bbl/day of gasoline with 90-92 unleaded research octane number from Western coals are discussed. B.J.

A80-40758 Economic and market potential for SRC-II products. B. K. Schmid, J. C. Koenig, and D. M. Jackson (Gulf Mineral Resources Co., Denver, Colo.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 173-184. 8 refs.

The SRC-II (solvent refined coal) process has shown considerable promise in pilot plant work, and plans are being made to demonstrate the process using commercial size equipment in a 6000

tons/day plant to be located near Morgantown, W. Virginia. It is shown that low-sulfur distillate fuel produced from coal by the SRC-II process can be economically competitive with comparable petroleum fuels within the 1980s. In addition to fuel oil, the process produces substantial quantities of methane, light hydrocarbons, and naphtha. The potential value of these products as feedstock for the preparation of pipeline gas, ethylene, and high-octane unleaded gasoline may make the SRC-II process incrementally more attractive. B.J.

A80-40826 Plasma physics for nuclear fusion. K. Miyamoto (Nagoya University, Nagoya, Japan). Cambridge, Mass., MIT Press, 1980. 625 p. 367 refs. Translation. \$50.

The book focuses on the properties of gaseous plasmas needed in the attainment of controlled fusion reactions. The first five chapters develop the fundamentals of plasma physics and present the conditions of nuclear fusion reactions. The next four provide a magnetohydrodynamic description of plasmas, followed by four chapters that explain wave phenomena and instabilities by means of a kinetic model. The three final chapters deal with the problems of heating, diagnostics, and confinement. V.T.

A80-40830 Wood for energy production. N. P. Chermisnoff (Exxon Research and Engineering Co., Florham Park; New Jersey Institute of Technology, Newark, N.J.). Ann Arbor, Mich., Ann Arbor Science Publishers, Inc., 1980. 159 p. 150 refs. \$20.

The current potential of wood as an alternative renewable energy source is surveyed. Following a review of the major industries that depend on wood, total world energy reserves and the potential supplies of wood as an energy source, the chemical, structural, species, physical and thermal properties of wood are examined. Combustion technologies for industry and the home are surveyed, with attention given to wood waste fuels, conventional steam generation, fluid bed incineration, fireplace, wood stove, multifueled and wood furnace designs, and thermoconversion technologies including pyrolysis, gasification, methanation and methanol production. Harvesting and preparation techniques for industry and the home are discussed, and the concept of the wood biomass energy plantation is examined. It is concluded that wood has the potential to make a major contribution to energy supplies, allowing less dependence to be placed on fossil fuel reserves. A.L.W.

A80-40832 Solid waste conversion to energy: Current European and U.S. practice. H. Alter (Chamber of Commerce of the United States, Washington, D.C.) and J. J. Dunn, Jr. (Black and Veatch Consulting Engineers, Silver Spring, Md.). New York, Marcel Dekker, Inc., 1980. 179 p. 175 refs. \$24.75.

The book provides an introduction to the background and technology of resource recovery from municipal solid wastes, as practiced in the United States and Europe. Quantity and composition of wastes in the United States and Europe are analyzed, and recovery of materials from waste in Europe is studied. Examples of waste-to-energy conversion and use technologies are discussed. Decision making for waste-to-energy system planning and implementation is considered, and marketing recovered products are outlined. V.T.

A80-41169 Basic elements in waste treatment operations. B. G. Kreiter (Stichting Verwijdering Afoalstoffen, Amersfoort, Netherlands). (*European Commission and Koninklijke Nederlandse Jaarbeurs, Congress on Packaging, Recovery and Reuse: Governmental and Industrial Viewpoints, Utrecht, Netherlands, Oct. 23, 24, 1979*) *Resource Recovery and Conservation*, vol. 5, June 1980, p. 27-37. 8 refs.

This paper indicates and clarifies a number of basic elements in waste treatment operations. These are mostly specific for the Netherlands. Therefore, the introduction of new approaches or new

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processes for waste treatment should be considered in this specific context. Some emphasis is put on energy-related aspects because of growing concern for the energy supply of the Western world. It is common practice to consider municipal solid waste as an energy carrier and, therefore, as an alternative for the usual sources of energy. Finally, an indication is given about the marketability of products from waste. (Author)

A80-41171 Packaging materials - Industrial possibilities for resource recovery. A. V. Bridgwater (Aston, University, Birmingham, England). (*European Commission and Koninklijke Nederlandse Jaarbeurs, Congress on Packaging, Recovery and Reuse: Governmental and Industrial Viewpoints, Utrecht, Netherlands, Oct. 23, 24, 1979.*) *Resource Recovery and Conservation*, vol. 5, June 1980, p. 51-72.

Consideration is given to possible industrial means for the recovery, recycling reuse and fuel conversion of packaging materials. The need for incentives for the industrial development and implementation of resource recovery programs is pointed out, and various techniques for the separation of packaging wastes from refuse are indicated. Possible techniques for the disposal, reuse, recovery, pyrolysis, compatibilization and fuel conversion of plastics, the recycling and conversion of paper, the recovery, separation and reuse of glass and the recycling and recovery of iron and steel and aluminum are then examined. A.L.W.

A80-41172 Recovery and reuse - Mechanical processing. H. Alter (National Center for Resource Recovery, Inc., Washington, D.C.). (*European Commission and Koninklijke Nederlandse Jaarbeurs, Congress on Packaging, Recovery and Reuse: Governmental and Industrial Viewpoints, Utrecht, Netherlands, Oct. 23, 24, 1979.*) *Resource Recovery and Conservation*, vol. 5, June 1980, p. 73-83. 26 refs.

This paper reviews mechanical processes for the processing of municipal solid waste for the recovery of magnetic metals, aluminum, glass, paper and the conversion of separated organic materials into various forms of refuse-derived fuel. Where possible, the descriptions of the processes are related to the purity and form requirements of product specifications which are available or under development. (Author)

A80-41174 Waste incineration and pyrolysis. A. V. Bridgwater (Aston, University, Birmingham, England). (*European Commission and Koninklijke Nederlandse Jaarbeurs, Congress on Packaging, Recovery and Reuse: Governmental and Industrial Viewpoints, Utrecht, Netherlands, Oct. 23, 24, 1979.*) *Resource Recovery and Conservation*, vol. 5, June 1980, p. 99-115.

The treatment of waste materials by incineration, gasification and pyrolysis is examined. Incineration, in which complete combustion or oxidation occurs, provides waste reduction by weight and volume, a sterile residue and the possibility of heat and/or power recovery, and is expected to become more viable as an energy source as energy costs increase. Thermal processing by gasification, in which incomplete combustion or oxidation occurs, and by pyrolysis, in which thermal degradation is effected by the noncombustive addition of heat, provides waste reduction by weight and volume, a sterile residue and, depending on conditions, a mixture of fuel gas, pyrolytic oil, aqueous condensate and a carbonaceous solid residue. Pyrolysis processes for the production of such fuels and chemicals as methanol are more complex and costly than incineration, and implementation is not likely to occur for a considerable time, although research is continuing. A.L.W.

A80-41213 # Gas turbine combustor design challenges for the 1980's. G. J. Sturgess (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1285*. 20 p. 45 refs.

The challenges in combustion, facing the industry at the beginning of this decade are discussed, including improved combustor durability, broad-based and synthetic fuels, and the design and

development process itself. Their origins and salient features are briefly described, and areas where more knowledge is required are highlighted. V.T.

A80-41662 Remote sensing of earth resources. Volume 8 - Annual Remote Sensing of Earth Resources Conference, 7th, Tullahoma, Tenn., March 27-29, 1979, Technical Papers. Edited by F. Shahrokhi and T. Paludan (Tennessee, University, Tullahoma, Tenn.). Tullahoma, Tenn., University of Tennessee, 1980. 379 p.

Topical problems involving computer-controlled and manual systems for interpreting multispectral photography, and scanner data are discussed along with sensor technology, information applications, and data flow schemes. Particular consideration is given to site-specific mapping of surface temperature based on NOAA-5 satellite VHRR data, digital resampling of Landsat forest imagery for multirate registration, estimation of vegetation biomass in bunchgrass rangelands of Alberta using Landsat imagery, and the applicability of Landsat imagery for mapping soils in arid and semiarid regions. B.J.

A80-41871 # Energy and civil aviation (Energia ed aviazione civile). G. Nicosia (Alitalia, Rome, Italy). *Istituto Italiano di Navigazione, Atti*, Jan.-Mar. 1980, p. 5-16. In Italian.

Repercussions of the energy crisis on air transport are examined, considering available resources of oil, natural gas, coal, sands and bituminous shales. Attention is given to the utilization of nuclear energy and of hydrogen, the synthesizing of fuel, and the amount of fuel used in air transport. The relationships between energy, economics and demand are also addressed, and a comparison is presented between the amount of fuel used by a Boeing 747 and the supersonic Concorde making the same Paris-New York flight. J.P.B.

A80-41892 Specific heats of Colorado oil shales - A differential scanning calorimetry study. D. B. Jones, K. Rajeshwar, and J. B. DuBow (Colorado State University, Fort Collins, Colo.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 19, Mar 1980, p. 125-128. 14 refs. Research supported by the U.S. Department of Energy.

A80-42019 # Measurement of geothermal fluxes by aerial thermal surveys (O registratsii geotermal'nykh potokov teplovoi aëros'emkoi). B. V. Shilin, V. I. Gornyi, and V. E. Karizhenskii (Laboratoriia Aerometodov, Leningrad, USSR). *Akademiia Nauk SSSR, Doklady*, vol. 252, no. 2, 1980, p. 321-323. 7 refs. In Russian.

It is shown that aerial thermal surveys of geothermal fluxes have not succeeded in detecting geothermal anomalies smaller than those of the order of several degrees. This problem has occurred in spite of the high sensitivity of airborne television systems and is found to be associated with considerable temperature contrasts arising as a result of solar radiation heating of the earth surface. In the present paper, the minimum values of anomalous geothermal heat flux that can be detected by aerial thermal surveys are determined. B.J.

A80-42151 # Autoignition and vaporization of no. 3 diesel oil spray under lean conditions. D. J. White (Solar Turbines International, San Diego, Calif.) and E. Cichanowicz (Electric Power Research Institute, Palo Alto, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-10*. 8 p. Members, \$1.50; nonmembers, \$3.00. Research supported by the Electric Power Research Institute.

Spray or heterogeneous autoignition has recently taken on great importance with the advent of low emission (NO_x) combustors requiring precise control of the primary zone equivalence ratio. Many of these combustors, particularly lean premixed systems, rely on the prevaporation and mixing of the fuel and air prior and external to the primary zone combustion process. At high pressures and temperatures, heterogeneous autoignition occurs readily and it can

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prevent the necessary (for low NO_x) premixing and prevaporization of the fuel and air. Experimental results of an investigation into the relationship between vaporization and autoignition has revealed that the necessary level of mixing and vaporization for low NO_x can be achieved without autoignition for most of the present industrial gas turbine engines. (Author)

A80-42186 # Fuel property effects on life characteristics of aircraft turbine engine combustors. C. C. Gleason and D. W. Bahr (General Electric Corp., Aircraft Engine Group, Cincinnati, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-55.* 9 p. 8 refs. Members, \$1.50; nonmembers, \$3.00. Contracts No. F33615-77-C-2042; No. F33615-77-C-2043.

Results of a program to determine the effects of fuel properties on the life characteristics of two USAF/General Electric aircraft turbine engine combustors are presented. Thirteen test fuels were evaluated in an older technology cannular combustion system (J79) and in an advanced technology, virtually smokeless, compact, annular combustion system (F101) over wide ranges of simulated engine operating conditions. Fuel variables were hydrogen content, aromatic structure, volatility and distillation end point. Significant increases in combustor liner temperatures were observed as fuel hydrogen content was decreased. With fuel hydrogen contents of 14.5, 14.0, 13.0 and 12.0, the resulting relative combustor liner cyclic life predictions are 1.00, 0.78, 0.52, and 0.35 for the J79 combustor and 1.00, 0.72, 0.52 and 0.47 for the F101 combustor, respectively. Based on these findings, it is concluded that improved liner cooling design features will be needed in most current technology combustors to accommodate the projected lower hydrogen contents of future fuels. (Author)

A80-42194 # Comparative testing of petroleum surrogate fuels with coal-derived liquids in a combustion turbine burner. P. P. Singh, E. R. Bazarian, P. R. Mulik (Westinghouse Electric Corp., Pittsburgh, Pa.), G. W. Bauserman (Westinghouse Electric Corp., Concordville, Pa.), A. Cohn (Electric Power Research Institute, Palo Alto, Calif.), and T. R. Stein (Mobil Research and Development Corp., Princeton, N.J.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-64.* 10 p. Members, \$1.50; nonmembers, \$3.00. Research supported by the Electric Power Research Institute.

Tests have been made in a combustion turbine burner using six petroleum-derived surrogate (PDS) fuels simulating six coal-derived liquid (CDL) fuels tested earlier. The purpose was to examine their suitability for use in place of scarce CDL fuels for combustor development. The PDS and CDL fuels were matched in terms of aromaticity and fuel bound nitrogen although differences in viscosity, distillation range and constituent species existed. In three cases, the low fuel bound nitrogen present in the PDS fuels was made equal to their coal liquid counterparts via the addition of quinoline. All six PDS fuels were evaluated on a 0.14-m-dia combustor while one of the surrogate fuels was evaluated on a 0.3-m-dia Westinghouse commercial combustor. (Author)

A80-42197 # Combustion effects of coal liquid and other synthetic fuels in gas turbine combustors. I - Fuels used and subscale combustion results. P. P. Singh (Westinghouse Electric Corp., Pittsburgh, Pa.), P. W. Pillsbury, G. W. Bauserman (Westinghouse Electric Corp., Concordville, Pa.), T. R. Stein (Mobil Research and Development Corp., Paulsboro, N.J.), A. Cohn (Electric Power Research Institute, Palo Alto, Calif.), P. R. Mulik, and E. R. Bazarian. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-67.* 11 p. 13 refs. Members, \$1.50; nonmembers, \$3.00.

The paper discusses coal derived liquid fuels and results obtained from tests in a subscale combustor. Emission measurements were made of NO_x, smoke, CO, and unburned hydrocarbons, establishing that fuel-bound nitrogen influences NO_x production. In particular,

the coal and shale derived liquid fuels tested are found to be basically satisfactory for use in present combustion turbines from an operational standpoint. Certain fuels containing high FBN may produce NO_x above that allowed from emission regulations. All fuels burned satisfactorily and with no more difficulty than with petroleum-derived fuels with similar properties. S.D.

A80-42198 # Combustion effects of coal liquid and other synthetic fuels in gas turbine combustors. II - Full scale combustor and corrosion tests. G. W. Bauserman (Westinghouse Electric Corp., Concordville, Pa.), C. J. Spengler (Westinghouse Electric Corp., Pittsburgh, Pa.), and A. Cohn (Electric Power Research Institute, Palo Alto, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-68.* 11 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

The paper describes the combustion tests on over twelve types of coal derived liquid fuels from the EDS, H-coal, SRC-I and SRC II processes and three shale oil fuels conducted in gas turbine combustors. Emission measurements were made of the NO(x) smoke, CO, and unburned hydrocarbons; combustor wall temperature profiles were measured. The results were correlated with the fuel properties: percent nitrogen, hydrogen, and aromaticity. This paper (Part II) describes the results of full scale combustor testing and of a long term corrosion-deposition test; a companion paper by Cohn et al. (Part I, 1980) discusses the fuels used in the program and the subscale combustor test results. A.T.

A80-42199.* # Low-NO_x/heavy fuel combustor program. E. Lister (U.S. Department of Energy, Germantown, Md.), R. W. Niedzwiecki, and L. Nichols (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-69.* 10 p. Members, \$1.50; nonmembers, \$3.00.

The paper deals with the 'Low NO_x/ Heavy Fuel Combustor Program'. Main program objectives are to generate and demonstrate the technology required to develop durable gas turbine combustors for utility and industrial applications, which are capable of sustained, environmentally acceptable operation with minimally processed petroleum residual fuels. The program will focus on 'dry' reductions of oxides of nitrogen (NO_x), improved combustor durability and satisfactory combustion of minimally processed petroleum residual fuels. Other technology advancements sought include: fuel flexibility for operation with petroleum distillates, blends of petroleum distillates and residual fuels, and synfuels (fuel oils derived from coal or shale); acceptable exhaust emissions of carbon monoxide, unburned hydrocarbons, sulfur oxides and smoke; and retrofit capability to existing engines. (Author)

A80-42200 # Fuel character effects on J79 and F101 engine combustor emissions. C. C. Gleason (General Electric Aircraft Engine Group, Cincinnati, Ohio) and J. A. Martone (USAF, Engineering and Services Center, Tyndall AFB, Fla.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-70.* 8 p. 12 refs. Members, \$1.50; nonmembers, \$3.00. USAF-supported research.

Results of a program to determine the effects of fuel properties on the pollutant emissions of two U.S. Air Force aircraft gas turbine engines are presented. Thirteen test fuels, including baseline JP-4 and JP-8, were evaluated in a cannular (J79) and a full annular (F101) combustor. The principal fuel variables were hydrogen content, aromatic structure, volatility, and distillation end point. Data analysis shows that fuel hydrogen content is a key fuel property, particularly with respect to high power emissions (oxides of nitrogen and smoke), and that low power emissions (carbon monoxide and hydrocarbons) are more dependent on fuel atomization and evaporation characteristics. (Author)

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A80-42226 * # Status of the DOE/NASA critical gas turbine R & T Project. J. S. Clark (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-104.* 10 p. 14 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

The purpose of the DOE/NASA CRT (Critical Research and Technology) Project at the Lewis Research Center is to provide an R&T data base for utility gas turbine systems burning coal-derived fuels. Coal-derived fuels present difficult problems in combustion (because of the high organically-bound nitrogen in the fuel), and materials (because of the trace metal contaminant levels in the fuels, leading to corrosion and deposition in the turbine hot section). The combustion task includes (1) an effort to model the rich-lean combustion process, to predict NO_x emissions; (2) a two-stage flame tube experiment to study the effects of combustion operating conditions and fuel properties on NO_x conversion; and (3) scaled combustor tests to evaluate the NO_x-reduction potential of several staged-combustion concepts. The materials-corrosion resistance effort attacks the problem on three sides. (Author)

A80-42230 # Design and test of a 73-MW water cooled gas turbine. A. Caruvana, R. S. Rose, E. D. Alderson, and G. A. Cincotta (General Electric Co., Gas Turbine Div., Schenectady, N.Y.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-112.* 20 p. 13 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

This paper presents a preliminary design of a water-cooled gas turbine capable of operating on coal derived fuels and producing 73 MW when burning low Btu coal gas. Particular emphasis is placed on the critical technology issues of combustion and heat transfer at 2600 deg firing temperature. The recent technology developments, i.e., materials developments, composite construction, water cooling, fuels cleanup, etc., which now make this advanced concept possible are discussed. Detailed descriptions of the hot gas path components, the staged sectoral combustor, the water cooled nozzles and buckets, are described showing the implementation of these recent developments. The component development test program which is underway is described and, where testing results are available, design confirmation is demonstrated. Future plans for the construction of a full scale prototype machine and for design verification testing are presented. An analytical evaluation is included which demonstrates the advantages of the water-cooled gas turbine in an integrated gasification combined cycle. (Author)

A80-42231 # Survey of integrated gasification combined cycle power plant performance estimates. J. W. Larson (Mitre Corp., Metrek Div., McLean, Va.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-113.* 14 p. 28 refs. Members, \$1.50; nonmembers, \$3.00.

The idea of a combined cycle power plant integrated with a coal gasification process has attracted broad interest in recent years. This interest is based on unique attributes of this concept which include potentially low pollutant emissions, low heat rate and competitive economics as compared to conventional steam plants with stack gas scrubbing. Results from a survey of technical literature containing performance and economic predictions have been compiled for comparison and evaluation of this new technique. These performance and economic results indicate good promise for near-term commercialization of an integrated gasification combined cycle power plant using current gas turbine firing temperatures. Also, these data show that advancements in turbine firing temperature are expected to provide sufficiently favorable economics for the concept to penetrate the market now held by conventional steam power plants. (Author)

A80-42243 # Diagnostics and instrumentation requirements for advanced power systems. D. R. Hardesty (Sandia Laboratories, Livermore, Calif.). *American Society of Mechanical Engineers, Gas*

Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-129. 18 p. 71 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

The paper summarizes a preliminary assessment of the diagnostics and instrumentation requirements for coal-fired gas turbine systems. Attention is given to diagnostics needs which are common to most of the Fossil Energy programs. Emphasis is placed on diagnostics needs related to material studies, in particular to the in situ detection of material surface properties. V.T.

A80-42245 # 2.5-MWe coal-fired, atmospheric fluidized bed, recuperated closed gas turbine electrical power generating plant. A. D. Harper (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-132.* 8 p. Members, \$1.50; nonmembers, \$3.00. Research supported by the Electric Power Research Institute.

A80-42267 # High-temperature, coal-fired combustor with ceramic heat exchangers for CCGT systems. H. W. Carpenter, J. Campbell, Jr., L. H. Russell, and D. E. Wright (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-155.* 6 p. Members, \$1.50; nonmembers, \$3.00. Contract No. EF-77-C-01-2612.

High-temperature, coal-fired combustors with ceramic heat exchangers were designed for CCGT systems. The objective in evaluating CCGT systems is to convert U.S. coal to electricity with higher efficiency. Higher temperatures are required to accomplish this goal and ceramic heat exchanger surfaces allow the use of working fluid temperatures to 2500 F and higher. The results of a comprehensive government study are described in which an atmospheric fluidized bed and cyclone fired combustor/heat exchanger were designed for operation at 1750 and 2250 F. (Author)

A80-42271 # Coal gasification/repowering - A means of increasing plant capacity while reducing oil consumption. S. J. Lehman, A. J. Giramonti (United Technologies Research Center, East Hartford, Conn.), and R. H. Meyer (Northeast Utilities Service Co., Berlin, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-161.* 7 p. 9 refs. Members, \$1.50; nonmembers, \$3.00.

A80-42278 # Low Btu coal gas combustion in high temperature turbines. R. L. Vogt (General Electric Co., Gas Turbine Div., Schenectady, N.Y.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-170.* 9 p. 13 refs. Members, \$1.50; nonmembers, \$3.00.

This paper defines the combustion consequences of burning low Btu coal gas in high temperature gas turbines. It identifies the limits of their application regarding the heating value and its thermodynamic constraints on turbine firing temperature, operating flammability limits, product carbon monoxide, oxides of nitrogen and combustor turndown ratio. Sensitivity to reaction zone radiation and effects on combustor hot gas path flow area are discussed. The effect of these constraints on the conceptual design of a combustor is described herein. The example discussed is the sectoral combustor which was designed under contract to the Department of Energy for use in the High Temperature Turbine Technology program. The sectoral combustor is to be fired on coal gas to within 250 C of the homogeneous, adiabatic, stoichiometric flame temperature limit. (Author)

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A80-42289 # High temperature combustor designed for operation with coal derived low Btu gaseous fuels. T. R. Koblisch and L. M. Nucci (Curtiss-Wright Corp., Wood-Ridge, N.J.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-187.* 9 p. 6 refs. Members, \$1.50; nonmembers, \$3.00.

A80-42290 # Development of a high temperature turbine for operation on coal-derived fuel. J. C. Wolf, S. Moskowitz (Curtiss-Wright Corp., Wood-Ridge, N.J.), and G. B. Manning (U.S. Department of Energy, Washington, D.C.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-188.* 8 p. Members, \$1.50; nonmembers, \$3.00. Contract No. EX-76-C-01-2291.

The efficiency of an integrated coal gasification-combined cycle powerplant can be improved above that of conventional coal-fired steam powerplants by increasing the gas turbine component firing temperature and pressure ratio while limiting component cooling requirements. A stage of the development of a transpiration-air-cooled turbine for operation at 2600 F (1427 C) and above in a combusted coal-derived fuel environment is presented. Results are presented from 300 hr of turbine cascade and 400 hr of rig-engine tests conducted at up to 3000 F (1649 C) using a jet fuel 'doped' with aluminum oxide or flyash to simulate the potentially erosive and corrosive nature of coal derived fuels. The metallographic examinations and flow permeability are discussed in terms of the effects from particle deposition. (Author)

A80-42448 Passive cooling systems in hot arid regions. M. N. Bahadori (Shiraz, University, Shiraz, Iran). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 461-479. 7 refs. Research supported by the University of Shiraz.

The paper describes the principle of operation of wind towers and curved roofs used for natural circulation of air through buildings. The wind towers can provide both sensible and evaporative cooling of the air, while the wind blowing over the curved roofs provides an entrainment and sensible cooling of the ambient air through the building. The natural production of ice on clear winter nights and storage of cold water in deep cisterns are discussed; the natural ice making depends on thermal radiation losses to the clear sky. The water in cisterns is kept cool through the summer months by maintaining an evaporation rate from its surface by the draft produced by several wind towers. A.T.

A80-42466 Pyrolytic gasification of renewable biomass resources. E. E. Robertson (Biomass Energy Institute, Inc., Winnipeg, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 1059-1089. 12 refs.

Pyrolytic biomass gasifiers are discussed, including updraft, downdraft, and cross-draft reactors and attention is given to the catalytic conversion of forest and field crops. In addition, gasification technology with regard to wood is traced along with the generic development of gasifiers. Also considered are the chemical constituents of wood, that is, cellulosic carbohydrates and lignin, and the reactions (drying, pyrolysis and oxidation) occurring in a fixed bed updraft unit, concerning which it is noted that the efficiency of

gasification will not exceed about 70% (cold gas basis) due to temperature requirements in the pyrolysis zone. J.P.B.

A80-42467 Compaction and densification of fuels from biomass. E. E. Robertson (Biomass Energy Institute, Inc., Winnipeg, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 1091-1103. 11 refs.

A80-42470 Wind power. G. M. Bragg (Waterloo, University, Waterloo, Ontario, Canada). In: Solar energy conversion: An introductory course; Course, 5th, University of Waterloo, Waterloo, Ontario, Canada, August 6-19, 1978, Selected Lectures. Toronto and New York, Pergamon Press, 1979, p. 1245-1265. 9 refs.

The fundamentals of wind power utilization are described with emphasis placed on the information needed to determine the basic geometry of wind power devices and to discuss the availability of wind for power generation. The economics and social acceptance of wind power systems at the present time are analyzed. V.T.

A80-42700 # The utilization of wind-energy resources (Ob ispol'zovanii vetroenergeticheskikh resursov). V. I. Sidorov, V. V. Sidorov, and V. M. Kuznetsov. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport, May-June 1980, p. 73-82.* 11 refs. In Russian.

A review of developments in wind-energy in the Soviet Union, U.S., and West Europe is presented. The resources of the USSR are evaluated in three zones with the highest wind-energy potential, and designs of a 5 MW wind generator are analyzed along with a multirotor unit of 40 MW which will serve as the basis of an experimental 1000 MW system. The latter will be used as the first stage of utilization of wind-energy resources for electrical power generation. The wind-energy programs in the U.S., West Germany, Denmark, and Sweden are described which plan to produce 2 to 10% of electrical energy from wind energy by the year 2000. A.T.

A80-42800 Models for hydrogen gasification of coal - Analysis and significance of methane formation reactions (Modelle für die Wasserstoffvergasung von Steinkohle - Analyse und Deutung der Methanbildungsreaktionen). K. J. Hüttinger and H. Kirrmann (Karlsruhe, Universität, Karlsruhe, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 33, June 1980, p. 267-271. 27 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

A study is reported in which four samples of open-burning coal, one coking type of coal, one short-flaming (smokeless) coal, as well as defined pvc-pyrolysis residues were gasified in a fixed bed reactor. Three areas of methane formation are analyzed and the results of these methane formations examined. It is found that the methane formation between 500 and 600 C can be traced back to the rupture of methyl groups and methylene bridges. Further, the methane formation between 700 and 800 C is based on the maximum disorder of the paracrystalline coke residue. Finally, the catalytic activity of iron on coke gasification is considered, noting that it leads to the formation of methane above 850 C, and that since iron acts as a catalyst only under pressure, methane formation in this range is noticed only in pressure gasification. M.E.P.

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A80-42928 # Burning refuse-derived fuel - 'The Woodstock experience'. R. Luka (Canada Cement Lafarge, Ltd., Woodstock, Ontario, Canada). *CanInfo Communications, Energy from Waste Seminar: A Decade of Development, Toronto, Canada, Nov. 21, 22, 1979, Paper. 5 p.*

The paper deals with a field test of a substituting part of a plant's normal kiln fuel by refuse (RDF). The discussion is limited to the description of the facilities installed for RDF use. The plant has a nominal cement production capacity of 575,000 tons per annum. The RDF facility is conceived to receive, shred, meter, and pneumatically convey the quantities of RDF as required to the kiln. RDF is air classified paper fraction of shredded municipal solid waste. Some mention is made of heat recovery from RDF but data available is minimal. V.T.

A80-42929 # The region of Peel Resource Recovery Plant - Resource recovery and energy from waste in partnership. C. C. Kemp (Grumman Energy Systems, Inc., Ronkonkoma, N.Y.). *CanInfo Communications, Energy from Waste Seminar: A Decade of Development, Toronto, Canada, Nov. 21, 22, 1979, Paper. 6 p.*

A resource recovery system is described. A proprietary materials separation technology has been selected for a materials recovery system. An energy recovery system is based on the VKW Dusseldorf Roller Grate technology described as a mass burning process. The whole system is considered to be a reliable means for reducing household and commercial solid waste to a small volume of safely landfillable residue and at the same time to be a dependable source of steam for industry, electricity for the community. V.T.

A80-42930 # Potential for conversion of refuse to energy in Ontario. R. M. R. Higgin. *CanInfo Communications, Energy from Waste Seminar: A Decade of Development, Toronto, Canada, Nov. 21, 22, 1979, Paper. 4 p. 8 refs.*

The current energy from waste situation in Canada and Ontario is considered with regard to wood residues and municipal waste. Attention is also given to the direct economic viability of energy from waste projects. It is concluded that prepared solid refuse-derived fuel plans have the highest internal rate of return of all options, that mass burning waterwall incinerators show considerable economics of scale, and that batch-fed mass burning controlled air incinerators in the range of 50-100 tonnes/day appear to be economic for commercial and residential heating. J.P.B.

A80-43186 # An update of solid waste resource recovery technology - Improved economics through potential penetration of new markets for recycled products. E. T. Sherwin and A. R. Nolle (AENCO, Inc., New Castle, Del.). *American Society of Mechanical Engineers, Intersociety Environmental Systems Conference, San Diego, Calif., July 14-17, 1980, Paper 80-ENAs-9. 8 p. 10 refs. Members, \$1.50; nonmembers, \$3.00.*

Twenty-six large solid waste resource recovery plants have been designed and/or built since 1971. These plants are designed to burn the solid waste to produce steam, or to produce refuse-derived fuel

(RDF). After taking credit for energy produced, and for other resources recovered, these plants must charge a 'tipping fee' of between \$15 and \$40 per ton to break-even. This compares with 'tipping fees' of about \$7.50 per ton to operate sanitary landfilling. Thus, resource recovery costs more than does landfilling. This paper discusses a recently-developed system to produce graded paper pulps from mixed solid waste. Such graded pulps have a market value two to five times the fuel value of paper. (Author)

A80-43831 Wave energy. I. Glendenning (Central Electricity Generating Board, Plant Engineering Dept., Barnwood, Glos., England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews, vol. 127, pt. A, no. 5, June 1980, p. 301-307. 24 refs.*

It is noted that wave-energy studies to date have aimed at producing outline system designs and realistic estimates of their performance and costs. Generic work is reported to have shown that the resource size is less than originally believed, and that wave-directional effects, equipment reliability and basic device/converter efficiency lead to a maximum productivity of about 25%, about 60-70 TWh/yr or 10% of UK energy needs. Attention is given to ways of improving wave-energy economics with consideration given to such factors as device efficiency, maintenance assessments, and performance and cost of structures. It is concluded that improved systems capable of 5-10 p/kWh should be possible, but wave energy is unlikely to compete economically with nuclear power. M.E.P.

A80-43834 Fossil-fuel heat pumps for domestic, commercial and industrial space heating. R. E. Critoph (Warwick University, Coventry, England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews, vol. 127, pt. A, no. 5, June 1980, p. 326-329. 7 refs.*

N80-22421 Oklahoma State Univ., Stillwater.
COAL DERIVED LIQUIDS HYDROTREATMENT-CATALYSTS DEACTIVATION STUDY Ph.D. Thesis
Mohammed Mushtaq Ahmed 1979 375 p
Avail: Univ. Microfilms Order No. 7928189

The hydrotreatment catalysts activity decay while processing coal derived liquids is assessed. Two Co-Mo-alumina catalysts and one Ni-Mo-alumina catalyst were tested. Experimental runs were conducted at 10,400 KPa (1500 psig) for temperatures in the range of 371 C to 454 C using four different coal derived liquids as feedstocks. A semimechanistic model has been developed to represent the data obtained in the study. Carbonaceous depositions seem to be the primary cause for catalyst activity decay. Inorganic depositions are also responsible for catalyst activity decay and can result in permanent deactivation due to a loss in surface area, pore volume, and dilution of the active species on the catalyst surface. Dissert. Abstr.

N80-22428 Pennsylvania State Univ., University Park.
PREDICTION OF THERMOPHYSICAL PROPERTIES OF PETROLEUM FRACTIONS Ph.D. Thesis
Mohammad-Reza Riazi 1979 243 p
Avail: Univ. Microfilms Order No. 8006043

Thermophysical properties of a petroleum fraction were predicted using properties of pure compounds together with a molecular type analysis of the fraction. For light (molecular weight (M) < 200), olefin free fractions, a n-alkane, n-alkylcyclopentane,

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n-alkylbenzene(NP-NN-NA) model was developed which describes the structure of the fraction. Only boiling point as a characteristic parameter was needed to choose a pure compound from each hydrocarbon group. Molecular weight, critical temperature, critical pressure, critical volume, liquid molar volume, density, refractive index, heat of vaporization, and ideal gas heat capacity of petroleum fractions and pure compounds were simply correlated to the absolute boiling point and specific gravity at 60/60 F. When tested against data on pure compounds and petroleum fractions, these correlations were comparable with or superior to those obtained from previously recommended methods.

Dissert. Abstr.

N80-22507 Illinois Univ. at Urbana-Champaign.

A STEAM PROCESS FOR THE GASIFICATION OF COAL

Ph.D. Thesis

Ronald Thomas Gibbs 1979 194 p

Avail: Univ. Microfilms Order No. 8009042

A process was studied for the gasification of coal which uses superheated steam in excess of stoichiometric amounts as the heat source for the endothermic gasification reactions. Energy to generate and superheat the steam was derived by burning a part of the cleaned product gas stream thus avoiding air pollution problems. The excess steam combined with the absence of oxygen in the reactor resulted in sulfur from the coal being converted to hydrogen sulfide with final removal as raw sulfur. Results show the feasibility of the process at temperatures above 1300 K. Further, results showed reasonable agreement with predictions made by the kinetic model.

Dissert. Abstr.

N80-22508# Union Carbide Corp., Tonawanda, N.Y.

DIRECT IGNITION OF PULVERIZED COAL WITH ARC HEATED AIR

Philip R. Blackburn 1980 39 p refs Backup document for AIAA synoptic, 'Ignition of Pulverized Coal with Arc Heated Air', scheduled for publication in Journal of Energy, May - Jun. 1980

Avail: NTIS HC A03/MF A01

Current power plant practice, with suspension fired boilers, involves consumption of large quantities of premium fuel to accomplish ignition of pulverized coal. A new approach to coal ignition is described. A vortex stabilized electric arc heater was attached to a full scale commercial pulverized coal burner. A continuous arc heated air jet was used as an ignition source. The equipment was operated in a power plant. Ignition was accomplished with igniter input power levels which are lower than conventional practice by a factor of six. Cost of an igniter system for a 150 million BTU/hr coal burner is estimated. It is shown that the arc igniter is economically viable and is competitive with conventional practice.

Author

N80-22516# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

BIOMASS ENERGY CONVERSION WORKSHOP FOR INDUSTRIAL EXECUTIVES

1979 77 p Workshop held at Claremont, Calif., 9-10 Apr.

1979 Prepared in cooperation with Calif. Energy Comm., Sacramento

(Contract EG-77-C-01-4042)

(SERI/TP-62-299; CONF-790465)

Avail: NTIS

HC A05/MF A01

The potential to turn industrial waste or residue into an energy source was discussed at a workshop which provided industrial managers with current information on using residues and wastes as industrial energy sources. Successful industrial experiences were described by managers from the food processing and forest product industries, and direct combustion and low-Btu gasification equipment was examined. Some major conclusions of the conference were: numerous current industrial applications of wastes and residues as fuels are economic and reliable; off-the-shelf technologies exist for converting biomass wastes and residues to energy; a variety of financial (tax credits) and institutional (PUC rate structures) incentives can help make these waste-to-energy projects more attractive to industry. Many of

these incentives are still being developed and their precise impact must be evaluated on a case-by-case basis.

DOE

N80-22518# UOP, Inc., Des Plaines, Ill. Corporate Research Center.

UPGRADING OF COAL LIQUIDS: UPGRADING DISTILLATES FROM COAL LIQUEFACTION Annual Report, 31 Jan. 1978 - 31 Jan. 1979

A. J. deRosset, Gim Tan, and Lee Hilfman May 1979 16 p refs

(Contract EF-77-C-01-2566)

(FE-2566-26) Avail: NTIS HC A02/MF A01

The coal-derived naphthas from the H-Coal and Exxon Donor Solvent (EDS) processes were hydrotreated and reformed in research pilot plants to 100 Research Octane Number (RON) gasoline. The 400 F(+) distillates from the H-Coal and EDS processes converted by hydrotreating, hydrocracking and fluid catalytic cracking (FCC). In general, hydrotreatment is required prior to either hydrocracking or FCC to reduce excessive amounts of nitrogen and to enhance processability. Hydrotreating alone will give high yields of environmentally acceptable No. 2 fuel oil. Hydrogen consumption was high, however, a portion of the hydrogen can be recovered by reforming the hydrocracked naphtha to 100 RON gasoline. Additional hydrogen can potentially be recouped by steam reforming light gases. The hydrotreated distillates responded to fluid catalytic cracking as well as petroleum derived stocks of comparable hydrogen content. FCC gasoline product octane numbers ranged from 92 to 99 RON.

DOE

N80-22519# UOP, Inc., Des Plaines, Ill. Corporate Research Center.

UPGRADING OF COAL LIQUIDS: HYDROTREATING AND REFORMING EXXON DONOR SOLVENT (EDS) PROCESS DERIVED NAPHTHAS Interim Report

G. Tan and A. J. DeRosset Feb. 1979 48 p refs

(Contract EF-77-C-01-2566)

(FE-2566-25) Avail: NTIS HC A03/MF A01

Exxon donor solvent (EDS) process naphtha which was processed in research pilot plants into 100 octane motor fuel by conventional refinery processes, using commercial UOP catalysts is described. The naphtha comprises principally cyclic hydrocarbons. In addition, it contains over 10 percent heterocyclic structures, such as phenols, pyridines, and thiophenes. Hydrotreatment was effective in reducing the sulfur and nitrogen to levels acceptable for reforming. Reforming the hydrotreated naphtha gave 90 volume percent of 100 octane gasoline.

DOE

N80-22521# Engineering Societies Commission on Energy, Inc., Washington, D. C.

GUIDELINES FOR ECONOMIC EVALUATION OF COAL CONVERSION PROCESSES Final Report

Apr. 1979 83 p refs

(Contract EF-77-C-01-2468)

(FE-2468-44) Avail: NTIS HC A05/MF A01

Guidelines developed for use in preparing and reporting engineering designs, cost estimates, and financial analyses of large scale fossil energy facilities are presented, primarily for the preliminary economic analysis of coal conversion projects, producing either gas or coal liquids. In a preliminary estimate, the process, equipment, and site factors are sufficiently defined to justify a preliminary engineering design. However, the general structure and subject matter of these guidelines are applicable to either more simplified or more detailed analyses of energy facilities. Particular emphasis is placed on the treatment of capital cost estimates of new processes at various stages of technical development. Also, the financial methods and parameters to be used in determining the required selling price of products are defined in order to establish a base case for sensitivity analysis of technical, locational, or financial variables.

DOE

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N80-22524# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SURVEY OF BIOMASS GASIFICATION. VOLUME 2: PRINCIPLES OF GASIFICATION

T. B. Reed, comp. Jul. 1979 241 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-33-239-Vol-2) Avail: NTIS HC A11/MF A01

Biomass gasification and associated technologies are surveyed. The technical background necessary for understanding the science, engineering, and commercialization of biomass is presented. DOE

N80-22525# Technische Hochschule, Aachen (West Germany). Inst. fuer Eisenhuettenkunde.

PRÉSSURE-CHANGE UNDERGROUND GASIFICATION: THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF GASIFICATION Final Report

Christian Paul Beckervordersandforth, Jochen Belzer, Manfred Kuehn, Mehrdat Mohtadi, Wolfgang Sitte, Guenther Subklew, and Walter Terschueren Bonn Bundesmin. fuer Forsch. u. Technol. Jun. 1979 93 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.

(BMFT-FB-T-79-05) Avail: NTIS HC A05/MF A01; Fachinformationszentrum Energie, Phys., Math., Eggenstein-Leopoldshafen, West Germany DM 19,10

The extraction of SNG, reduction gas, and other gaseous fuels by means of in situ coal gasification with hydrogen, air, and oxygen mixtures was studied both theoretically and experimentally. Special emphasis was placed on the pressure-change process. Simulation experiments were carried out above ground at pressures up to 60 bar and temperatures up to 1000 C. A feasibility study was performed taking into account technical and economic factors. Author (ESA)

N80-22614# Sandia Labs., Albuquerque, N. Mex.

HIGH-TEMPERATURE ELECTRONICS: AN OVERVIEW

Richard C. Heckman 1979 8 p refs

(Contract EY-76-C-04-0789)

(SAND-79-2319A) Avail: NTIS HC A02/MF A01

The state of the art in high temperature electronics is briefly described and the major areas where developments are needed are identified. The geothermal program, high temperature oil and gas well logging, jet engine monitors, and circuits for operation in the sodium coolant loop of a breeder reactor have simulated research. DOE

N80-22776*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

LITERATURE SURVEY OF PROPERTIES OF SYNFUELS DERIVED FROM COAL Interim Report

Thaine W. Reynolds, Richard W. Niedzwiecki, and John S. Clark Feb. 1980 162 p refs

(Contract EF-77-A-01-2593)

(NASA-TM-79243; DOE/NASA/2593-79/8; E-150) Avail: NTIS HC A08/MF A01 CSDL 21D

A literature survey of the properties of synfuels for ground-based gas turbine applications is presented. Four major concepts for converting coal into liquid fuels are described: solvent extraction, catalytic liquefaction, pyrolysis, and indirect liquefaction. Data on full range syncrudes, various distillate cuts, and upgraded products are presented for fuels derived from various processes.

including H-coal, synthoil, solvent-refined coal, donor solvent, zinc chloride hydrocracking, co-steam, and flash pyrolysis. Some typical ranges of data for coal-derived low Btu gases are also presented. R.E.S.

N80-22852# United Technologies Corp., South Windsor, Conn. **A 300 Btu GAS COMBUSTOR DEVELOPMENT PROGRAM, PHASE 1 Final Report**

B. N. Baillif, F. H. Boenig, J. R. Grant (Pratt and Whitney Aircraft, West Palm Beach), and T. E. Holladay (Pratt and Whitney Aircraft, West Palm Beach) Aug. 1979 100 p refs Prepared jointly with Pratt and Whitney Aircraft, West Palm Beach (EPRI-AF-1144) Avail: NTIS HC A05/MF A01

Industrial turbines fired on medium heating value (MHV) gas (nominally 300 Btu/scf) synthesized from coal offer an attractive alternative means of producing electrical power in the future. Three MHV gas turbine combustor capable of meeting EPA NO/sub x/ requirements without water injection were designed, fabricated, and tested. Design of the combustion was based on a lean-premix concept. By premixing fuel and air in lean proportions prior to combustion flame temperatures and thus NO/sub x/ formation were controlled. Tests were conducted in a single-can combustion rig at simulated engine conditions ranging from 40 to 125% of engine baseload (74 MW). Rig data were analyzed to obtain performance parameters of combustion efficiency, burner pressure loss, and exit temperature pattern factor. Results show that all three combustors meet the NO/sub x/ goal, with connected concentrations of 12 ppmv or less over the range of test conditions. DOE

N80-22853# Oak Ridge National Lab., Tenn.

FOSSIL ENERGY PROGRAM Progress Report, Sep. 1979

Nov. 1979 86 p refs

(Contract W-7405-eng-26)

(ORNL-TM-7095) Avail: NTIS HC A05/MF A01

Research and development programs that are in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy are summarized. Topics covered include coal conversion development, materials engineering, a coal equipment test program, an atmospheric fluidized bed combustor for cogeneration, engineering studies and technical support, process and program analysis, environmental assessment studies, magnetic beneficiation of dry pulverized coal, technical support to the TVA fluidized bed combustion program, coal cogeneration/district heating plant assessment, chemical research and development, and technical support to major liquefaction projects. DOE

N80-22854# Oak Ridge National Lab., Tenn.

FOSSIL ENERGY PROGRAM Progress Report, Aug. 1979

Oct. 1979 98 p refs

(Contract W-7405-eng-26)

(ORNL/TM-7057; Rept-61) Avail: NTIS HC A05/MF A01

A compendium is presented for monthly progress reports for the ORNL research and development programs that are in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. The projects reported this month include those for coal conversion development, materials engineering, a coal equipment test program, an atmospheric fluid bed combustor for cogeneration, engineering studies and technical support, process and program analysis, environmental assessment studies, magnetic beneficiation of dry pulverized coal, technical support to the TVA fluid bed combustion program, coal cogeneration/district heating plant assessment, chemical research and development, and technical support to major liquefaction projects. DOE

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N80-22855# Oak Ridge National Lab., Tenn.
FOSSIL ENERGY PROGRAM Progress Report, Jul. 1979
Sep. 1979 72 p refs
(Contract W-7405-eng-26)
(ORNL/TM-7031; Rept-60) Avail: NTIS HC A04/MF A01

A compendium is presented of monthly progress reports for the ORNL research and development programs that are in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. The projects reported include those for coal conversion development, materials engineering, a coal equipment test program, an atmospheric fluid bed combustor for cogeneration, engineering studies and technical support process and program analysis, environmental assessment studies, magnetic beneficiation of dry pulverized coal, technical support to the TVA fluid bed combustion program, coal cogeneration/district heating plant assessment, chemical research and development, and technical support to major liquefaction projects. DOE

N80-23399# California Univ., Berkeley. Lawrence Berkeley Lab. National Geothermal Information Resource.
AQUEOUS SOLUTIONS DATABASE TO HIGH TEMPERATURES AND PRESSURES: NaCl SOLUTIONS

S. L. Phillips, Roland J. Otto, Huseyin Ozbek, and Mehdi Tavara
Aug. 1979 30 p refs Presented at the Workshop on Tech. for Meas. of Thermodyn. Properties, Albany, Oreg. 21-23 Aug. 1979

(Contract W-7405-eng-48)

(LBL-9621; CONF-790896-1) Avail: NTIS HC A03/MF A01
Available experimental data on sodium chloride solutions which are used in geothermal energy exploration and development for electrical power production and direct use were surveyed. The data are classified as thermodynamic, transport and physical; they are useful in the design and development of a geothermal area from brine production through utilization, to brine disposal. An ideal data system for geothermal energy is described. DOE

N80-23472*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THE IMPACT OF FUELS ON AIRCRAFT TECHNOLOGY THROUGH THE YEAR 2000

Jack Grobman and Gregory M. Reck 1980 26 p refs Presented at the Intern. Meeting and Tech. Display: Global Technol. 2000, Baltimore, 5-11 May 1980; sponsored by AIAA
(NASA-TM-81492; E-429) Avail: NTIS HC A03/MF A01 CSCL 21D

The impact that the supply, quality, and processing costs of future fuels may have on aircraft technology is assessed. The potential range of properties for future jet fuels is discussed along with the establishment of a data base of fuel property effects on propulsion system components. Also, the evolution and evaluation of advanced component technology that would permit the use of broader property fuels and the identification of technical and economic trade-offs within the overall fuel production-air transportation system associated with variations in fuel properties are examined. M.G.

N80-23474# Suntech, Inc., Marcus Hook, Pa.
RESEARCH ON DIAMANTANE AND OTHER HIGH DENSITY HYDROCARBON FUELS

Final Report, 1 Jun. 1978 - 30 Jun. 1979

A. Schneider and H. K. Myers Wright-Patterson AFB, Ohio
AFAPL Oct. 1979(93 p refs
(Contract F33615-78-C-2037; AF Proj. 3048)
(AD-A080749; AFAPL-TR-79-2080) Avail: NTIS HC A05/MF A01 CSCL 21/4

This report describes the preparation of (a) diamantane, (b) exo-tetrahydro-tricyclopentadiene, (c) the hydrogenated

product of isomerized endo, endo-di(norbornadiene), and (d) some precursors of polyalkyldiamantanes. GRA

N80-23476# Institute for Industrial Research and Standards, Dublin (Ireland). Information Technology Group.

RETROSPECTIVE SEARCH ON THE BIOCHEMICAL PRODUCTION OF ALCOHOL FUELS

Jul. 1979 233 p Prepared in cooperation with National Board for Science and Technology, Dublin

(NP-24137) Avail: NTIS (US Sales Only) HC A11/MF A01; DOE Depository Libraries

The production of alcohol from a wide variety of carbohydrate and cellulose sources from 1957 to 1979 is discussed. Some general information relating to the bioconversion process and alcohol fuels is also included. DOE

N80-23481# Battelle Columbus Labs., Ohio.
CARBOHYDRATE CROPS AS A RENEWABLE RESOURCE FOR FUELS PRODUCTION. VOLUME 1: AGRICULTURAL RESEARCH

E. S. Lipinsky, D. R. Jackson, S. Kresovich, M. F. Arthur, and W. T. Lawhon 15 May 1979 94 p refs

(Contract W-7405-eng-92)

(BMI-2031-Vol-1) Avail: NTIS HC A05/MF A01

Narrow row spacing of sweet sorghum and sugarcane as a means of reducing costs and increasing availability in selected geographical areas was emphasized. The influence of row spacing, cultivar selection, and planting date on yield and composition of sweet sorghum were evaluated in a typical corn belt state (Ohio). Similar data were obtained for Texas, Louisiana, Mississippi, and Florida for sweet sorghum and sugarcane. DOE

N80-23482# Lehigh Univ., Bethlehem, Pa. Center for Surface and Coatings Research.

METHANOL AND METHYL FUEL CATALYSTS Quarterly Report, Mar. - May 1979

Kamil Klier and Richard G. Herman Jun. 1979 14 p

(Contract ET-78-S-01-3177)

(FE-3177-3) Avail: NTIS HC A02/MF A01

Additional preparations of CuO/ZnO catalysts were made, and the materials were examined by X-ray powder diffractions. A series of cerium(IV) containing catalysts was prepared, and it was shown that the CuO/ZnO/CeO₂ = 25/65/10 wt percent catalyst precursor contained the copper in the form of (Cu,Zn)2(OH)2CO₃, analogous to the binary Cu/Zn = 30/70 sample. Calcination of this material, as well as of a binary ZnO/CeO₂ = 87/13 sample, yielded oxides having small crystallite sizes (< 135 Å). The reduced binary Cu/Zn catalysts were examined by diffuse reflectance spectroscopy and by X-ray powder diffraction. It was observed that the amount of noncrystalline copper assayed by X-ray diffraction correlated well with that found dissolved in the zinc oxide phase by an earlier scanning transmission electron microscopy study. The relationship between the optical parameters, such as the emergence of the high intensity visible absorption and the loss of the fundamental absorption edge of the zinc oxide, and the existence of the copper-zinc oxide solid solution were established. DOE

N80-23484# Bituminous Coal Research, Inc., Monroeville, Pa.
TEST AND EVALUATE THE TRI-GAS LOW-Btu COAL GASIFICATION PROCESS Quarterly Report, Apr. - Jun. 1979

Jul. 1979 38 p

(Contract ET-78-C-01-2798)

(FE-2798-66; BCR-L-1001) Avail: NTIS HC A03/MF A01

A total of three tests were conducted in the TRI-GAS PEDU. In the last two tests, the system was operated with the char and gas flows integrated in the process design mode. Smooth transfer of both char and gas between reactors was accomplished. Several minor equipment problems were encountered, but these will be alleviated through modifications. Work on the bench-scale equipment continued. DOE

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N80-23486# Gilbert Associates, Inc., Reading, Pa.
**RESEARCH AND EVALUATION OF BIOMASS RESOURCES/
CONVERSION/UTILIZATION SYSTEMS (MARKET/
EXPERIMENTAL ANALYSIS FOR DEVELOPMENT OF A
DATA BASE FOR A FUELS FROM BIOMASS MODEL)**
Quarterly Progress Report, 1 Aug. - 31 Oct. 1979
Y. K. Ahn, Y. C. Chen, H. C. Chen, E. T. Nelson, R. P. Stringer,
and Richard C. Bailie 1979 35 p refs Prepared in cooperation
with West Virginia Univ., Morgantown, and Environmental Energy
Engineering, Inc., Morgantown, W. Va.
(Contract ET-78-C-02-5022)
(COO-5022-9) Avail: NTIS HC A03/MF A01

Biomass characterization procedures were developed to
characterize approximately 100 biomass species. Thermal
gravimetric analyses were supplemented with a pyrogram and a
pyrochromatogram to further characterize each biomass. Tests
were run on the PDU in the fluidized bed mode to determine
the effects of particle size on reaction time. Thirteen tests were
run during this quarter to verify the results from previous testing.
The process development unit was modified to accommodate
future sustained runs. A mathematical model developed by
modifying the Texaco entrained bed pilot plant gasifier model to
simulate biomass gasification in an entrained bed. Results were
evaluated. A biomass economic program was developed to
provide average product fuel costs using 15 thermochemical
processes. DOE

N80-23487# Gilbert Associates, Inc., Reading, Pa.
**RESEARCH AND EVALUATION OF BIOMASS RESOURCES/
CONVERSION/UTILIZATION SYSTEMS (MARKET/
EXPERIMENTAL ANALYSIS FOR DEVELOPMENT OF A
DATA BASE FOR A FUELS FROM BIOMASS MODEL)**
R. P. Stringer and R. C. Bailie 1979 17 p Prepared in
cooperation with West Virginia Univ., Morgantown, and Environ-
mental Energy Engineering, Inc., Morgantown, W. Va.
(Contract ET-78-C-02-5022)
(COO-5022-8) Avail: NTIS HC A02/MF A01

A market analysis of the need for biomass derived fuels
presented and the regional availability of biomass resources on
seasonal bases are discussed. Biomass conversion profiles were
developed for 100 biomass materials including wood species,
bagasse, sugar cane, wheat and rice straw, corn stover, and
others. Conversion profiles were developed from thermal
gravimetric analyses runs under various conditions of temperature
and pressure and in the presence of catalysts. Gasification,
pyrolysis, and direct combustion were the modes of conversion.
An attempt was made to develop biomass-to-fuel process models
and to verify them using process development unit runs. Finally,
a linear programming model was developed for selecting the
most profitable combination of feedstocks and the conversion
processes required to satisfy fuels need under given market
conditions. The data banks of market conditions for biomass
resources and biomass derived fuels, biomass conversion profiles,
and commercial scale process economics were used as input to
the model. DOE

N80-23711* National Aeronautics and Space Administration,
Marshall Space Flight Center, Huntsville, Ala.
COAL-SHALE INTERFACE DETECTOR Patent
Harry Reid, Jr., inventor (to NASA) Issued 1 Apr. 1980 8 p
Filed 3 Nov. 1977
(NASA-Case-MFS-23720-1; US-Patent-4,195,512;
US-Patent-Appl-SN-848419; US-Patent-Class-73-12;
US-Patent-Class-73-82) Avail: US Patent and Trademark
Office CSDL 081

A coal-shale interface detector for use with coal cutting
equipment is described. The detector consists of a reciprocating
hammer with an accelerometer to measure the impact of the
hammer as it penetrates the ceiling or floor surface of a mine.
Additionally, a pair of reflectometers simultaneously view the
same surface, and the outputs from the accelerometer and
reflectometers are detected and jointly registered to determine
when an interface between coal and shale is being cut through.

Official Gazette of the U.S. Patent and Trademark Office

N80-23755# Geokinetics, Inc., Concord, Calif.
GEOKINETICS IN SITU SHALE OIL RECOVERY PROJECT

Annual Report, Mar. 1979
Mar. 1979 61 p
(Contracts ET-78-F-03-1787; DE-FC20-78LC-0787)
(LETC-10787-25; AR-2) Avail: NTIS HC A04/MF A01

Eighteen in situ retorts were constructed, ranging in size
from 330 tons to 46,000 tons. Eleven of these retorts were
burned, and a total of 5400 barrels of shale oil were recovered.
Oil shale thicknesses of 30 feet, and cross-sectional areas of
3800 square feet were, successfully blasted. The results are
encouraging, and the project will continue to scale up its size
of the operation in 1979. DOE

N80-23756# University of Southern California, Marina del Rey,
Medical Imaging Sciences Group.
**REMOTE SENSING FOR GEOTHERMAL ENVIRONMENTAL
ASSESSMENTS Final Report**
W. Frei, T. Shibata, and G. C. Huth 30 Jun. 1979 35 p refs
Sponsored in part by California Univ., Lawrence Livermore Lab.
(Contract W-7405-eng-48)
(UCRL-15108) Avail: NTIS HC A03/MF A01

The role of remote sensing is examined in the context of
the DOE Environmental Assessment Studies. Particular attention
is paid to the exploitation by computer analysis, of low altitude
aerial photographs, which were made available for this project.
One technique, change detection, developed during this project,
was found to be particularly useful because it permits the detection
of environmental changes at a very early stage where it might
escape detection on the ground. This technique, which was
perfected for use on a routine basis, can thus provide a very
effective environmental early warning capability. Several examples
are shown in known Geothermal Resource Areas (KGRA's) in
the Imperial Valley and the Geysers, California, which lead to
the conclusion that remote sensing become an essential tool for
the Environmental Assessment Studies. DOE

N80-23757# National Bureau of Standards, Boulder, Colo.
Electromagnetic Fields Div.
**DEVELOPMENT AND TESTING OF A MICROWAVE SYSTEM
TO MEASURE COAL LAYER THICKNESS UP TO 25 cm**
K. C. Roe and D. A. Ellerbruch Jan. 1979 27 p refs
(Contract ET-77-1-01-8881)
(FE-8881-1; SR-723-8-79) Avail: NTIS HC A03/MF A01

The design, construction and testing of a microwave coal
thickness indicator built to demonstrate the hypothesis that an
electromagnetic coal interface detector (EMCID) corrected for
surface admittance variation can measure coal thickness up to
25 cm within + or - 10 percent accuracy is described. The
design is based upon the FM-CW radar technique where reflections
from layered strata are detected in time relationship to propagation
path lengths. Relative depths to layered strata are displayed in
numerical digits. Determining the thickness of the coal layer
left on mine-haulageway roofs is important for both mine safety
and maximum coal recovery. A specified thickness is required in
many mines to maintain roof strength and to prevent exposure
of the overlying slate or shale to air, which deteriorates slate
and shale. DOE

N80-23795# Los Alamos Scientific Lab., N. Mex.
**THERMAL FRACTURE EFFECTS IN GEOTHERMAL ENERGY
EXTRACTION**
Ruth B. Demuth and Francis H. Harlow Nov. 1979 148 p
refs
(Contract W-7405-eng-36)
(LA-7963) Avail: NTIS HC A07/MF A01

Heat and water exchange between the primary crack and a
lateral thermal fracture are analyzed by means of numerical
modeling on a high-speed computer. Three dimensional heat
flow in the rock is coupled to a two dimensional approximation
for the time-varying convective patterns that result from both
forced flow and buoyancy. The physical and mathematical bases
for the study are described together with the numerical technique
for solution. Three versions of the computer code are listed and
some results of representative calculations are included. DOE

N80-23808# Dow Chemical Co., Midland, Mich. Process
Development Dept.

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ENERGY FROM IN SITU PROCESSING OF ANTRIM OIL SHADE Quarterly Technical Progress Report, Apr. - Jun. 1979

Lawrence J. Washington 20 Jul. 1979 43 p ref
(Contract EX-76-C-01-2346)
(FE-2346-49) Avail: NTIS HC A03/MF A01

Four wells were drilled and cored in the 100 series for use in evaluating the fracturing in Wells No. 101-106 and for possible use in subsequent extraction trails. Extensive logging, liquid permeability, air permeability and well communication tests were carried out for fracture assessment at both the hydraulic/explosive fracture site and the explosive underream site. Although these evaluations are still incomplete and no decision can yet be made as to which would be preferred for an extraction trail, both site have much greater permeability and better interwell communications than was present in the first extraction trails on the existing site. DOE

N80-23828# Oak Ridge National Lab., Tenn.
FOSSIL ENERGY PROGRAM Progress Report, Oct. 1979
L. E. McNeese Dec. 1979 79 p refs
(Contract W-7405-eng-26)
(ORNL/TM-7144) Avail: NTIS HC A05/MF A01

The utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy is addressed. Coal conversion development, materials engineering, a coal equipment test program, an atmospheric fluid bed combustor for cogeneration, engineering studies and technical support, process and program analysis, environmental assessment studies, magnetic beneficiation of dry pulverized coal, technical support to a fluid bed combustion program, coal cogeneration/district heating plant assessment, chemical research and development, and technical support to major liquefaction projects are specifically discussed. DOE

N80-23840# Puerto Rico Univ., Rio Piedras. Agricultural Experiment Station.

PRODUCTION OF SUGARCANE AND TROPICAL GRASSES AS A RENEWABLE ENERGY SOURCE Quarterly Report, 1 Dec. 1978 - 28 Feb. 1979

Alex G. Alexander, W. Allison, and M. Garcia 1979 45 p refs
(Contract ET-78-S-05-5912; AES-UPR Proj. C-481)
(ORO-5912-T1; QR-3) Avail: NTIS HC A03/MF A01

Research on candidate screening, water and nitrogen regimes, and ratoon-crop performance for row-spacing, harvest frequency, and varietal variables is discussed. Greenhouse tests revealed several grasses having growth and drought-tolerance characteristics superior to Sordan 70A, the project's outstanding short-rotation candidate up to this time. Johnson grass (*Sorghum halepense*), regarded as a weed by farmers, gave very favorable growth performances under simulated arid and semi-arid conditions. At six months into year 2, first ratoon data for sugarcane and napier grass indicate yield increases of 33% and 4%, respectively, over plant crop yields. The NCo 310 is emerging as the outstanding sugarcane variety tested to date. There are no consistent responses to narrow row spacing. Frequent recutting (at 2 month intervals) is gradually destroying sugarcane but is not appreciably affecting napier grass. DOE

N80-23925# Prakla-Seismos G.m.b.H., Hannover (West Germany).

FURTHER DEVELOPMENT OF SEISMIC METHODS: THREE-DIMENSIONAL VELOCITY DETERMINATIONS Final Report

Erich Meixner Bonn Bundesmin. fuer Forsch. und Technol. Sep. 1979 128 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. und Technol. (BMFT-FB-T-79-19) Avail: NTIS HC A07/MF A01; Fachinformationszentrum Energie, Phys., Math., Eggenstein-Leopoldshafen, West Germany DM 26.45

A survey of current methods to determine the velocity of seismic waves in geological formations is presented. An iterative computer method is described to calculate seismic interval velocities. A field test example is used to illustrate the method. Author (ESA)

N80-24462# Canada Inst. for Scientific and Technical Information, Ottawa (Ontario).

NONISOTHERMAL EXPERIMENTS ON THE HYDRODESULFURIZATION OF COAL

H. Baumann, J. Klein, and H. Juentgen 1980 22 p refs Transl. into ENGLISH from Erdoel Kohle, Petrochem. (West Germany), v. 30, no. 4, 1977 p 159-164 (NRC/CNR-TT-1963; ISSN-0077-5606) Avail: NTIS HC A02/MF A01

The hydrodesulfurization of bituminous coal by nonisothermal pyrolysis in an atmosphere of hydrogen was investigated. The rate of formation of hydrogen sulfide when samples were heated at a constant rate was plotted as a function of temperature. The curves divide into three regions: one to about 500 C. and the HS formed results from organically bound sulfur; the second is between 500 and 600 C. and the HS is due to the decomposition of pyrites into FeS; the third region extends from 600 to 1000 C. and the HS is due to organically bound sulfur, and the reduction of FeS. It is concluded that for low rank coals, moderate temperatures are sufficient for removal of most of the organic sulfur. F.O.S.

N80-24464*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

COAL DESULFURIZATION BY LOW TEMPERATURE CHLORINOLYSIS, PHASE 2 Final Report

J. J. Kalvinskas, Karel Grohmann, Naresh Rohatgi, John Ernest, and Don Feller 15 Jan. 1980 146 p (Contracts NAS7-100; ET-N-I-019060) (NASA-CR-163152; JPL-Pub-80-15) Avail: NTIS HC A07/MF A01 CSCL 21D

An engineering scale reactor system was constructed and operated for the evaluation of five high sulfur bituminous coals obtained from Kentucky, Ohio, and Illinois. Forty-four test runs were conducted under conditions of 100 by 200 mesh coal, solvents - methylchloroform and water, 60 to 130 C, 0 to 60 psig, 45 to 90 minutes, and gaseous chlorine flow rate of up to 24 SCFH. Sulfur removals demonstrated for the five coals were: maximum total sulfur removal of 46 to 89% (4 of 5 coals with methylchloroform) and 0 to 24% with water. In addition, an integrated continuous flow mini-pilot plant was designed and constructed for a nominal coal rate of 2 kilograms/hour which will be operated as part of the follow-on program. Equipment flow sheets and design drawings are included for both the batch and continuous flow mini-pilot plants. J.M.S.

N80-24465*# Technology Development Corp., Huntsville, Ala.
COAL CONVERSION PRODUCTS INDUSTRIAL APPLICATIONS

Joseph H. Dunkin and Dennis Warren 28 Feb. 1980 213 p (Contract NAS8-33759) (NASA-CR-161469; TDC-80-005) Avail: NTIS HC A10/MF A01 CSCL 21D

Coal-based synthetic fuels complexes under development consideration by NASA/MSFC will produce large quantities of synthetic fuels, primarily medium BTU gas, which could be sold commercially to industries located in South Central Tennessee and Northern Alabama. The complexes would be modular in construction, and subsequent modules may produce liquid fuels or fuels for electric power production. Current and projected industries in the two states which have a propensity for utilizing coal-based synthetic fuels were identified, and a data base was compiled to support MFSC activities. A.R.H.

N80-24467# Badger Plants, Inc., Cambridge, Mass.
CONCEPTUAL DESIGN OF A COAL-TO-METHANOL-TO-GASOLINE COMMERCIAL PLANT, VOLUME 1 Final Report, 31 Aug. 1977 - 1 Mar. 1979

Mar. 1979 311 p refs (Contract EX-76-C-01-2416) (FE-2416-43-Vol-1) Avail: NTIS HC A14/MF A01

An engineering and economic assessment of the conceptual design for an integrated commercial facility to convert coal-to-methanol-to-gasoline was investigated. The process steps involved an oxygen blown, high pressure coal gasification technique, followed by a chemical shift reaction, acid gas removal, sulfur

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recovery, methanol synthesis, methanol conversion, gas fractionation, and HF alkylation. DOE

N80-24468# Badger Plants, Inc., Cambridge, Mass.
CONCEPTUAL DESIGN OF A COAL-TO-METHANOL-TO-GASOLINE COMMERCIAL PLANT. VOLUME 2: COMMERCIAL PLANT ECONOMIC ANALYSIS Final Report, 31 Aug. 1977 - 1 Mar. 1979
Mar. 1979 322 p refs
(Contract EX-76-C-01-2416)
(FE-2416-43-Vol-2) Avail: NTIS HC A14/MF A01

The economic aspects of the coal-to-methanol-to-gasoline project are presented. Capital and product costs are specifically addressed. DOE

N80-24469# Badger Plants, Inc., Cambridge, Mass.
CONCEPTUAL DESIGN OF A COAL-TO-METHANOL-TO-GASOLINE COMMERCIAL PLANT. VOLUME 4A: DRAWINGS, SPECIFICATIONS, AND ALTERNATE DESIGNS Final Report, 31 Aug. 1977 - 1 Mar. 1979
Mar. 1979 504 p
(Contract EX-76-C-01-2416)
(FE-2416-43-Vol-4A) Avail: NTIS HC A22/MF A01

Block flow diagrams, utility flow diagrams, and the one line electrical diagrams pertaining to the base case coal-to-gasoline commercial plant are presented. Mass balance figures for the main process units are tabulated. Components and totals are shown for major process streams. The duty specifications and sketches for the major equipment items and buildings comprising the facility are presented. The conceptual and mechanical design features of the slag gasifier are also presented. R.C.T.

N80-24470# Badger Plants, Inc., Cambridge, Mass.
CONCEPTUAL DESIGN OF A COAL-TO-METHANOL-TO-GASOLINE COMMERCIAL PLANT. VOLUME 4B: DRAWINGS, SPECIFICATIONS, AND ALTERNATE DESIGNS Final Report, 31 Aug. 1977 - 1 Mar. 1979
Mar. 1979 459 p
(Contract EX-76-C-01-2416)
(FE-2416-43-Vol-4B) Avail: NTIS HC A24/MF A01

The conceptual designs for a coal gasifier are discussed. The following alternating coal gasifier concepts are described: slag bath; gas velocity in gasifier; carbon gasifier per pass; carbon gasifier overall; gasifier diameter; and number of gasifiers. R.C.T.

N80-24471# Oak Ridge National Lab., Tenn. Chemical Technology Div.
EVALUATION OF AN IN SITU COAL GASIFICATION FACILITY FOR PRODUCING M-GASOLINE VIA METHANOL
W. C. Ulrich, M. S. Edwards, and R. Salmon Dec. 1979 250 p refs
(Contract W-7405-eng-26)
(ORNL-5439) Avail: NTIS HC A11/MF A01

A conceptual process design and cost estimate was formulated for a facility producing approximately 15,000 barrels of M-gasoline per day via methanol from synthesis gas generated by gasification of coal in situ. The design was based on experimental data and mathematical predictions on the linked vertical well in situ coal gasification process. In place coal consumption is 20,000 tons/day, based on a subbituminous Wyoming coal. The capital investment was estimated to \$535 million in first-quarter 1978 dollars. M-gasoline product price was calculated as a function of the debt/equity ratio, annual earning rates on debt and equity, in place coal cost, and plant factor (onstream efficiency). Using a debt/equity ratio of 70/30, and interest rate on debt of 9%, an after tax earning rate on equity of 15%, an in place coal cost of \$5/ton, an LPG (propane) by-product credit of \$410 to the 6th power Btu, and a plant factor of 90%, the product price of M-gasoline is approximately \$0.90/gal at the plant gate. Calculated overall efficiency for the facility was 22%, based on in place coal. DOE

N80-24472# Argonne National Lab., Ill.
METHANE FROM LANDFILLS
R. E. Zimmerman and M. L. Wilkey 1979 13 p refs Presented

at the 2nd Ann. Conf. of Appl. Res. and Practice on Municipal and Ind. Waste, Madison, Wis., 18 Sep. 1979
(Contract W-31-109-eng-38)
(CONF-790999-1) Avail: NTIS HC A02/MF A01

The recovery, processing, and utilization technology operational in the landfill methane recovery field are described. The status of the US Department of Energy's Landfill Gas Utilization research and development program are also described. DOE

N80-24474# Illinois Univ., Urbana. Dept. of Civil Engineering.
BIOLOGICAL CONVERSION OF BIOMASS TO METHANE CORN STOVER STUDIES Progress Report, 1 Dec. 1977 - 1 Aug. 1978
John T. Pfeffer and Gerald E. Quindry Jun. 1979 171 p refs
(Contract EY-76-S-02-2917)
(COO-2917-13; UIIU-ENG-79-2004) Avail: NTIS HC A08/MF A01

A series of experiments was conducted to determine the performance characteristics of the methane fermentation process using corn stover processed through four parallel fermenters each having a capacity of 775 liters. A continuous feed system was employed to determine the conversion efficiency. The dewatering characteristics of the effluents and the quality of the liquid and solid residues were determined. The biodegradability of corn stover is low. Data obtained at a fermentation temperature of 59 + -1 C show that only 36 percent of the volatile solids are biodegradable. Pretreatment with caustic (NaOH) concentration of 0.30 molar and a temperature of 115 C for one hour increased the biodegradable fraction to 71 percent of the volatile solids. The reactor slurries were easily dewatered by both vacuum filtration and centrifugation. Corn stover does not appear to be attractive economically at the present energy prices. DOE

N80-24476# Pennsylvania State Univ., University Park. Coal Research Station.
CHARACTERISTICS OF AMERICAN COALS IN RELATION TO THEIR CONVERSION INTO CLEAN ENERGY FUELS Quarterly Technical Progress Report, Jul. - Sep. 1978
W. Spackman, A. Davis, P. L. Walker, H. L. Lovell, F. J. Vastola, P. H. Given, N. H. Suhr, and R. G. Jenkins May 1979 83 p refs
(Contract EX-76-C-01-2030)
(FE-2030-13) Avail: NTIS HC A05/MF A01

Certain important aspects of the chemical and physical composition of American lignite coals were characterized. Differential scanning calorimetry and thermogravimetric analysis were used to study the interaction between oxygen and seventeen coal chars (40 x 100 mesh) at 100 C. The same techniques were used to investigate briefly the interaction between air and a highly caking coal at selected isothermal temperatures in the range 100 to 275 C. DOE

N80-24478# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
FUEL FROM FARMS: A GUIDE TO SMALL-SCALE ETHANOL PRODUCTION
Feb. 1980 165 p refs
(Contract EG-77-C-01-4042)
(SERI/SP-451-519) Avail: NTIS HC A08/MF A01

A guide on fermentation processes with emphasis on small-scale production of ethanol using farm crops as a source of raw material is published. The status of on-farm ethanol production as well as an overview of some of the technical and economic factors is presented. Decision and planning worksheets and a sample business plan for use in decision making are included. Specifics in production including information on the raw materials, systems components, and operational requirements are also provided. Diagrams of fermentors and distilling apparatus are included. DOE

N80-24479# Department of Energy, Washington, D. C.
COAL CONVERSION COMPARISONS, TASK 002 Final Report

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K. A. Rogers and R. F. Hill Jul. 1979 99 p refs
(Contract EF-77-C-01-2468)
(FE-2468-51) Avail: NTIS HC A05/MF A01

Technologies for producing synthetic fuels from coal are examined. The conclusion is made that many processes are ready for commercial demonstration but synthetic fuel will cost more than conventional petroleum fuels. An economic comparison method was developed to reflect the value differences of the different fuel products. The value method assigns relative values to all producing from a multiproduct synfuel process. This method incorporates the preferences of the marketplace to arrive at the necessary selling prices for each product. Two methods of financing, using typical utility and private venture returns on investment, are included for all products. The fourteen conversion processes studied are divided into six groups: solid clean fuel, direct liquefaction, indirect liquefaction, synthetic natural gas, industrial gas, and electric power from a combined cycle-integrated gasifier system. Three of the processes are shown in an alternate mode of operations giving a total of seventeen sets of energy costs. The prediction is made that no major technological advances are expected which will significantly decrease synfuel costs. DOE

N80-24480# Department of Energy, Washington, D. C. Coal Conversion Div.
COAL LIQUEFACTION Quarterly Report, Oct. - Dec. 1978
Sep. 1979 61 p refs
(Contract EX-76-C-01-2297)
(DOE/ET-0068/4) Avail: NTIS HC A04/MF A01

The conversion of coal to liquid fuels is discussed with emphasis on improved process configurations for both catalytic processes. The advantage of coal liquefaction is assessed with respect to its high yield of a wide range of liquid products, especially boiler fuels, distillate fuel oil, and gasoline. The development of several conversion processes are briefly described. DOE

N80-24481# Department of Energy, Washington, D. C. Fossil Fuel Processing Div.
COAL CONVERSION Technical Report, 1978
Sep. 1979 188 p refs
(Contract EX-76-C-01-2297)
(DOE/ET-0061/2) Avail: NTIS HC A09/MF A01

Development of processes for converting coal into products that substitute for those derived from oil and natural gas is considered with emphasis on rapid commercialization. These substitute fuels include crude oil, fuel oil and distillates, chemical feedstocks, pipeline quality and fuel gas, and other products such as char that may be useful in energy production. J.M.S.

N80-24482# Chevron Research Co., Richmond, Calif.
REFINING AND UPGRADING OF SYNFUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES
Quarterly Report, Jul. - Sep. 1979
R. F. Sullivan and D. J. ORear Oct. 1979 44 p
(Contract EX-76-C-01-2315)
(FE-2315-43) Avail: NTIS HC A03/MF A01

The denitrification fouling rate of ICR 106 catalyst was measured in an accelerated fouling rate test. At comparable conditions, the H-coal whole process product is denitrified to a greater extent than the solvent-refined coal 2 whole process product. Deposits were formed in the preheater of the whole oil hydrotreater, which appear to be from either asphaltenes of soluble iron compounds in the feed. An alumina guard bed ahead of the catalyst successfully removed these contaminants. A large batch of low aromatic, denitrified H-coal whole process product was prepared for downstream hydrocracking. In this preparation hydrogen was consumed by the oil at roughly 2100 SCF/bbl. The whole product from this hydrotreater was then cracked in an extinction recycle hydrocracker to make a 350 F product. In this hydrocracking step, hydrogen was consumed by the oil 800 SCF/bbl. DOE

N80-24484# Argonne National Lab., Ill. Materials Science Div.

MATERIALS TECHNOLOGY FOR COAL-CONVERSION PROCESSES Quarterly Report, Apr. - Jun. 1979
Nov. 1979 70 p refs
(Contract W-31-109-eng-38)
(ANL-79-93; QR-18) Avail: NTIS HC A04/MF A01

A 500-h test run, exposing 11 water-cooled refractions to basic slag (B/A = 1.5), was completed. High chromia content and high density again appeared to be significant factors contributing to the corrosion resistance of refractories used for slag containment. A literature review on high temperature ultrasonic coupling was completed and suggest that studies on long term (month to years) pressure-coupling stability are needed. Flow-induced acoustic energy studies (relevant to acoustic leak detection) suggest that a 20% coal-water slurry flowing through an orifice under pressure produces acoustic-energy excitation mainly at frequencies < 65 kHz and that a better correlation between acoustic runs levels and flow rate is obtained as the differential pressure is increased. Corrosion studies of type 310 stainless steel at 1000 C with various P/sub O2/ and P/sub S2/ suggested that titanium addition increases the corrosion rate relative to that of commercially available steels. DOE

N80-24485# Argonne National Lab., Ill.
METHANE RECOVERY FROM URBAN REFUSE
M. L. Wilkey and R. Eric Zimmerman 1979 8 p Presented at the 2nd World Energy Eng. Conf., Atlanta, 28 Oct. 1979
(Contract W-31-109-eng-38)
(CONF-7910105-2) Avail: NTIS HC A02/MF A01

The goals of the methane recovery program are discussed. Major emphasis is placed on the develop, evaluation and implementation of the technologies necessary for recovery, processing, and utilization of combustible gases generated in landfills. To achieve these goals, a research program that examined the feasibility of landfill gas recovery and use, as well as future optimization techniques and methods, has been undertaken. DOE

N80-24486# Argonne National Lab., Ill.
REFUSE CONVERSION TO METHANE (REFCOM): A PROOF-OF-CONCEPT ANAEROBIC DIGESTION FACILITY
D. K. Walter and Caroline Brooks 1979 7 p refs Presented at the Joint Power Generation Conf., Charlotte, N.C., 7 Oct. 1979 Prepared in cooperation with DOE, Washington, D.C. and Mittelhauser Corp., Downers Grove, Ill.
(Contract W-31-109-eng-38)
(CONF-791006-2) Avail: NTIS HC A02/MF A01

A process for the anaerobic digestion of solid waste and sewage sludge into methane is described. Known as RefCOM (Refuse Conversion to Methane), the DOE experimental facility in Florida can process 100 tons of raw refuse per day with an output as high as 700,000 cubic feet of gas (CH4 and CO2) per day. Based on an average home gas consumption of one million cubic feet per year, a 1,000 tons-per-day plant has the potential to meet the gas needs of over 7,000 homes. The objectives of the RefCOM experiment are to: establish information on the quality and quantity of gas produced; ascertain optimum operating parameters for both mesophilic and thermophilic modes; and evaluate the reliability of the techniques. DOE

N80-24487# Los Alamos Scientific Lab., N. Mex.
CATALYTIC COAL CONVERSION SUPPORT: USE OF LASER FLASH-PYROLYSIS FOR STRUCTURAL ANALYSIS
Progress Report, 1 May - 31 Aug. 1979
N. E. Vanderborgh, W. J. Verzino, Jr., and B. A. Nichols Nov. 1979 47 p refs
(Contract W-7405-eng-36)
(LA-8133-PR) Avail: NTIS HC A03/MF A01

The project plan for determining the structural changes occurring in coal, using laser pyrolysis are delineated. The pertinent, computer generated references are appended. The determination of trial heating regimes and the selection and collection of appropriate catalysts are reported. DOE

N80-24488# Montana State Univ., Bozeman.
CATALYTIC HYDROGENATION FOR COAL-DERIVED LIQUIDS Interim Report, Jun. - Aug., 1979

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L. Berg and F. P. McCandless Sep. 1979 43 p
(Contract EY-76-C-01-2034)
(FE-2034-16) Avail: NTIS HC A03/MF A01

The catalysts specifically designed to hydrodenitrogenate solvent refined coal continue. Using catalyst bases of specific surface area, pore volume and pore diameter and impregnating them with tungsten, nickel, cobalt and/or molybdenum yielded denitrogenation of SRC from 1.17% nitrogen to as low as 0.01% nitrogen after 45 minutes use and 0.1% nitrogen after 90 minutes, and desulfurization of SRC from 0.73% to as low as 0.2% sulfur after three hours. The catalysts appear to be a cross between hydrotreating and hydrocracking catalysts and will require a burn-off and resulfiding after four to six hours of operation. Five additional catalysts were discovered which appear to offer the possibility of an economically attractive process for converting solvent-refined coal into a feedstock suitable for a conventional petroleum refinery. DOE

N80-24490# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

LBL CONTINUOUS BIOMASS LIQUEFACTION PROCESS ENGINEERING UNIT (PEU)

Carlos Figueroa, Jim Wrathall, and Sabri Ergun Nov. 1979 6 p. ref Presented at the Thermochem. Conversion Contractors' Meeting, Rolla, Mo., 7 Nov. 1979
(Contract W-7405-eng-48)

(LBL-10092; CONF-791166-2) Avail: NTIS HC A02/MF A01

Project goals and preliminary tests of a biomass liquefaction process engineering unit are briefly described. Findings from slurry pumping capability tests indicate that hydrolyzed slurries of 20 percent can be pumped without any difficulties. A schematic for the process engineering unit is given. M.G.

N80-24498# TRW, Inc., McLean, Va. Energy Systems Planning Div.

COAL DERIVED FUEL GASES FOR MOLTEN CARBONATE FUEL CELLS

Nov. 1979 91 p
(Contract EY-77-C-21-8085)

(METC-8085-T2) Avail: NTIS HC A05/MF A01

The range of raw gas compositions available from the major classes of coal gasifiers, the degree of gas clean-up achievable with state-of-the-art and future gas clean-up systems, and the energy penalties associated with gas clean-up are described. The results indicate that gasifier product raw-gas compositions are influenced by the gasifier type, operating conditions and coal type. Fixed-bed gasifiers, that do not subject the coal pyrolysis products to temperatures above approximately 1600 F, contain significant quantities of tars, oils, organic sulfur compounds and organic nitrogen compounds in the product raw gas. Fluid-bed, entrained-bed, and molten salt gasifiers that operate at higher temperature, produce less of these materials. Increasing operating temperature also favors the formation of H₂ and CO as compared to CO₂, H₂O and CH₄. Since the presence of H₂ and CO is preferred over CH₄ for a molten carbonate fuel cell feed, high operating temperature seem to be indicated for gasifiers operating with molten carbonate fuel cells. DOE

N80-24499# Johns-Manville Sales Corp., Denver, Colo. **FILTRATION PROCESS AND EQUIPMENT STUDIES FOR COAL LIQUEFACTION PROCESSES Final Report**

I. Bastidas, R. C. Himes, F. B. Hutto, and P. Martin May 1979 217 p refs
(Contract EX-76-C-01-2007)

(FE-2007-T1) Avail: NTIS HC A10/MF A01

A rotary pressure precoat filter test leaf was designed and constructed which makes it possible to simulate the operation of a full scale rotary pressure precoat filter. Variables affecting the operation of the rotary pressure precoat filter were investigated in detail. Precoat filtration principles were also reviewed. The effect of filtration variables as determined by studies with the rotary pressure precoat filter test leaf is discussed. DOE

N80-24501# Eyring Research Inst., Provo, Utah. **EXPERIMENTAL AND PROCESS DESIGN STUDY OF A HIGH RATE ENTRAINED COAL GASIFICATION PROCESS Final Report, Jan. 1974 - Nov. 1978**

M. J. McIntosh and Ralph L. Caotes 1978 415 p refs
(Contract EX-76-C-01-1548)
(FE-1548-T2) Avail: NTIS HC A18/MF A01

Work began in January 1974. The original experimental equipment was designed, fabricated and installed during the first eight months of the project. A total of 296 test runs were made for a total of 800 operating hours. Cold gas efficiencies of 73 percent at specific gasification rates of 115 pounds coal/hour cu ft atmospheres were achieved. Extensive equipment modifications were made to overcome problems encountered. An extended series of runs on a range of feed coals and char were conducted. Using the results a semi-empirical mathematical model was developed. This model incorporated material and energy balances, assumption of frozen water gas shift equilibrium and Arrhenius correlations of carbon gasification and methane formation. The Arrhenius constants were found to depend directly on the carbon percentages and the percent volatile matter for the four coals tested. Mathematical models of the entrained gasifier integrated in various ways with a combined cycle system were developed and used to study the effect of mode of integration, coal type, gasifier heat loss and gasifier steam feed rate on combined cycle performance. DOE

N80-24504# NEUS, Inc., Santa Monica, Calif. **BIO-SOURCES DIGEST. A JOURNAL ON BIOMASS UTILIZATION, VOLUME 1, NUMBER 3**

Harry Sobel Jul. 1979 65 p refs
(Grant NSF PFR-77-12500)

(PB80-139306; NSF/RA-790296) Avail: NTIS HC A04/MF A01 CSCL 10A

A rubber analysis procedure is described which publicizes laboratory instructions and details for pilot plant operations along with a discussion on gasohol production. Four eggshaped digesters being constructed by the City of Los Angeles are also described. Multi-use oil and hydrocarbon-producing crops in adaptive systems for food, material and energy production are briefly examined. Patents pertinent to biomass utilization, sources of new available information, are listed. GRA

N80-24630# Biomass Energy Inst., Inc., Winnipeg (Manitoba). **PROCEEDINGS FOREST AND FIELD FUELS SYMPOSIUM 1977** 336 p refs Symp. held at Winnipeg, Canada, 12 Oct. 1977

(CONF-7710156) Avail: NTIS (US Sales Only) HC A15/MF A01; DOE Depository Libraries

Forest and field fuels are examined areas where RD and D funding would be effective in expanding their marketability and use as substitutes for oil are identified. The present uses and immediate constraints on the wider uses of these renewable resources, compaction of field residues, and gasification and liquefaction of biomass are discussed. DOE

N80-24728# Energy and Environmental Analysis, Inc., Arlington, Va.

FORECAST OF LONG TERM COAL SUPPLY AND MINING CONDITIONS: MODEL DOCUMENTATION AND RESULTS Final Report

7 Mar. 1980 240 p refs Sponsored by NASA and DOE Prepared for JPL

(Contract JPL-955552)

(NASA-CR-163141; JPL-9950-310) Avail: NTIS HC A11/MF A01 CSCL 08I

A coal industry model was developed to support the Jet Propulsion Laboratory in its investigation of advanced underground coal extraction systems. The model documentation includes the programming for the coal mining cost models and an accompanying users' manual, and a guide to reading model output. The methodology used in assembling the transportation, demand, and coal reserve components of the model are also described. Results presented for 1986 and 2000, include projections of coal production patterns and marginal prices, differentiated by coal sulfur content. A.R.H.

04 FUELS AND OTHER SOURCES OF ENERGY

N80-24735# Department of Energy, Washington, D. C. **UNCONVENTIONAL GAS RECOVERY - ENHANCED GAS RECOVERY**

Oct. 1979 71 p refs
(DOE/EDP-0049) Avail: NTIS HC A04/MF A01

The development of gas recovery methods that will make it economically possible to produce gas resources that are currently uneconomic is examined including resource targets for future development. Processes developed and tested to assist conventional gas extraction processes in the recovery of unconventional gas resources include advanced hydraulic fracturing, chemical explosive fracturing, and directionally deviated wells. The technology program, commercialization plan for unconventional gas recovery, environmental concerns and requirements, and environmental strategy are among the topics discussed. DOE

N80-24799# Naval Weapons Center, China Lake, Calif. **GEOHERMAL ENERGY RESOURCES OF NAVY/MARINE CORPS INSTALLATIONS ON THE ATLANTIC AND GULF COASTAL PLAIN Interim Report, Jun. - Sep. 1978**

Douglas W. Edsall (Naval Academy) Mar. 1980 43 p refs
(AD-A082400: NWC-TP-6062) Avail: NTIS HC A03/MF A01 CSCL 10/1

The search for alternative energy sources is of great importance to the U.S. Navy. Preliminary examination of data from the literature, bottom hole temperatures from existing deep wells, and heat flow measurements in wells drilled at selected sites as part of a current research program sponsored by the Department of Energy have demonstrated that low temperature waters (-212 F or 100 C) may be available at moderate depths in the major sedimentary basins along the Atlantic and east Gulf Coastal Plain. Although the possible geothermal energy resources present here are not sufficient for electrical power generation, they appear adequate for space heating and cooling. The Navy should take a leading role in planning and executing exploratory drilling and resource evaluation programs, especially at the following installations, all of which are major energy users: Norfolk, Portsmouth, and Virginia Beach, Virginia; Charleston, South Carolina; and Pensacola, Milton, and Panama City, Florida. GRA

N80-24808# Badger Plants, Inc., Cambridge, Mass. **CONCEPTUAL DESIGN OF A COAL-TO-METHANOL-TO-GASOLINE COMMERCIAL PLANT. VOLUME 5: ALTERNATE DESIGN STUDIES Interim Final Report, 31 Aug. 1977 - 1 Mar. 1979**

Mar. 1979 209 p
(Contract EX-76-C-01-2416)

(FE-2416-43-Vol-5; IFR-2) Avail: NTIS HC A10/MF A01

Three design cases were investigated for converting methanol to gasoline using the Mobil process. These are defined as Case A, which produces gasoline and byproduct Liquid Propane Gas (LPG); Case B, which produces gasoline, high Btu gas, and byproduct LPG; and Case C, which produces gasoline only. The LPG includes propane LPG and high purity isobutane. Alternate Cases A and C are described. Additional process studies, including economy of scale evaluations, studies of Lurgi methanol synthesis recommendations, integration of Methanol-to-Gasoline facilities with a refinery, and recovery of aromatics from stabilized synthetic gasoline, are discussed. DOE

N80-24849# Science Applications, Inc., La Jolla, Calif. **CALIFORNIA THERMAL OIL UTILIZATION. VOLUME 1: EXECUTIVE SUMMARY Final Report**

R. Colman and E. W. Standley Dec. 1979 385 p refs
(Contract ET-78-C-03-1864)

(SAN-1864-1) Avail: NTIS HC A17/MF A01

The potential for significant increases in California thermally produced crude oil (CTO) production and utilization by 1985 was studied. The DOE goal of 900,000 barrels/day of total CTO production by 1985 was evaluated. The constraints to increased CTO production were discussed. Incentives for increasing production were recommended. Physical and chemical properties, conventional refining processes, and alternate technologies for CTO were also discussed. DOE

N80-24906* National Aeronautics and Space Administration, Pasadena Office, Calif.

GEOLOGICAL ASSESSMENT PROBE Patent
Earl R. Collins, inventor (to NASA) (JPL) Issued 8 Apr. 1980
8 p Filed 25 Sep. 1978 Supersedes N80-12642 (18 - 3, p 0365) Sponsored by NASA
(NASA-Case-NPO-14558-1; US-Patent-4,196,619;
US-Patent-Appl-SN-945436; US-Patent-Class-73-155) Avail:
US Patent and Trademark Office CSCL 08G

A probe is described which can be installed in a side hole that extends from a bore hole in the Earth, to assess the permeability of the strata surrounding the borehole. The probe is elongated and has a plurality of seals spaced therealong and sealed to the walls of the side hole to form a plurality of chambers sealed from one another. A tracer fluid injector on the probe can inject a tracer fluid into one of the chambers, while a tracer fluid detector located in another chamber can detect the tracer fluid, to thereby sense the permeability of the strata surrounding the side hole. The probe can include a train of modules, with each module having an inflatable packer which is inflated by the difference between the borehole pressure and the strata pressure. Official Gazette of the U.S. Patent and Trademark Office

N80-24909 Stanford Univ., Calif.
ATTENUATION OF SEISMIC WAVES IN ROCKS AND APPLICATIONS IN ENERGY EXPLORATION Ph.D. Thesis
Einar Kjartansson 1980 160 p

Avail: Univ. Microfilms Order No. 8011658

The absorption and dissipation of seismic wave energy into heat is examined. A mathematical description for the general elastic response and wave propagation in materials where the specific loss or Q factor is exactly independent of frequency is developed. One particular mechanism for the dissipation of energy, thermal relaxation, is examined. This mechanism, which affects compressional waves more than shear waves, is highly sensitive to the state and the nature of the pore fluids. Wave propagation in media where attenuation and velocity are spatially heterogeneous is also discussed. Finite difference solutions to the wave equation are developed to include the effects of absorption, as well as arbitrary spatial heterogeneities. Finally, methods are developed to extract information about spatial variations of attenuation and velocities from seismic reflection data. The application of the inversions to amplitude and travelttime data from unstacked common-midpoint reflection data yield detailed pictures of the subsurface. Dissert. Abstr.

N80-24964# California Univ., Livermore, Lawrence Livermore Lab.

NUMERICAL WIND FIELD MODEL VALIDATION FOR A COMPLEX TERRAIN AREA IN THE VICINITY OF LAWRENCE LIVERMORE LABORATORY

W. M. Porch, H. Walker, C. R. Veith, and M. H. Dickerson 20 Sep. 1979 35 p refs

(Contract W-7405-eng-48)
(UCRL-52837) Avail: NTIS HC A03/MF A01

The computer program, MATHEW, a mass consistent wind field model including topography, was tested using statistically selected data stations in the region of Lawrence Livermore Laboratory (LLL). Predicted versus measured winds were compared for data taken across a windy pass in the hills 3 km east of LLL. The topographic scale and the number of selected stations were varied to assess their relative impact on the agreement of the winds predicted by the model and those measured at Patterson Pass. The test results for a one hour data set show that the model underestimates the measured winds by 25% and the wind energy by a factor of 2.4, with little dependence on topographic scale and some dependence on which data stations were included in the model; however, high winds were predicted in high wind areas. DOE

N80-24966# Battelle Pacific Northwest Labs., Richland, Wash.
WIND RESOURCE ASSESSMENT STATUS

L. L. Wendell 1979 13 p refs Presented at the EPRI Workshop on Econ. and Operational Requirements and Status of Large-Scale Wind Systems, Monterey, Calif., 28-30 Mar. 1979
(Contract EY-76-C-06-1830)

(PNL-SA-6918-Rev-1) Avail: NTIS HC A02/MF A01

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Prototype techniques for the analysis of wind energy potential and distribution over a large area were developed. These techniques involve the utilization of a large data set, the application of meteorological and topographic factors in the analysis, and the use of indirect methods of wind power estimation in areas where no wind measurements exist. The techniques were tested in five Pacific Northwest states. DOE

N80-24968# Northwestern Univ., Evanston, Ill. Dept. of Civil Engineering.

STATISTICAL MODELS FOR WIND CHARACTERISTICS AT POTENTIAL WIND ENERGY CONVERSION SITES Final Report, 15 Sep. 1977 - 14 Oct. 1978

R. B. Corotis Jan. 1979 86 p refs

(Contract EY-76-S-06-2342)

(DOE/ET/20283-1; RLO-2342-79/1)

Avail: NTIS

HC A05/MF A01

Simple models and guidelines are developed for wind energy site surveys. Probabilistic procedures are employed to assess survey duration, climatological adjustment, and run duration statistics. A climatological adjustment procedure is derived for the enhancement of candidate site data from a reference site with long term data, and the computation of confidence intervals is shown for existing data and for projected survey durations. The value of the enhancement procedure is diminished because of the sensitivity of the procedures to long term cross correlations. A simplified run duration model is developed for initial persistence assessment. The model is simply calibrated for each run level from the seasonal mean wind speed at a site. DOE

N80-25196# National Bureau of Standards, Washington, D.C. **DIMENSIONS/NBS, VOLUME 63, NO. 12 Monthly Report** Dec. 1979 37 p refs

(PB80-130701; NBS/DIM-63/12)

Avail: NTIS

HC A03/MF A01 CSCL 14B

Short summaries of major technical developments, highlights of work in progress, major speeches and statements by Bureau management, and a listing of NBS publications are presented. Topics covered include: protecting citizens' rights; once is enough; guidelines for the use of modernized metric system; refractory concrete strength measured under simulated usage; chemical degradation of refractory liners in coal gasifier systems; data centers established to aid coal conversion industry; conferences; publications; index; and news briefs. GRA

N80-25398# Montana State Univ., Bozeman. Dept. of Chemical Engineering.

CATALYTIC HYDROGENATION OF COAL-DERIVED LIQUIDS Interim Report, Sep. - Nov. 1979

Lloyd Berg and F. P. McCandless Dec. 1979 25 p

(Contract EX-76-C-01-2034)

(FE-2034-17) Avail: NTIS HC A02/MF A01

Three catalysts containing molybdenum, cobalt, nickel and/or tungsten on bases of specific surface area, pore volume and pore diameter, were fabricated and partially evaluated. Two of them produced product equaling or exceeding the nitrogen specification. Regeneration via an air burnoff of the deposited carbon was accomplished on all three of the catalysts and a subsequent run with each indicated that activity had been restored. DOE

N80-25455# C-E Lummus, Bloomfield, N.J. **SYNTHANE PILOT PLANT, SOUTH PARK TOWNSHIP, PENNSYLVANIA Final Report**

1979 548 p refs

(Contract EY-76-C-02-0003)

(COO-0003-41-T1) Avail: NTIS HC A23/MF A01

The Synthane pilot plant was operated during the period 1975-1978 to test the feasibility of the Synthane process to produce pipeline quality gas from coal. The operations of the Synthane pilot plant were suspended in September, 1978. The unit was mothballed and is presently being maintained in a standby mode. Various aspects of this project are summarized. The operation, technical evaluation, and engineering for the period 1976-1978 are also included. DOE

N80-25456# New Zealand Energy Research and Development Committee, Auckland.

POTENTIAL OF ENERGY FARMING FOR TRANSPORT FUELS IN NEW ZEALAND

G. S. Harris, M. L. Leamy, T. Fraser, J. B. Dent, W. A. N. Brown, W. B. Earl, T. W. Fookes, and J. Gilbert 1979 135 p refs

(NZERDC-46) Avail: NTIS HC A07/MF A01

Farming for production of fuel in New Zealand is discussed. The technical and economic aspects of energy farming and guidelines for development of this energy source are presented. Costs and energy ratios are given and areas of concern are highlighted. The results of studies on sugar beets, fodder beets, maize, lucerne, and radiata pine are discussed. The production of methanol, methane, and ethanol by fermentation and gasification are described. Environmental issues are also discussed. DOE

N80-25457# New Zealand Energy Research and Development Committee, Auckland.

POTENTIAL OF ENERGY FARMING FOR TRANSPORT FUELS IN NEW ZEALAND, APPENDICES

G. S. Harris, M. L. Leamy, T. Fraser, J. B. Dent, W. A. N. Brown, W. B. Earl, T. W. Fookes, and J. Gilbert 1979 135 p refs

(NZERDC-46-App) Avail: NTIS HC A07/MF A01

Farming for production of fuel in New Zealand is discussed. Subjects studied in this report are: the suitability and distribution of land for the production of biomass, forestry, agricultural crops, maize grain production in the Waikato; processing routes for transport fuels; advisory panel research in the Waikato; scenarios for transport fuels to 2000; toxicity and other potential danger considerations associated with distribution and opportunity costs. DOE

N80-25460# Oklahoma State Univ., Stillwater. Dept. of Chemistry.

CONSEQUENCES OF THE MASS SPECTROMETRIC AND INFRARED ANALYSIS OF OILS AND ASPHALTENES FOR THE CHEMISTRY OF COAL LIQUEFACTION. CHARACTERIZATION OF COAL-DERIVED LIQUIDS AND OTHER FOSSIL FUEL RELATED MATERIALS EMPLOYING MASS SPECTROMETRY

P. A. Benson, S. E. Scheppele, G. J. Greenwood, T. Aczel, Q. G. Grindstaff, and B. F. Beier Sep. 1979 120 p refs Prepared in cooperation with Exxon Research and Engineering Co., Baytown, Tex.

(Contract EX-76-S-01-2537)

(FE-2537-10) Avail: NTIS HC A06/MF A01

A COED liquid was separated into oils, asphaltenes, and residue. Anion and cation exchange chromatography fractionated the oils and asphaltenes into acids, bases, and neutrals; silica gel chromatography separated neutral fractions into saturate and aromatic concentrates. Infrared spectra of the aromatic concentrates identified functional groups. Carbon number distributions for the aromatic concentrates were obtained using high and low resolution FI/MS and high resolution 70-eV EI/MS and ultra high resolution low-voltage EI/MS. The asphaltenes contain higher molecular weight Z series, higher molecular weight homologs and different compound types than do the oils. Results show that simple solvent extraction produces compositionally nonunique fractions. Thus, detailed molecular analysis is a prerequisite for the correct assessment of: (1) reaction conditions and catalyst on the mechanism and kinetics of coal liquefaction; and (2) alteration in process conditions on the quality of the coal liquid. DOE

N80-25461# West Virginia Univ., Morgantown. Dept. of Chemical Engineering.

OPTIMIZATION STUDIES OF VARIOUS COAL-CONVERSION SYSTEMS: COAL DISSOLUTION PHENOMENA Interim Report, Apr. - Dec. 1978

C. Y. Wen and K. W. Han 1978 199 p refs

(Contract EX-76-C-01-2274)

(FE-2274-7) Avail: NTIS HC A09/MF A01

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The bituminous coal dissolution was investigated in order to develop information which would be useful in the design and scale up considerations for a commercial liquefaction plant. The experiment data were derived from pilot plants using various coal liquefaction processes. The data were analyzed in order to better understand the phenomena which occur in the preheater and reactor sections during the liquefaction of coal. Two different stages were found to exist in the coal dissolution reactions. In the initial stage of coal dissolution, a first order reaction scheme was proposed, whereby coal undergoes a fast thermal reaction producing preasphaltene as the predominant product. In the second stage of coal dissolution, a slower first order rate expression was proposed in which the preasphaltene was converted to benzene solubles with subsequent rehydrogenation of the coal derived solvent. DOE

N80-25482# Dynatech R/D Co., Cambridge, Mass.
LIQUID FUELS PRODUCTION FROM BIOMASS, NO. 7
Progress Report, 1 Jan. - 31 Mar. 1979
J. E. Sanderson, D. V. Garcia-Martinez, G. S. George, J. J. Dillon, and D. L. Wise 1979 86 p refs
(Contract EG-77-C-02-4388)
(COO-4388-7) Avail: NTIS HC A05/MF A01

The process of converting biomass into liquid hydrocarbon fuels is discussed with reference to another process which ferments marine algae to acetic acid. The conditions under which substrates other than marine algae may be converted in good yield to organic acids are also reported. Results indicate that the electrolysis of organic acids produced by fermentation to liquid hydrocarbon fuels operates with a favorable energy balance of 6/1 based on the applied potential and over 10/1 based on the working potential. DOE

N80-25483# Adelphi Univ., Garden City, N. Y.
FEASIBILITY STUDY OF USING A COAL/WATER OIL EMULSION AS A CLEAN LIQUID FUEL Final Report
Feb. 1980 43 p
(Contract EX-76-S-01-2437)
(FE-2437-T1-Add) Avail: NTIS HC A03/MF A01

The combustion, rheology, and settling of various concentrations of No. 6 oil emulsions and slurries were compared with various average particle sizes of coal. The No. 6 oil and a slurry of 40 percent coal, 60 percent oil with an average coal particle size anti $x = 56.6$ microns were burned. Pendulum, and viscosity data is presented on four different concentrations of coal, oil and water with four different particle size distributions. Infrared radiation tests were performed on No. 6 oil and a coal/No. 6 oil slurry, and for a comparison on No. 4 oil and a coal/No. 4 oil emulsion. DOE

N80-25485# Battelle Pacific Northwest Labs., Richland, Wash.
THERMOCHEMICAL CONVERSION OF BIOMASS: AN OVERVIEW OF R AND D ACTIVITIES SPONSORED BY THE BIOMASS ENERGY SYSTEMS BRANCH OF DOE
G. F. Schiefelbein, L. J. Sealock, Jr., and S. Ergun Oct. 1979 18 p Prepared in cooperation with California Univ., Lawrence Berkeley Lab.
(Contract EY-76-C-06-1830)
(PNL-SA-8266) Avail: NTIS HC A02/MF A01

The mission is to develop competitive processes for the conversion of renewable biomass resources into clean fuels and chemical feedstocks which can supplement those produced from conventional sources were developed. A description of thermochemical conversion program areas and an overview of specific thermochemical conversion projects, are presented. DOE

N80-25486# Garrett Energy Research and Engineering, Inc., Claremont, Calif.
CONVERSION OF BIOMASS MATERIALS INTO GASEOUS PRODUCTS. OPERATION OF THE POU Final Report
Donald E. Garrett and Ritchie D. Mikesell Sep. 1979 431 p refs
(Contract EY-76-C-03-1241)
(SAN-1241-3) Avail: NTIS HC A19/MF A01

Initial work on a two foot diameter, single hearth reactor provided comprehensive design data through an examination of

the pertinent variable over a fairly wide range of operations. Kinetic and dynamic models were obtained for each of the reaction stages that would occur within a multiple hearth reactor. This data led to the design and construction of a process development unit (PDU) which consisted of four, four foot diameter hearths capable of processing six wet tons (50% moisture), or three dry tons of biomass per day through the steps of preheating, drying, pyrolysis, combustion, and gasification. Operation of the PDU included 10 to 20 runs on each of these steps, and work was completed with a five day, 24 hour per day, continuous operation. Process design, capital and operating costs, and an economic analysis based on this data indicated that no cost, moisture manure could produce about a 300 Btu gas with a breakeven price of \$4 per million Btu's in a 100 dry ton per day unit and \$2.40 per million Btu's in a 300 tons per day unit. DOE

N80-25488# Brookhaven National Lab., Upton, N. Y. Process Sciences Div.
FLASH HYDROLYSIS OF COAL Quarterly Report, 1 Jan. - 31 Mar. 1979
Meyer Steinberg and Peter Fallon Jun. 1979 104 p refs
(Contract EY-76-C-02-0016)
(BNL-51052: QR-8) Avail: NTIS HC A06/MF A01

Process chemistry and design information were obtained on the flash hydrolysis process. The design, construction, and operation of a 1 lb/hr downflow entrained tubular reactor system were included. The effect of process variables such as temperature, pressure, feed rates, residence time, coal type and feed gas composition were studied. R.C.T.

N80-25471# Lummus Co., Bloomfield, N. J.
DEVELOPMENTAL RESEARCH PROGRAM FOR CLEAN INDUSTRIAL AND TRANSPORTATION FUELS FROM COAL: MILESTONE REPORT ON COMPARISON OF CATALYSTS, MARCH 1979
H. D. Schindler and R. H. Long Jul. 1979 36 p refs
(Contract EX-76-C-01-2514)
(FE-2514-M4) Avail: NTIS HC A03/MF A01

Employing a reference cobalt-molybdate 1/16 in extrudate catalyst, a short series of operations were conducted to obtain activity and performance data for comparison with the nickel-molybdenum catalyst previously utilized. Two sets of conditions were investigated as follows: temperatures - 830 and 850 F, pressures - 2100 and 2700 psig, coal space rates - 1.6 and 2.5 lbs coal/hr/lb catalyst, volumetric liquid recycle/fresh feed ratios - 1.5 and 0.8, and coal content of paste - 30 and 35 weight percent. Catalyst ages for the two sets of conditions were 170.4 and 275 lbs coal per lb of catalyst, respectively. The yields and product quality comparisons of the two catalysts at equivalent catalyst ages indicated very little difference in performance. DOE

N80-25472# Institute of Gas Technology, Chicago, Ill.
PREPARATION OF A COAL CONVERSION SYSTEMS TECHNICAL DATA BOOK Quarterly Report, 1 Nov. 1978 - 31 Jan. 1979
Nov. 1979 175 p refs
(Contract EX-76-C-01-2286)
(FE-2286-44) Avail: NTIS HC A08/MF A01

The results of calculations of ammonia and hydrogen sulfide partial pressures in NH₃-H₂S-H₂O subsystem are composed. Results from application of a calorific value formula to chars are also presented. Enthalpies of distillate fractions of various syncrudes are reported along with the comparison of the experimental data with correlations developed for estimating the enthalpies of petroleum fractions. Combustion characteristics of SRC-I liquid are also described. Fixed bed gasification of coal is reviewed. For coal pyrolysis results of investigations of relations between tar-plus-light oil yield in Fischer Assay and various coal rank parameters are described. Carbon deposition boundaries are shown for temperatures between 600 F and 2400 F and pressures ranging between 15 psia and 1000 psia. Two types of carbon were considered graphite and non ideal. DOE

N80-25473# Gulf Research and Development Co., Pittsburgh, Pa.

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RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE MOTOR FUELS

Quarterly Report, Jun. - Aug. 1979

D. C. Succop and F. E. Wynne Dec. 1979 22 p refs
(Contract EX-76-C-01-1800)

(FE-1800-42) Avail: NTIS HC A02/MF A01

Coal slurry heating for hydroliquefaction process is described. Results are reported for Taitel/Dukler predicted flow regimes.

DOE

N80-25474# Exxon Research and Engineering Co., Florham Park, N.J.

EDS COAL LIQUEFACTION PROCESS DEVELOPMENT, PHASE 4 Interim Report

Sep. 1979 92 p ref Sponsored in part by Carter Oil Co., Elec. Power Res. Inst., Japan Coal Liquefaction Develop. Co., Phillips Petrol. Co., and Atlantic Richfield Co.

(Contract EF-77-A-01-2893)

(FE-2893-33) Avail: NTIS HC A05/MF A01

A maximum liquids case which utilizes steam reforming of methane, ethane, and propane for hydrogen generation is described. The FLEXICOKING of vacuum bottoms is utilized to generate low Btu gas fuel for the plant. Main plant fuel utilized as onsite fuel and fuel to the offsite boilers is low Btu gas (LBG). A vaporized C3 LPG backup fuel system is provided in the steam reforming furnaces. Besides LBG, Illinois no. 6 coal can be used in the offsite boilers to generate steam. The short term onsite fuel system variability is accommodated by varying the coal firing rate in the offsite boilers. Longer term variability in onsite fuel demand is accommodated by varying the operations in FLEXICOKING. The plant utilizes LBG for pilots to protect against flameout in all onsite process furnaces, except steam reforming. Pilots are not needed in steam reformers because of the multiplicity of burners. Use of LBG for pilot gas avoids the consumption of high value LPG.

DOE

N80-25475# Exxon Research and Engineering Co., Florham Park, N.J.

EDS COAL LIQUEFACTION PROCESS DEVELOPMENT, PHASE 4. EDS COMMERCIAL PLANT STUDY DESIGN UPDATE, OFFSITE DESIGN BASIS: ILLINOIS COAL MARKET FLEXIBILITY SENSITIVITY CASE Interim Report

Jul. 1979 66 p Sponsored in part by Carter Oil Co., Elec. Power Res. Inst., Japan Coal Liquefaction Develop. Co., Phillips Petrol. Co., and Atlantic Richfield Co.

(Contract EF-77-A-01-2893)

(FE-2893-37) Avail: NTIS HC A04/MF A01

The offsite design basis for the EDS commercial plant study design update Illinois coal market flexibility sensitivity case is presented. The use of partial oxidation to produce H₂ and sell the C₂ gas which was processed by steam reforming was evaluated.

DOE

N80-25476# Bituminous Coal Research, Inc., Monroeville, Pa. TEST AND EVALUATE THE TRI-GAS LOW BTU COAL GASIFICATION PROCESS Quarterly Report, Oct. - Dec. 1979

Jan. 1980 20 p refs

(Contracts ET-78-C-01-2798)

(FE-2798-74) Avail: NTIS HC A02/MF A01

Three tests were conducted in the TRI-GAS PEDU, each in the process design mode. Smooth transfer of both char and gas between reactors was accomplished. Several minor equipment problems were encountered which were alleviated through modifications.

DOE

N80-25478# National Technical Information Service, Springfield, Va.

SYNTHETIC FUELS: METHANE, VOLUME 1. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - 1977

Diane M. Cavagnaro Feb. 1980 212 p

(PB80-805245) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

Reports from worldwide research are cited covering the production of methane. The citations pertain to the manufacturing processes and equipment process performance, economics, and combustion technology. The production of methane from wastes, especially agricultural wastes, are covered extensively. This updated bibliography contains 205 abstracts, none of which are new entries to the previous edition. GRA

N80-25479# National Technical Information Service, Springfield, Va.

SYNTHETIC FUELS: METHANE, VOLUME 2. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1978 - Jan. 1980

Diane M. Cavagnaro Feb. 1980 142 p Supersedes NTIS/PS-79/0030; NTIS/PS-78/0054

(PB80-805252; NTIS/PS-79/0030; NTIS/PS-78/0054) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The production of methane is discussed in this bibliography of worldwide journal articles. The reports pertain to the manufacturing processes, equipment used, performance, economics, and combustion technology. Many of the studies cover the production of methane from wastes, especially agricultural wastes. This updated bibliography contains 135 abstracts, 76 of which are new entries to the previous edition. GRA

N80-25707# Case Western Reserve Univ., Cleveland, Ohio. Dept. of Metallurgy.

HYDROGEN SULPHIDE STRESS CORROSION CRACKING IN MATERIALS FOR GEOTHERMAL POWER Final Report

A. R. Troiano, R. F. Hehemann, and J. A. Peterson Aug. 1979 91 p refs Prepared in cooperation with Armco Steel Corp., Middletown, Ohio

(Contract EY-76-S-02-2602)

(COO-2602-7) Avail: NTIS HC A05/MF A01

Two point bent beam, NACE tensile, C-Ring and DCB stress intensity type specimens were employed to examine a series of steels SSC resistance in the standard NACE solution and in several modifications pertinent to geothermal environments. Where direct comparisons were possible, the different types of tests qualitatively ranked the alloys in the same order. These steels all exhibit a 15 to 20 percent higher yield strength break-point at service temperatures near 300 to 450 F and/or at pH values approaching 7. Several versions of well head equipment type steels with adequate hardenability have demonstrated satisfactory SSC threshold stress values at adequate yield strengths. The austenitic stainless steels displayed the usual sensitivity to chlorides and cold work. Overaging of several of the age hardenable variety improved the resistance to SSC with only a moderate reduction in strength. Two ferritic stainless steels have shown a higher threshold stress than their commonly employed counterpart. Examination of C-ring specimens cut from commercially treated casing and tubing clearly indicated the advantages of a tempered martensitic and the very real potential for temper embrittlement. DOE

N80-25764*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ECONOMIC BASELINES FOR CURRENT UNDERGROUND COAL MINING TECHNOLOGY Final Report

William B. Mabe 15 Dec. 1979 65 p refs

(Contracts NAS7-100; ET-75-1-01-9036)

(NASA-CR-163259; JPL-Pub-79-122)

Avail: NTIS HC A04/MF A01 CSCL 081

The cost of mining coal using a room pillar mining method with continuous miner and a longwall mining system was calculated. Costs were calculated for the years 1975 and 2000 time periods and are to be used as economic standards against which advanced mining concepts and systems will be compared. Some assumptions were changed and some internal model stored data was altered from the original calculations procedure chosen, to obtain a result that more closely represented what was considered to be a standard mine. Coal seam thicknesses were varied from one and one-half feet to eight feet to obtain the cost of mining coal over a wide range. Geologic conditions were selected that had a minimum impact on the mining productivity. E.D.K.

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N80-25766# Sandia Labs., Albuquerque, N. Mex.
DRILLING HORIZONTAL HOLES IN COAL BED FROM THE SURFACE WITH WATER JETS
Marvin Timmerman and Clark R. Barker 1980 14 p refs
Presented at 5th Symp. of the Rocky Mountain Fuel Soc., Salt Lake City, 21 Feb. 1980
(Contract EY-76-C-04-0789)
(SAND-80-0057C; CONF-800229-1) Avail: NTIS HC A02/MF A01

A drilling system, using high pressure water jets is considered. The system could have important applications both in methane drainage and recovery and in well linking. DOE

N80-25768# New Mexico Inst. of Mining and Technology, Socorro. Petroleum Recovery Research Center.
DISPLACEMENT OF OIL BY CARBON DIOXIDE Annual Report, Oct. 1978 - Sep. 1979
F. M. Orr, Jr. and J. J. Taber Feb. 1980 72 p refs
(Contract DE-AC21-78MC-03260)
(DOE/MC-03260/4) Avail: NTIS HC A04/MF A01

A sophisticated apparatus for measurements of phase behavior and fluid properties of mixtures of CO₂ and crude oils was designed and built. The experimental setup permits a variety of multiple contact phase behavior experiments which explore mixture compositions which realistically model displacement processes at temperatures and pressures of interest. Gas chromatography techniques used to characterize crude oils was extended to allow analyses of mixtures containing CO₂ and hydrocarbons ranging from methane to molecules as heavy as tetracontane (C₄₀). A qualitative analysis is given for the complex phase behavior observed for mixtures of CO₂ and crude oils at temperatures below 50°C and the effects of phase behavior on expected displacement efficiency are calculated. The results indicate that relatively small changes in pressure can be expected to have a strong influence on the efficiency of CO₂ displacements of crude oils. DOE

N80-25770*# New Mexico Univ., Albuquerque. Technology Applications Center.
REMOTE SENSING APPLIED TO PETROLEUM AND MINERAL EXPLORATION. CITATIONS FROM THE INTERNATIONAL AEROSPACE ABSTRACTS DATA BASE Progress Report, 1973 - Dec. 1979
Robert W. Gonzales Feb. 1980 34 p Sponsored by NASA and NTIS
(NASA-CR-163311; PB80-804800) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 081

The use of LANDSAT Satellites and other remote sensing methods used in petroleum and mineral exploration is discussed in 118 abstracts. Topics covered include mineral deposits, oil exploration, petroleum operations, geomorphology, resources management, thematic mapping, photogeology, photomapping and photointerpretation and imaging and digital techniques. GRA

N80-25797# TRW Defense and Space Systems Group, Redondo Beach, Calif. Applied Technology Div.
POTENTIAL APPLICATIONS OF BIOMASS TECHNOLOGY AT NATIONAL TECHNOLOGY LABORATORIES AND MISSISSIPPI ARMY AMMUNITION PLANT Final Report, 30 Jun. 1978 - 29 Feb. 1980
E. P. Motley, B. G. Cruz, L. McClanathan, and J. A. Anastasi Feb. 1980 211 p
(Contract DAAK10-78-C-0268)
(AD-A082756; TRW-33682) Avail: NTIS HC A10/MF A01 CSCL 21/4

This study was initiated to evaluate the feasibility of utilizing a common biomass (energy wood) system to produce energy for use at NASA's National Space Technology Laboratories (NSTL) and the proposed Mississippi Army Ammunition Plant (MSAAP) to be established at NSTL. The study investigated: the form and quantity of energy required at NSTL and MSAAP; the amount and characteristics of the available energy wood supply; the conversion technology; the legal and environmental issues associated with the operation of an energy wood plant; and the economics of an energy wood plant. GRA

N80-25859# Sandia Labs., Albuquerque, N. Mex.
MAGMA ENERGY: A FEASIBLE ALTERNATIVE?
J. L. Colp 1979 21 p refs Presented at Conf. on Long-Term Energy Resources, Montreal, Canada, 3 Dec. 1979
(Contract EY-76-C-04-0789)
(SAND-80-0309C; CONF-791216-2) Avail: NTIS HC A02/MF A01

A program to investigate the scientific feasibility of extracting energy directly from deeply buried circulating magma sources is described. The following program tasks are discussed: sources location and definition, source tapping, magma characterization, magma/material compatibility, and energy extraction. DOE

N80-25863# Completion Technology Co., Houston, Tex.
PERFORMANCE EVALUATION OF MAGMA POWER COMPANY'S REINJECTION WELL NO. 46-7 AT THE EAST MESA KGRA, CALIFORNIA
R. M. Jorda Feb. 1980 35 p refs Sponsored in part by Sandia Labs., Albuquerque, N. Mex.
(Contract EY-76-C-04-0789)
(SAND-79-7127) Avail: NTIS HC A03/MF A01

Water has cooled to 100 F to simulate total heat extraction and then tested using membrane filter flow procedures. The cooled water contains particles which are in the high colloid size range, and formation impairment by these particles is unlikely. There is evidence that acid soluble corrosion products and calcium compounds constitute about two thirds of the particulates, and that the acid insoluble residue contains precipitated silica, insoluble corrosion products, and possibly formation fines carried in the produced water. Under stabilized conditions, the suspended solids content of the water is less than 2 parts per million. However, during the frequent production well start ups, a higher concentration of suspended solids is carried in the produced water and into the injection well, conceivably augmenting fill in the injector. But most likely, fill occurs when the injection well surges during shut-downs, because of inadequate sand control in the well completion. At the time of the test, the injection well was found to be severely impaired. DOE

N80-25865# Battelle Pacific Northwest Labs., Richland, Wash.
LONG-TERM SUPPLY CURVES FOR GEOTHERMAL ENERGY: THE IMPACTS OF TECHNOLOGY
L. L. Fassbender and C. H. Bloomster Jan. 1980 94 p refs
(Contract EY-76-C-06-1830)
(PNL-3072) Avail: NTIS HC A05/MF A01

Near term and long term supply curves are presented for electric applications of geothermal energy. The GEOCOST model was used to determine the present and future energy production costs for identified high temperature and intermediate temperature hydrothermal resources. The long term supply curves illustrate the potential shifts in the near-term supply curve which would result from certain technology improvements currently being pursued. Curves were drawn to show the impacts of individual technology improvements and also to show the cumulative impacts of combinations of technological advances expected to be achieved by 1982 and 1985. Successful completion of all the programs evaluated would result in a cumulative cost reduction of \$90 billion (not discounted) in electrical generating costs from the identified hydrothermal resources. DOE

N80-25868# Aerojet Energy Conservation Co., Sacramento, Calif.
MULTI-USE GEOTHERMAL ENERGY SYSTEM WITH AUGMENTATION FOR ENHANCED UTILIZATION. A NON-ELECTRIC APPLICATION OF GEOTHERMAL ENERGY IN SUSANVILLE, CALIFORNIA Quarterly Technical Report, 1 Apr. - 30 Jun. 1978
G. R. Cunningham and G. K. Olson 1978 56 p refs
(Contract ET-78-C-03-1740)
(SAN-1740-2) Avail: NTIS HC A04/MF A01

The economic and technical feasibility of using the low to moderate temperature geothermal resource in the Susanville anomaly in a district heating/cooling system for public or private users and in a Park of Commerce developed in conjunction with the resources development is analyzed. Design approaches were studied which permit economical utilization of the resource

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regardless of the outcome of the drilling. The system selected depends on the result of the drilling program. A data base is presented on systems for the temperature range from 150 to 239 F. Based on a predicted fuel inflation rate of 7% and a municipal bond interest rate of 10%, the development of the Susanville Geo-Heating District is economically feasible over the entire range of anticipated reservoir conditions. Under conditions of high well costs (\$130 to \$175 thousands dollars per well) and low resources temperature (150 to 165 F), economic and operational advantages can be shown for the use of heat pumps to augment the resource temperature. DOE

N80-25878# Battelle Pacific Northwest Labs., Richland, Wash. **SITING SMALL WIND TURBINES** W. T. Pennell and H. L. Wegley Mar. 1979 16 p refs Presented at the Workshop on Wind Energy Appl. in Agr., Ames, Iowa, 15-16 May 1979.

(Contract EY-76-C-06-1830)

(PNL-SA-7603) Avail: NTIS HC A02/MF A01

A procedure is presented for choosing the best available site for a wind turbine. A method for estimating the pertinent wind characteristics once the site is chosen is also described. In some cases, extensive onsite measurements may be required before an accurate analysis of turbine performance can be made. DOE

N80-25908# NEUS, Inc., Santa Monica, Calif. **BIORESOURCES DIGEST, A JOURNAL ON BIOMASS UTILIZATION, VOLUME 1, NO. 1**

Harry Sobel, ed. Jan. 1979 90 p refs

(Grant NSF PFR-77-12500)

(PB80-140973; NSF/RA/790088)

Avail: NTIS

HC A05/MF A01 CSCL 10A

Biomass utilization, enzyme technology as it relates to it, renewable resources, industrial chemicals, fuels and energy from biomass biological nitrogen fixation, and biophotolysis are considered with energy derived from biomass. Benefits derived from stored solar energy collected from forests are discussed along with a theory and methodology for quantifying them. Alternatives to the presently-utilized processes for large-scale regeneration of ATP and ADP as required by biosynthetic processes are given. Production and collection of biomass and conversion of biomass are discussed. GRA

N80-25909# NEUS, Inc., Santa Monica, Calif. **BIORESOURCES DIGEST: A JOURNAL ON BIOMASS UTILIZATION, VOLUME 1, NO. 4**

Harry Sobel, ed. Oct. 1979 61 p refs

(Grant NSF PFR-77-12500)

(PB80-140981; NSF/RA-790297)

Avail: NTIS

HC A04/MF A01 CSCL 10A

Information on various aspects of biomass utilization is presented. Recent biomass related grants are abstracted and listed giving the title, sponsor, organization, grant number and project investigator. Articles are presented on thermochemical conversion of biomass to gasoline, predicting solar energy fluxes in polluted urban areas, principles, equipment and operation of two lab-scale biodigesters, energy farming in New Zealand, and a general procedure for converting latex-bearing crops to glucose, lignin and rubber. Also included are miscellaneous documents received and a report on forestation as a renewable energy source and one on the photoproduction of hydrogen. GRA

N80-25929# Department of Energy, Washington, D. C. Assistant Secretary for Resource Applications.

ENVIRONMENTAL ASSESSMENT: GEOTHERMAL ENERGY GEOPRESSURE SUBPROGRAM. DOE SWEET LAKE NO. 1, CAMERON PARISH, LOUISIANA

Feb. 1980 245 p refs

(DOE/EA-0065) Avail: NTIS HC A11/MF A01

Geothermal geopressure resource feasibilities in the Louisiana-Texas Gulf Coast region were examined. An environmental assessment was prepared to evaluate environmental effects of test site construction, of geothermal fluid wells for intermittent production testing. Physical and chemical composition of the fluids, their temperature, the nature of flow, fluid disposal

techniques, and the reliability and performance of equipment were studied. Biological surveys were prepared of ecosystem cultural alterations due to the construction of the geothermal geopressure test facilities. R.G.D.

N80-26138# Wisconsin Univ., Madison. Dept. of Nuclear Engineering.

SUMMARY OF THE FUSION-FISSION HYBRID FUEL CYCLE ANALYSIS (TRITIUMLESS HYBRIDS)

G. A. Moses, comp. Dec. 1979 34 p refs

(Contract EY-76-S-02-2272)

(UWFD-337) Avail: NTIS HC A03/MF A01

Fusion-fission hybrid reactors were used for the fusion to impact the energy productions. The elimination of the tritium breeding function in the fusion blanket and its effect on the early introduction of hybrid reactors are discussed. DOE

N80-26426*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

IMPROVED PFB OPERATIONS: 400-HOUR TURBINE TEST RESULTS

R. J. Rollbuhler, S. M. Benford, and G. R. Zellars 1980 23 p refs Presented at 6th Intern. Conf. on Fluidized Bed Combust., Atlanta, 9-11 Apr. 1980; sponsored by DOE, Elec. Power Res. Inst., EPA and TVA

(NASA-TM-81511; E-260) Avail: NTIS HC A02/MF A01 CSCL 11F

A pressurized fluidized bed (PFB) coal-burning reactor was used to provide hot effluent gases for operation of a small gas turbine. Preliminary tests determined the optimum operating conditions that would result in minimum bed particle carryover in the combustion gases. Solids were removed from the gases before they could be transported into the test turbine by use of a modified two stage cyclone separator. Design changes and refined operation procedures resulted in a significant decrease in particle carryover, from 2800 to 93 ppm (1.5 to 0.05 grains/std cu ft), with minimal drop in gas temperature and pressure. The achievement of stable burn conditions and low solids loadings made possible a 400 hr test of small superalloy rotor, 15 cm (6 in.) in diameter, operating in the effluent. Blades removed and examined metallographically after 200 hr exhibited accelerated oxidation over most of the blade surface, with subsurface alumina penetration to 20 micron m. After 400 hours, average erosion loss was about 25 micron m (1 mil). Sulfide particles, indicating hot corrosion, were present in depletion zones, and their presence corresponded in general to the areas of adherent solids deposit. Sulfidation appears to be a materials problem equal in importance to erosion. A.R.H.

N80-26480*# National Aeronautics and Space Administration. Pasadena Office, Calif.

AUTOCATALYTIC COAL LIQUEFACTION PROCESS Patent Application

Shaik A. Qader, inventor (to NASA) (JPL) Filed 28 Jan. 1980 31 p Sponsored by NASA

(NASA-Case-NPO-14876-1; US-Patent-Appl-SN-116310) Avail: NTIS HC A03/MF A01 CSCL 21D

An improved process is disclosed for liquefying coal in which coal minerals at high content are utilized as a hydrocracking catalyst. A slurry of 10 to 60% by weight of coal in recycled liquefied coal product which contains 15% to 30% by weight of coal minerals, is pressurized with excess hydrogen to a pressure of 2,000 to 4,000 psi and heated to a temperature of 450 to 550 C. The coal minerals autocatalytically convert coal solids to a low viscosity liquid product and to gas product in high yields while reducing oxygen, nitrogen and sulfur content of the coal product as compared to other coal liquefaction processes under development. NASA

N80-26481# Pittsburgh Energy Technology Center, Pa. **THE 2ND INTERNATIONAL SYMPOSIUM ON COAL-OIL MIXTURE COMBUSTION, VOLUME 2**

1979 689 p refs Symp. held at Danvers, Mass., 27 - 29 Nov. 1979 Sponsored by DOE 2 Vol.

(CONF-791160-Vol-2) Avail: NTIS HC A99/MF A01

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Technologies associated with coal oil mixtures (COM) are assessed. Production of COM, including techniques as well as equipment used, properties of the mixture, and additives needed for stabilization are discussed. Combustion efficiencies and byproducts are also studied

N80-26462# Pennsylvania State Univ., University Park. Mineral Processing Section.

GRINDING OF COAL IN OIL

P. T. Luckie and P. S. Bagga /*n* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 20 p refs

Avail: NTIS HC A99/MF A01

Grinding kinetic parameters were determined in various fluids for three typical coals. It was found that the breakage action parameters for all of the coals did not change with environment as previously thought. Measurements of power draw of the test batch mill were also made. The implications of these findings to industrial results are discussed. Fuel oil as a grinding fluid appears to create a more sensitive tumbling action condition, and hence, lifter configuration and operational critical speed may be more critical. In addition, heating the fuel oil may achieve results similar to grinding the coal in water. E.D.K.

N80-26463# Transamerica Delaval, Inc., Crystal River, Fla. Imo Pump Div.

HANDLING COAL OIL MIXTURES WITH POSITIVE DISPLACEMENT PUMPS

Timothy W. Mabes, Sr. /*n* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 5 p

Avail: NTIS HC A99/MF A01

The use of two and three screw positive displacement pumps for use with coal oil mixtures is discussed. Particular attention is given to both the location of wear that occurs within these pumps as well as its effect on volumetric performance. Consideration is also given to the economics involved for coal oil mixture pump packages versus conventional fuel oil pump packages. E.D.K.

N80-26464# Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.

GRINDING OF COAL-IN-OIL SLURRIES

O. Trass and G. Papachristodoulou /*n* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 28 p refs Prepared in cooperation with General Comminution Inc., Don Mills, Ontario

Avail: NTIS HC A99/MF A01

Grinding of coal in fuel oil for COM preparation is simpler and may give better slurry properties than dry grinding followed by dispersion in oil. A 42 weight percent slurry of 600 to 840 micrometer monosize of hard Pittsburgh coal in No. 2, No. 4, and No. 6 fuel oils was ground with the Szego mill. Particle size distributions at different residence times are reported down to a 10 micrometer mean size, along with energy consumption data. Low mill hold ups and high rotational speeds enhanced the rate of grinding. E.D.K.

N80-26465# New England Power Service Co., Westborough, Mass.

DEVELOPMENT OF STANDARDS FOR COAL-OIL MIXTURES

Sushil K. Batra and Roy C. Kurtzrock (Pittsburgh Energy Technol. Center) /*n* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 6 p

Avail: NTIS HC A99/MF A01

As the coal oil mixture technology nears its commercialization, there is a need for uniform performance criteria, testing procedures, and quality control for trouble free and reliable utilization of this technology. Also, various terminologies associated with this technology need to be defined more precisely to have more meaningful application. With this in view, a Standards and

Practice Committee was formed to establish criteria for process equipment, instrumentation, characterization of the coal oil mixtures, and combustion characteristics with respect to industrial and utility application of coal oil mixtures, as well as to develop guidelines and procedures considering feasibility from the standpoints of both cost and engineering. The goals and objectives of this committee with special reference to the various efforts underway in the area of development of standards and procedures are presented. E.D.K.

N80-26466# Dravo Corp., Pittsburgh, Pa.

PROGRESS IN DEVELOPING ULTRAFINE COAL-OIL MIXTURES

F. R. Sell and J. W. Cochran (Florida Power Corp., Crystal River) /*n* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 23 p refs

Avail: NTIS HC A99/MF A01

A comparison between ultrafine COM and 200 mesh COM shows that ultrafine COM has many potential advantages, such as low settling rate, minimization of equipment erosion and abrasion, reduction of boiler ash related problems, and beneficiation potential. Despite high grinding costs, the total cost of ultrafine COM fuel compares favorably with 200 mesh/additive COMs. Work on the fluid mill grinding approach for preparing ultrafine (100% minus 325 mesh) COM was continued. A technical development program to address energy consumption, mill wear, and scale-up of COM fuels for U.S. and foreign user evaluations was created. Plans are discussed concerning the building of a COM preparation plant for producing large quantities of demonstration fuel. E.D.K.

N80-26467# Massachusetts Univ., Amherst.

COAL-OIL MIXTURES 4: SEDIMENTATION AND SUBSIDENCE STUDIES OF THE STABILITY AND STRUCTURE OF COAL-OIL MIXTURES

R. L. Rowell, B. J. Marlow, T. S. Tsai, Sushil K. Batra, and J. R. Pitman (New England Power Co., Salem, Mass.) /*n* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 21 p refs Sponsored by Elec. Power Res. Inst. Prepared in cooperation with New England Power Service Co., Westborough, Mass.

Avail: NTIS HC A99/MF A01

The limits of the sedimentation column method are explored and the techniques of sedimentation and subsidence are applied to long term studies of the stability and structure of coal oil mixtures. Significant environmental effects are considered, especially the effect of carbon dioxide as a blanketing gas. It is shown that sedimentation and subsidence measurements are a sensitive probe of the stability and structure of coal oil fluids. The importance of the concept of a critical solids concentration is shown and model studies of stabilized and unstabilized COM at high concentration are given. Preliminary test results of slurry samples from various locations in the system are presented and compared to samples produced at the laboratory. The standard tests include determination of solid concentration, particle size distribution, sedimentation column drain time and sedimentation column bottom compaction. E.D.K.

N80-26468# Tufts Univ., Medford, Mass. Dept. of Chemical Engineering.

CHARACTERIZATION AND STRUCTURAL STUDIES OF THE VARIOUS TYPES OF COM

G. D. Botsaris, Y. M. Glazman, M. Adams-Viola, P. S. Goldsmith, and R. J. Haber /*n* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 37 p refs

(Contract DE-ASO1-78ET-10748)

Avail: NTIS HC A99/MF A01

The surface properties of coal, specifically its philicity or oleophilic/hydrophilic nature, are important parameters governing both the aggregative and sedimentative stability, the structure, and the rheology of COM. Moreover, it is contended that the surface properties of the coal are not only important in COM which contain additives but also in those which do not. The

rheology and stability properties of various COM formulations prepared with different coals were investigated. Three parameters, a sedimentation number, an aggregation number, and a gelation number were developed to concisely reflect the results of the rheological and stability tests. An attempt was made to develop a model to explain the effect of additives on the structure, stability, and rheological properties of COM prepared from coals having different surface properties. E.D.K.

N80-28469# New England Power Service Co., Westborough, Mass.

FEASIBILITY STUDY OF USING A COAL/OIL/WATER EMULSION AND COAL/OIL MIXTURES AS CLEAN LIQUID FUELS 2

S. Y. Tsai, S. K. Batra, John P. Dooher (Adelphi Center for Energy Studies), Richard W. Genberg (Adelphi Center for Energy Studies), Sung Moon (Adelphi Center for Energy Studies), Donald Wright (Adelphi Center for Energy Studies), Steven E. Jakatt (Adelphi Center for Energy Studies), Barbara J. Gilmartin (Adelphi Center for Energy Studies), Donald Albert (Adelphi Center for Energy Studies), and Carl Denauski (Adelphi Center for Energy Studies) *In* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 13 p

(Contract DE-AC22-79PC-10328)

Avail: NTIS HC A99/MF A01

The rheological and combustion properties of coal-water-oil mixtures were investigated and the use of alkaline additives to remove the sulfur oxide gases were studied. Results on stability and pumpability indicate that mixtures of 50% by weight of coal and stoichiometric concentrations of alkaline absorbents are pumpable. Correlation between viscometer data and pumping data follows a power law behavior for these mixtures. Thermal efficiencies are about the same as for pure oil. Combustion efficiencies are approximately 97%. It is possible to remove in a small scale combustion from 50 to 80% of the sulfur dioxide gases. E.D.K.

N80-28470# Germantown Labs., Inc., Philadelphia, Pa.
THE PRODUCTION OF STABLE COAL-OIL MIXTURES USING HIGH INTENSITY MECHANICAL MIXING DEVICES

C. S. Stokes and N. H. Cherry *In* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 28 p ref

(Contract DE-AC77-ET-10634)

Avail: NTIS HC A99/MF A01

The use of four different commercially available high intensity mechanical mixing devices to produce stable coal-oil-water mixtures were investigated. The four types of mixing devices used included a Gaulin Corporation Model 15 Homogenizer, a Sonic Corporation Triplex 1000A, a Branson Sonic Power Model 190 Ultrasonic Processing System, and a Total (French) System. The stability of a coal-oil-water mixture up to 45% coal loading was evaluated by a K-scan unit. A detailed description of the parameters and operating conditions for producing the stable mixtures using the four different units is presented. The Gaulin unit proved to be the most versatile unit producing stable 45% coal loaded materials using single pass operation. The unit also produced relatively stable 30% coal loaded mixtures using a recycle mode. The Sonic unit and the Branson equipment produced similar stable emulsions, and either apparatus could be used for 45% coal loaded mixtures. The Total system produced only stable emulsions using 45% coal loaded mixtures under recycle operation. M.G.

N80-28471# Adelphi Univ., Garden City, N. Y.
RHEOLOGICAL PROPERTIES OF SOLVENT REFINED COAL-OIL MIXTURES

John P. Dooher, E. P. Foster (Air Products/Wheelabrator-Frye Joint Venture), A. S. Gudta (Air Products/Wheelabrator-Frye Joint Venture), and C. M. Kelly *In* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 p 1-14 Prepared in cooperation with Villanova Univ., Pa.

(Contract DE-AC05-78OR0-3054)

Avail: NTIS HC A99/MF A01

The rheological properties and stability of various mixtures of solvent refined coal (SRC) solid in No. 6 oil and one mixture with No. 5 oil are investigated. The apparent viscosity was measured as a continuous function of shear rate by a rotoviscometer. Suspension settling stability was assessed by using a pendulum-period technique. The mixtures were found to differ somewhat from coal-oil mixtures of equivalent composition. SRC solid-oil mixtures are non-Newtonian, with an apparent viscosity significantly higher than coal-oil mixtures of equivalent composition. Except for very finely divided SRC particles at low shear rate, all mixtures tested are considered pumpable. There is apparently no significant reaction between SRC solid and the oil, as indicated by a lack of change of viscosity with time. Mixtures of SRC solid and oil alone settled somewhat. Mixtures stabilized by emulsification with water or addition of surfactant are felt to be sufficiently stable for commercial use. Of the mixtures tested, an emulsion of 47 wt% SRC solid, 47 wt% No. 6 oil, and 6 wt% water is considered the best. M.G.

N80-28472# Pittsburgh Energy Technology Center, Pa.
THE ROLE OF COAL AND OIL CHARACTERISTICS IN THE STABILITY OF COAL-OIL MIXTURES

J. M. Ekmann and D. Bienstock *In* its the 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 30 p refs

Avail: NTIS HC A99/MF A01

The effect of coal type and oil type on the settling behavior of coal-oil mixtures (COM) is examined. Some discussion on the role of dispersion method and addition of water is included. The effect of oil chemistry and viscosity on settling was examined for five No. 6 oils - a correlation was found. Viscosity of the No. 6 oil strongly influenced COM viscosity, while no significant difference was found for several coals. Simple models for the shear stress-shear rate relationship were fit to available data - significant deviation from the models were found for high coal loadings. A simple model for settling is discussed. M.G.

N80-28473# Kentucky Univ., Lexington. Institute for Mining and Minerals Research.

EVALUATION OF 'STABLE' EMULSIONS OF COAL

T. T. Coburn *In* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 25 p refs

Avail: NTIS HC A99/MF A01

A method of testing the long term stability of coal/oil/water emulsion samples is described. The emulsions investigated were commercial coal/oil/water mixtures, 55/35/10 by weight, prepared by an ultrasonic emulsifying method. Apparent viscosity determination proved to be a convenient method of sample evaluation. A rotational type viscometer was used, and a method based on an expression which had previously been used to determine the concentration of solids in latex dispersion was applied: $\text{Log}(\text{apparent viscosity}) = a \text{Log}(\text{Spindle speed}) + b$. For emulsion samples from which solids settled slightly over a period of time, the weight percent solids as a function of depth could be related to the a term in the expression. At low spindle speeds it was more convenient to relate apparent viscosity and concentration of solids directly. A gravimetric method which required isolation of the dry coal solids was used to check the viscometry results. M.G.

N80-28474# Dow Chemical Co., Midland, Mich.
STABILIZATION OF COAL/FUEL OIL SLURRIES

W. C. Meyer *In* Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 15 p refs

Avail: NTIS HC A99/MF A01

Water as an effective means of stabilizing coal-oil mixtures (COM) against settling by acting as a flocculating third phase is examined. Wetting agents are found to enhance the flocculating efficiency of water by increasing the cross sectional area of contact between coal particles, as evidenced by increased static yield values--a measure of particle-particle interaction. At excessive

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levels of wetting agent, the more favorable wetting of the hydrophobic surface of coal by water is counterbalanced by greatly reduced interfacial tensions between water and oil. Some loss of flocculating efficiency occurs. The effect of particle size distribution, solids content, type of fuel oil, and type of coal (having a highly oxidized surface), along with the substitution of formamide in place of water as the flocculating third phase, are briefly examined to further define the stabilizing influence of water in COM. Possible adverse consequences of continuous agitation or recirculation on COM stability derived via this means are pointed out. M.G.

N80-26475# Kawasaki Heavy Industries, Ltd., Akashi (Japan).
RESULTS OF EXPERIMENT PRODUCTION OF FINE COM BY WET TYPE MILL

Noboru Sato /n Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 28 p

Avail: NTIS HC A99/MF A01

The experimental production of fine coal-oil mixtures (COM) with a wet type mill using four kinds of bituminous coal together with Middle East heavy crude oil is discussed. The following results were obtained: (1) the holdup of COM in the mill has an important influence on grindability; (2) all types of coal submitted to the tests presented good grindability; (3) the coal density of 50% and 55% presented satisfactory grindability; (4) the temperature of COM during the pulverizing process should be as high as possible; (5) an increase in the production rate coarsens the particle size distribution of COM almost linearly; (6) when total moisture content of the crushed coal is of the order to 10% or less, it was confirmed that the residual moisture content of COM can be dewatered to approximately 2%, by heating the heavy oil supplied to the mill. M.G.

N80-26476# Hitachi, Ltd., Tokyo (Japan). Shipbuilding and Engineering Div.

FINE COM PREPARATION TEST

Masazumi Yanase /n Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 32 p

Avail: NTIS HC A99/MF A01

Tests designed to determine the coal-oil mixture (COM) preparation conditions required to attain a satisfactory COM stability with a line mixer are discussed. The results indicate that, in premixing, the time between injection of the additive and agitation in the line mixer should be as short as possible. However a macroscopically homogenous mixing by agitation, as well as the method of injection of additive are necessary and important factors. Preparation using a line mixer gives better results compared with other preparation methods. In the preparation of COM with a line mixer, both specific agitation energy and turbine blade edge speed exceeding definite values are required. The optimum COM preparation conditions are different according to the additive, but these differences are not very pronounced. M.G.

N80-26477# Dai-ichi Kogyo Seiyaku Co. Ltd., Tokyo (Japan).
THE USE OF ADDITIVES TO STABILIZE COAL-OIL MIXTURE

Akihiro Naka /n Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 44 p

Avail: NTIS HC A99/MF A01

The performance of additives intended to stabilize oil-coal mixtures (COM) is discussed. Approximately 1,300 types of additives were mixed more than 10 different COM and the obtained mixture was poured into a cylinder in order to measure precipitation of the coal particles after still storage at a temperature of 70 C. As a result of these tests, several types of additives with excellent stabilizing effects were discovered. The effectiveness of these stabilizers in the COM was tested under various conditions, i.e., vibration, heat, freezing, and agitation. Based on these tests, the additive presenting the best results was selected (ACOM). The addition of approximately 0.1 wt% of ACOM to a mixture, without addition of water, resulted

in more than 10 types of COM stable for periods of one to two months and showing, in addition, excellent economic characteristics. M.G.

N80-26478# Neos Co. Ltd., Tokyo (Japan).
COM STABILITY FORECASTING METHOD

Yoshikazu Ogura /n Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 32 p

Avail: NTIS HC A99/MF A01

From a discussion of a stable system model composed of coal-oil mixtures (COM) with addition of an additive, a method for evaluating long term stability of the system, by measuring the quantity of additive distributed in the COM immediately after production is devised. The distribution forms considered are (1) additive dispersed and dissolved in the oil medium; (2) additive absorbed in the coal; and (3) additive present on the surface of coal. In case of using additive NEOS N-1, if the quantity of additive present on the surface of the coal exceeds 1,000 micro-g/coal-g experimental results demonstrate that the COM in question is able to remain as a stable system, even when still-stored for more than one month. M.G.

N80-26479# Kao Soap Co. Ltd., Tokyo (Japan).
STUDIES ON THE STABILIZATION OF COM

Masaaki Yamamura, Tatsuji Yamashita (Lion Fat and Oil Co. Ltd., Tokyo), and Taizo Igarashi (Nippon Oil and Fat Co. Ltd., Tokyo) /n Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 57 p refs

Avail: NTIS HC A99/MF A01

Stabilizers for coal-oil-mixtures (COM) and related technologies were developed. Emphasis was placed on developing stabilizers to minimize the sedimentation of coal particles contained in the COM. The factor influencing COM stability were determined and measures to cope with the variations occurring in the these factors were surveyed. R.C.T.

N80-26480# Electric Power Development Co. Ltd. (Japan).
FINE AND COARSE COAL OIL MIXTURE COMBUSTION TESTS OF AIR ATOMIZED BURNER IN JAPAN

Y. Nakabayashi and Donald J. L. Lin, P. E. (Forney International, Inc.) /n Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 24 p refs

Avail: NTIS HC A99/MF A01

A tristage air atomized burner was tested at the facilities of the three leading boiler makers in Japan. Coal oil mixtures (COM) of 50/50 weights with both fine and coarse coal particles were tested under conventional excess air and modified off-stoichiometric combustion modes. Nitrogen-oxygen reduction techniques via flue gas recirculation and two stage off-stoichiometric combustion were confirmed. Coal-oil-mixture combustion characteristics were compared to those of heavy oil. R.C.T.

N80-26481# Atlantic Research Corp., Alexandria, Va.
DEVELOPMENT AND EVALUATION OF HIGHLY-LOADED COAL SLURRIES

R. S. Scheffe and E. T. McHale /n Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 14 p refs

(Contract DE-AC01-77-ET-13041)

Avail: NTIS HC A99/MF A01

Highly loaded coal slurry fuels were developed and evaluated. Slurry fuels comprised of either bituminous, subbituminous, or lignite coal and either aqueous media or emulsions of No. 6 oil in water as the carrier were examined at solids loadings up to 70% by weight. The water slurries of bituminous coals were emphasized. These slurries were developed for use in place of No. 6 oil in oil fired burners, and represent a companion concept to coal-oil-mixtures. R.C.T.

N80-26482# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.
ATOMIZATION OF COAL SLURRY JETS

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T. Butcher, A. Pucci, and C. R. Krishna *In Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust.*, Vol. 2 1979 13 p refs

(Contract EY-76-C-02-0016)
Avail: NTIS HC A99/MF A01

Jet length and drop size were examined for water and No. 2 oil slurries up to 30% concentration. Preliminary data from an air-atomized nozzle are presented for illustration. R.C.T.

N80-26483# Wayne State Univ., Detroit, Mich. Dept. of Mechanical Engineering.

ATOMIZATION OF COAL-OIL MIXTURES

S. Carmi and M. R. Ghassemzadeh *In Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust.*, Vol. 2 1979 17 p refs

(Grant DE-FG01-77-ET-10658)

Avail: NTIS HC A99/MF A01

Atomization characteristics of coal-oil mixtures were studied by an experimental set up consisting of an airblast atomizer fed from a flow control rig, which discharges through a spray channel into a storage tank. Vapors generated were removed via an exhaust system. The fully developed spray was photographed at different axial locations using 35 mm camera fitted with a microflash designed for high speed photography. Slides and prints were analyzed for particle size distribution. R.C.T.

N80-26484# Mitsubishi Heavy-Industries Ltd., Tokyo (Japan).

BASIC STUDIES ON COM COMBUSTION

U. Takahashi, H. Hino, U. Fujima, and A. Komori *In Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-oil Mixture Combust.*, Vol. 2 1979 29 p

Avail: NTIS HC A99/MF A01

Special appropriate conditions necessary for the satisfactory atomization of the coal-oil-mixture (COM) were examined. The conditions preventing the atomizer, which has very narrow passages for transporting the COM, from clogging in order to achieve stable operation was studied. The feasibility of the technological development aiming at coping with that problem was investigated. R.C.T.

N80-26486# Hitachi, Ltd., Tokyo (Japan).

REPORT ON FINE COM COMBUSTION TEST

Hitoshi Migaki *In Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-oil Mixture Combust.*, Vol. 2 1979 15 p

Avail: NTIS HC A99/MF A01

The utilization fine coal-oil mixtures transported as a fluid and as a fuel for boilers was investigated. Major emphasis was placed on the combustion, the nitrogen-oxygen countermeasures (i.e., two stage combustion), and the recirculation of gas mixing combustion. R.C.T.

N80-26486# Methacoal Corp., Dallas, Tex.

THE CFOS (CARBONACEOUS FUEL-IN-OIL SUSPENSIDS) FUELS

Leonard J. Keller *In Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combustion*, Vol. 2 1979 16 p refs

Avail: NTIS HC A99/MF A01

The methods producing carbonaceous fuel-in-oil suspensoid fuels are discussed. It is shown that most of the CFOS fuels, if made from pulverized coal, although not as completely stable as those made from CHC fuels, are relatively stable compared to other coal-oil-mixtures fuels. R.C.T.

N80-26524# Germantown Labs., Inc., Philadelphia, Pa.

INVESTIGATION OF FUELS CONTAINING COAL-OIL-WATER EMULSIONS Quarterly Report, 1 Oct. - 1 Dec. 1978

Norman H. Cherry and Charles S. Stokes Jan. 1979 16 p

(Contract EF-77-C-01-2689)

(FE-2689-5; QR-5) Avail: NTIS HC A02/MF A01

A total of five emulsifiers were assessed for the production of stable coal-oil-water emulsions and the determination of the practicality of their use in a boiler system was being investigated. Ancillary equipment was set up and experiments completed on two units. Mounting fixtures designed and fabricated for the third and fourth units. The third unit was evaluated using 45% coal, 50% number 6 Gulf oil and 5% water. The stability of the emulsions was evaluated on the K-scan unit. DOE

N80-26525# Rockwell International Corp., Canoga Park, Calif. Environmental and Energy Systems Div.

DEVELOPMENT OF A SINGLE-STAGE, ENTRAINED-FLOW, SHORT-RESIDENCE-TIME HYDROGASIFIER Final Report

Jul. 1979 503 p refs

(Contract EF-77-C-01-2518)

(FE-2518-24) Avail: NTIS HC A22/MF A01

A single-storage, entrained flow, short residence time reactor for flash hydrogasification of coal was developed. The unique feature was the application of rocket engine injection/mixing techniques to the rapid mixing and reaction of hot hydrogen (approximately 2000 F) and pulverized coal in very high throughput reactors. Experiments were conducted in three different hydrogasifier reactor systems. The first was a bench scale apparatus with coal feed rates of 2 to 4 lbm/hr. Results are reported for a subbituminous coal where overall carbon conversion varied between 21 and 55% and were comparable with conversions of lignite. Engineering scale tests were conducted in the other two reactor systems at a nominal coal feed rate of 1/4 ton/hour. Results with subbituminous coal compared well with those from the bench scale reactors. DOE

N80-26528# Catalytic, Inc., Wilsonville, Ala.

SOLVENT REFINED COAL (SRC) PROCESS OPERATION OF SOLVENT REFINED COAL PILOT PLANT, WILSONVILLE, ALABAMA Annual Report, Jan. - Dec. 1978

H. E. Lewis, W. H. Weber, G. B. Usnick, W. R. Hollenack, H. O. Blair, and R. G. Boykin Oct. 1979 227 p refs Prepared in cooperation with Southern Serv., Inc., Birmingham, Ala.

(Contract EX-76-C-01-2270)

(FE-2270-46) Avail: NTIS HC A11/MF A01

Operating conditions and test results obtained at six ton per day solvent refined coal (SRC) pilot plant are summarized. Two coals were processed and the effects of process variables on SRC yield and solvent quality were investigated. These variables included space rate, coal mineral concentration in the dissolver, hydrogen partial pressure, and temperature. A system for continuously withdrawing a portion of the dissolver contents was operated to investigate the effects of minimizing the concentration of solids in the dissolver. Tests confirming the high rate of coal conversion at short residence time were completed. Several methods of deashing the low pressure reaction product were tested: pressure leaf filtration; centrifugation with antisolvent addition; and 10 mm hydroclones with antisolvent addition. Both horizontal and vertical pressure leaf filtration units were tested. Filter aids such as perlite, fly ash, and several grades of diatomite were used. Operating without precoat was also studied. DOE

N80-26529# Catalytic, Inc., Philadelphia, Pa.

PRELIMINARY ENGINEERING EVALUATION OF PROMISING COAL LIQUEFACTION CONCEPTS Final Report, Dec. 1979

D. Agarwal, J. J. Cicalese, J. H. Harkins, M. T. McShance, D. J.

Onio, and J. R. Polek Dec. 1979 201 p refs

(EPRI Proj. 832-2)

(EPRI-AF-884) Avail: NTIS HC A10/MF A01

Cost liquefaction concepts were evaluated. Ten thousand tons of coal per day were processed in the liquefaction section. Emphasis was placed on producing clean burning solid and liquid fuels suitable for electric power generation. Flash hydrogenation, supercritical gas extraction, conventional solvent refined coal (with filtration of ash), two stage solvent refined coal, conventional solvent refined coal (with critical solvent deashing), and short contact time solvent refined coal (with critical solvent deashing and hydrotreating) were investigated. For the liquefaction sections, detailed material balances, process flow diagrams, equipment sections, detailed material balances, process flow diagrams,

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equipment specifications, utility requirements and estimated costs were developed. For areas ancillary to the liquefaction sections, terminal material balances, overall utility requirements, and estimated costs were calculated. The conventional SRC design produced the highest thermal efficiency and product heating value, primarily due to the higher recovery of SRC when using fibrillation as compared to critical solvent deashing for ash removal. DOE

N80-26530# Fluor Engineers and Constructors, Inc., Irvine, Calif. **ENGINEERING EVALUATION OF CONCEPTUAL COAL CONVERSION PLANT USING THE H-COAL LIQUEFACTION PROCESS** Final Report, Dec. 1979

P. A. Buckingham, R. Ravikumar, and A. A. Leavitt Dec. 1979 199 p refs

(EPRI Proj. 411-4)

(EPRI-AF-1297) Avail: NTIS HC A09/MF A01

The objective was to develop the capital costs and the product costs for and H-Coal liquefaction facility were developed. A key part of this effort was the development of a processing configuration in order to provide self sufficient facilities with respect to hydrogen, fuel, electric power, and all other utility services. The overall facility consists of a coal liquefaction plant along with the required support, utility and offsite facilities to comprise a self-sufficient operation. The major processing sections included coal preparation, coal liquefaction and product separation, light ends processing, hydrogen plant, oxygen plant, emission control systems, effluent control systems, product storage and shipping, utility systems and offsites. Capital costs upon a mid 1979 basis are \$1.146 billion and \$1.315 billion. The primary products naphtha, turbine oil, and distillate fuel oil are desulfurized to very low levels. The oxygen content of all three products is very high, while the nitrogen content of the turbine oil and the distillate fuel oil exceeds usual levels for conventional petroleum stocks. DOE

N80-26533# Midwest Research Inst., Kansas City, Mo. **CONTINUATION OF SYSTEMS STUDY OF FUELS FROM GRASSES AND GRAINS, PHASE 2 AND PHASE 3** Final Report

A. D. McElroy, Cynthia Tinberg, Michael Davis, Michael Snyder, and A. D. Allen 31 Jul. 1979 195 p refs

(Contract EG-77-C-01-4042)

(DSE-4042-T2) Avail: NTIS HC A09/MF A01

Biomass-derived fuels from grasses and grains are studied. A region-by-region analysis of biomass production, considering both the present (near term) and the future (mid term) is presented. The near term analyses involved least cost estimate of production, transportation, and energy conversion. The mid term analyses involved modified crop production systems, improved crop management, and crop mixes. Conversion plants ranged in size from 500 oven dry tons per day to 3000 oven dry tons per day, or an energy input of 75×10 to the 9th power Btu to 45×10 to the 9th power Btu 7500 Btu per pound. The conversion processes consisted of anaerobic digestion, fermentation, direct combustion, and thermochemical conversion. Ammonia and methanol production was accomplished by using thermochemical conversion. DOE

N80-26534# SRI International Corp., Menlo Park, Calif. **HOMOGENEOUS CATALYTIC HYDROCRACKING PROCESSES FOR CONVERSION OF COAL TO LIQUID FUELS: BASIC AND EXPLORATORY RESEARCH** Quarterly Report, 16 Sep. - 15 Dec. 1979

1979 15 p refs

(Contract EF-76-C-01-2202)

(FE-2202-51) Avail: NTIS HC A02/MF A01

The major chemical features of the catalytic activity in our CO-blue water system was determined and a preliminary investigation of its potential for coal upgrading was conducted. The nature of blue water catalysis and test its effectiveness with CO and H₂ was studied. Catalyst candidates of selected transition metal salts were similarly tested. We have determined that blue water catalysis is not due to coal-derived components, and we have ruled out any major involvement of formate. It is shown that the activity of blue water is due to transition metals,

content. Also blue water catalysts is less effective in the pressure of H₂ than CO. DOE

N80-26535# SRI International Corp., Menlo Park, Calif. **PREPARATION OF A COST DATA BANK FOR DOE/BIOMASS ENERGY SYSTEMS BRANCH Quarterly Progress Report, 1 Jul. - 30 Sep. 1979**

Anthony Y. Kam, Ronald L. Dickenson, Jerry L. Jones, David C. Bomberger, Anil K. Chatterjee, Wing S. Fong, Paul C. Meagher, and Donald J. Wilhelm 1979 82 p refs

(Contract EY-76-C-03-0115-141; Contract

DE-AT03-76ET-20605)

(DOE/ET-20605/4; QPR-4) Avail: NTIS HC A05/MF A01

Technical and economic analyses of Biomass Energy Systems (BES) technology options are reviewed. A total of 22 biomass conversion technology options (14 thermochemical and 8 biochemical) were selected for inclusion in the data bank. These options cover the production of electric power, steam, gases, liquids, and solid fuels from biomass. A consistent methodology for construction of the data bank was developed. For each option, the process/product data were gathered and analyzed. A base case was established to generate estimates for plant investments required, operating cost, and product cost. Statistical methods to produce error band estimates are used. Preliminary results for catalytic liquefaction (PETC and LBL processes), gasoline from biomass (China Lake process), and MBG from wood, ethanol fermentation are reported. A sensitivity analysis for cogeneration is also reported. DOE

N80-26537# California Univ., Livermore. Lawrence Livermore Lab.

LLL DATA ACQUISITION SYSTEM FOR LIQUEFIED GASEOUS FUELS PROGRAM

John Baker 17 Mar. 1980 15 p

(Contract W-7405-eng-48)

(UCID-18576) Avail: NTIS HC A02/MF A01

The liquefied natural gas dispersion tests were examined. The system employed 51 battery powered complementary metal oxide semiconductor (CMOS) data acquisition units to measure gas concentration, wind direction and speed, temperature, humidity, and heat flux. Data acquired by the CMOS data acquisition units were telemetered via UHF radio links to a trailer based microcomputer command, control, and data recording system (CCDRS). In the CCDRS wind data were displayed graphically. DOE

N80-26540# Oak Ridge National Lab., Tenn. **BIOLOGICALLY IMPORTANT COMPOUNDS IN SYNFUELS PROCESSES**

B. R. Clark 1980 26 p refs Presented at the 179th Meeting of the Am. Chem. Soc., Symp. on Environ. Control in Syntfuels Processes, Houston, Tex., 25 Mar. 1980

(Contract W-7405-eng-26)

(CONF-800303-13) Avail: NTIS HC A03/MF A01

Biologically active constituents were isolated in preparative scale amounts from complex mixtures utilizing combinations of liquid-liquid extraction and various liquid chromatographic column-eluant combinations. Fractions were characterized using a combination of spectroscopic techniques and gas chromatography/mass spectrometry. DOE

N80-26543# Occidental Research Corp., Irvine, Calif. **FLASH PYROLYSIS COAL LIQUEFACTION PROCESS DEVELOPMENT** Final Report, Jul. 1976 - Jun. 1978

Stanley C. Che, Kandaswamy Duraiswamy, Everett W. Knell, and Chang-Kuei Lee Apr. 1979 184 p refs

(Contract EX-76-C-01-2244)

(FE-2244-26) Avail: NTIS HC A09/MF A01

A specially designed, proprietary, caking coal reactor was demonstrated to process caking coals without oxidative pretreatment. Tar yields of about 35 wt % mixed amine fuel (MAF) were achieved in a 3 ton per day process development unit (PDU) from Western Kentucky No. 9 seam bituminous coal, and tar yields of about 22 wt % MAF were achieved from Wyoming Monarch seam subbituminous coal at a reactor residence time of about 1.5 seconds and a temperature of about 1200 F. The

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hydrorefining processability of the pyrolysis tar was demonstrated using a continuous hydrotreater. Two major technical problems were encountered and solved: (1) the initial PDU tar yield results were low compared to projections from the bench scale reactor; and (2) poor char rate control severely limited the PDU reactor operability. DOE

N80-26545# Gulf Research and Development Co., Pittsburgh, Pa.

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE MOTOR FUELS

Annual Report, Jun. 1978 - May 1979

D. C. Succop and F. E. Wynne Jul. 1979 120 p

(Contract EX-76-C-01-1800)

(FE-1800-39-Vol-1) Avail: NTIS HC A06/MF A01

Urgently needed design criteria for hydroliquefaction slurry heating were developed. It is shown that data needed on heat transfer coefficients, tube wall temperatures, slurry viscosities, slurry residence times and solvent characteristics. It is also shown that reactions occur within the slurry heaters but the extent of these reactions and the effect of heater design on the reactions is not clearly defined in terms of heat requirements, physical property changes and the effect of heater design on subsequent reaction in the downstream reactors and their design. Also, heater operating limits related to fouling are needed and fouling tests conducted with coal/petroleum resid slurries indicated that these limiting factors could be examined by similar tests. DOE

N80-26546# Gulf Research and Development Co., Pittsburgh, Pa.

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE MOTOR FUELS

D. C. Succop and F. E. Wynne Jul. 1979 298 p Annual Report, Jun. 1978 - May 1979

(Contract EX-76-C-01-1800)

(FE-1800-39-Vol-2) Avail: NTIS HC A13/MF A01

Data are presented characterizing the operating conditions as well as the product yield for the process of converting coal to synthetic gasoline and other distillate motor fuels. Yields of distillate and residue were obtained by gas chromatography of the heater total liquid product. Hydrocarbon type analysis for the total liquid product was obtained by liquid chromatography and is reported under recovered heavy distillate. A common elemental analysis of the total liquid product is shown as product liquid fractions. Products were vacuum distilled and boiling ranges of the cuts were corrected to obtain optimum yields. R.C.T.

N80-26549# Chemical Engineering Research Group, Pretoria (South Africa).

HYDRODENITROGENATION OF COAL LIQUIDS AND PETROLEUM WITH HETEROGENOUS CATALYSTS IN MULTIPHASE REACTORS. REVIEW AND RECOMMENDATIONS FOR FURTHER WORK

C. M. Stander Nov. 1979 35 p refs

(PB80-151442; CSIR-CENG-298; ISBN-0-7988-1721-6) Avail: NTIS HC A03/MF A01 CSCL 21D

Absorption and catalytic hydrodenitrogenation in three stage reactors are considered for the removal of nitriles and heterocyclics from coal liquids. The intraparticle rate controlling processes were studied by determining effective diffusivities using model liquids and the interparticle rate controlling processes were evaluated by studying the hydrodynamics of coal liquids in trickle-bed reactors. GRA

N80-26608# Sandia Labs., Albuquerque, N. Mex.

SEMICONDUCTORS FOR HIGH TEMPERATURE ACTIVE DEVICES: SILICON, GaAs, AND GaP

Joe Allen Coquat 1980 10 p refs Presented at the Electro/80 Professional Program Meeting, Boston, 13 May 1980

(Contract EY-76-C-04-0789)

(SAND-80-0379C; CONF-800504)

Avail: NTIS HC A02/MF A01

Developments in the area of high temperature active semiconductor devices for use at 275 C in instrumentation needed

to characterize geothermal resources are described. Surveys of silicon bipolar, MOS, and JFET devices operated at high temperature and development work on high temperature silicon CMOS logic and DI analog circuits are reviewed. The initial results of development work on GaAs and GaP diodes are discussed. These efforts have identified several promising devices for high temperature applications, however, further development is required to resolve such problems as excessive leakage currents, metalization degradation, device stability, and long term aging. DOE

N80-26663*# National Aeronautics and Space Administration, Washington, D. C.

STUDIES ON QUESTIONS OF DESIGN AND CONSTRUCTION OF CHAIN SCRAPER CONVEYORS

Hubert Guder Mar. 1980 35 p refs Transl. into ENGLISH of Glueckauf-Forschungshefte, (West Germany) v. 30, no. 3, Jun. 1969 p 103-116 Transl. by Scientific Translation Service, Santa Barbara, Calif.

(Contract NASw-3198)

(NASA-TM-75810) Avail: NTIS HC A03/MF A01 CSCL 131

The basic behavior of mining crushed goods in chain scraper conveyors was examined using a special test stand. The characteristics resistance lines of the upper end-piece were determined for conveyor idle as a function of the determinative crushed good characteristics (granular structure, moisture content, type of goods) on the size of the conveyor load, on the conveyor construction and on the stopped time of the conveyor. Crushed goods with a narrow granular profile and sphere-like grains caused about 35% greater resistance than fine coal and raw coal with broad granular profile. For goods containing water more than 10% by weight, the solids friction retreated in favor of flow friction. The coefficient of resistance decreased considerably in the range of lower speeds and then increased with increasing conveyor speed. The conveyance of sandstone ore required about 280% greater specific drive than the conveyance of raw coal. Resistance coefficients for coal and raw coal showed no dependence on the design of the conveyor. Start-up of loaded conveyors after longer stop times was simulated and the specific break-loose force was determined. A.R.H.

N80-26669# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

HIGH-TEMPERATURE TURBINE TECHNOLOGY PROGRAM LOW-Btu GAS, LOW-TEMPERATURE CHEMICAL CLEANUP PILOT PLANT: DESIGN, CONSTRUCTION, STARTUP, AND OPERATION

M. W. Horner, A. Caruvana, G. A. Cincotta, J. C. Corman, K. L. House, S. G. Kimura, R. G. Lavigne, C. C. Lawson, C. K. Neulander, H. K. Ruhl et al Feb. 1980 89 p refs-

(Contract EX-76-C-01-1806)

(FE-1806-78) Avail: NTIS HC A05/MF A01

The completion of the low Btu gas, low temperature cleanup system pilot plant represents a major step toward a complete integrated coal gasification pilot plant which simulates the full-scale commercial Coal Gasification Combined Cycle Plant. Several important programmatic and technical milestones in the program were attained during the design, construction, and startup of the pilot scale chemical cleanup system. The ability to operate the system in a 30 hr fired test after only three short attempts at fired operation, attests to the excellence of the plant design, preparation, and operation personnel. The performance of the Benfield system met or exceeded expectations based on sulfur and carbon dioxide removal. The reheat and saturation equipment performed well and controllably. No evidence of foaming or mist carry over to the process gas stream was observed, and the particulate and alkali loading of the clean process gas was well within design limitations. DOE

N80-26729*# London Univ. (England).

HCCM IMAGERY FOR THE DISCRIMINATION OF ROCK TYPES, THE DETECTION OF GEOTHERMAL ENERGY SOURCES AND THE ASSESSMENT OF SOIL MOISTURE

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CONTENT IN WESTERN QUEENSLAND AND ADJACENT PARTS OF NEW SOUTH WALES AND SOUTH AUSTRALIA Progress Report

Monica M. Cole, Principal Investigator 28 Feb. 1980 5 p
Sponsored by NASA HCMM
(E80-10142; NASA-CR-163160) Avail: NTIS
HC A02/MF A01 CSCL 08M

The author has identified the following significant results. Day-visible and day-IR imagery of northwest Queensland show that large scale geological features like the Mitakoodi anticlinorium, which involves rocks of contrasting lithological type, can be delineated. North of Cloncurry, the contrasting lithological units of the Knapdale quartzite and bedded argillaceous limestones within the Proterozoic Corella sequence are clearly delineated in the area of the Dugald River Lode. Major structural features in the Mount Isa area are revealed on the day-visible cover which provides similar but less detailed information than the LANDSAT imagery. The day-IR cover provides less additional information for areas of outcropping bedrock than had been expected. Initial studies of the day-IR and night-IR cover for parts of South Australia suggest that they contain additional information on geology compared with day-visible cover.

N80-26747# Geological Survey, Anchorage, Alaska. THE UNITED STATES GEOLOGICAL SURVEY IN ALASKA, 1979 PROGRAMS

Katherine M. Reed, ed. 1979 100 p
(Circ-804-A) Avail: NTIS HC A05/MF A01

A survey of programs designed to identify the land, water, energy, and mineral resources of Alaska is presented. Emphasis is placed on demonstrating how the needs of both conservation and development can be met. Classification of federally owned mineral lands and water-power sites, the exploration and development of energy and natural resources on Federal and Indian lands, and the exploration and appraisal of the petroleum potential of the National Petroleum Reserve in Alaska are among the topics discussed. Regional geology, economic geology, stratigraphy, paleontology, hydrology, marine geology, and engineering and environmental geology are included. J.M.S.

N80-26754# Pennzoil Co., Vienna, W. Va. OIL RECOVERY BY CARBON DIOXIDE INJECTION Annual Report, Jul. 1978 - Jun. 1979

Paul E. King Nov. 1979 57 p
(Contracts EF-76-C-05-5301; DE-AC21-76MC-05301)
(ORO-5301-47) Avail: NTIS HC A04/MF A01

After one year of response, the increase in production due to waterflooding ended by December, 1978. The total production credited to the waterflood process was 10,403 barrels or 529 barrels per acre. Less than one month after limited carbon dioxide injection began, a high carbon dioxide content was found in the produced gas at Shaffer No. 1, apparently as a result of channeling through the Big Lime thief zone. In April, the carbon dioxide injection rate was reduced to a total of 90 tons per day in an attempt to increase the effective injection from 26.7% to the designed 50%. The net carbon dioxide injection was 10,595.50 tons on July 1, 1979, 42.3% of the total to be injected. DOE

N80-26798# Army Construction Engineering Research Lab., Champaign, Ill.

DENSIFIED BIOMASS AS AN ALTERNATIVE ARMY HEATING AND POWER PLANT FUEL HEATING Final Report

S. A. Hathaway, J. S. Lin, D. Mahon, T. Magrino, and K. Duster Mar. 1980 88 p refs
(AD-A083317; CERL-TR-E-158) Avail: NTIS
HC A05/MF A01 CSCL 10/1

This investigation evaluated the technical and economic potential of using of densified biomass (principally wood pellets) as a coal substitute in Army heating and power plants. The report reviews Department of Defense DOD experience with and tests of wood pellets production of wood pellets (excluding silvicultural aspects) handling, storing, and feeding; combustion; major environmental considerations; and economics of use. GRA

N80-26832# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

ADVANCED DEVELOPMENT OF A SHORT RESIDENCE-TIME HYDROGASIFIER Quarterly Technical Progress Report, 1 Apr. - 30 Jun. 1979

Aug. 1979 181 p refs
(Contract ET-78-C-01-3125)
(FE-3125-8; QTPR-3) Avail: NTIS HC A09/MF A01

The design, construction, and operation of a hydrogasifier reactor for commercial application is discussed. The tests were performed at three quarter tons per hour and then at 4 tons per hour. Injection element scaling was investigated by studying single element and clustered multiple element injections at a sufficient magnification factor. Subbituminous coal was used in the test proceedings. Nitrogen usage and cooling tower requirements were lower than expected. The lower nitrogen usage reduced the heat load on the product gas cooler as less water was formed in the reactor. B.D.

N80-26858# Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.

ENERGY FOR WIND POWERED OSCILLATORS Semiannual Technical Progress Report, 1 Aug. 1979 - 31 Jan. 1980

Patrick J. Starr 1980 10 p refs
(Contract DE-FG02-79R5-10129)
(DOE/R5/10129-1) Avail: NTIS HC A02/MF A01

Information is presented concerning a literature review on flow induced vibrations; an estimation of available power; design procedure for both vortex shedding and galloping; and conversion schemes. DOE

N80-27382# Science Applications, Inc., Woodland Hills, Calif. Combustion Dynamics and Propulsion Technology Div.

FUNDAMENTAL CHARACTERIZATION OF ALTERNATIVE FUEL EFFECTS IN CONTINUOUS COMBUSTION SYSTEMS

R. B. Edelman, A. Turan, P. T. Harsha, E. Wong, and W. S. Blazowski (Exxon Research and Engineering Co., Linden, N.J.)
In AGARD Combustor Modelling Feb. 1980 14 p refs

Avail: NTIS HC A17/MF A01

The problem of net soot generation which is aggravated by the reduced hydrogen content characteristic of syncrudes that have been identified as probable alternate fuel sources for use in gas turbines is addressed. The kinetics of the process are modeled using the quasi-global concept while experimental data are developed primarily from a laboratory jet stirred combustor. Results are presented showing that soot emissions can be characterized in terms of major species and that soot oxidation must be included in the prediction of net soot generation. In addition, the techniques being employed for coupling the chemical and aerodynamic processes are outlined. E.D.K.

N80-27493 California Univ., Berkeley. THE COMBUSTION OF CARBON, COAL AND COAL RELATED FUELS IN AN OPPOSED FLOW DIFFUSION FLAME BURNER Ph.D. Thesis

Wing Kai Chin 1979 44 p
Avail: Univ. Microfilms Order No. 8014636

The burning characteristics of various carbonaceous fuels as well as polymethylmethacrylate (PMMA) were compared and showed PMMA to have the highest regression rate. The comparison results also indicated that a high rate of volatiles yield enhances the regression rate. The relative importance of oxygen and carbon dioxide on the surface oxidation mechanism was investigated by determining the regression rates in mixtures of oxygen and carbon dioxide and comparing with that obtained in mixtures of oxygen and nitrogen. Because of the opposing effects of carbon dioxide as an oxidizing agent and heat sink, its importance in the surface combustion mechanism could not be unambiguously determined. The gaseous products from the combustion of coal at various oxygen mole fractions and oxidizer velocities were measured and showed that the ratios of carbon monoxide to carbon dioxide decreases with increasing oxygen mole fraction. Temperature profiles in the solid and gas phases and surface temperature were determined. Dissert. Abstr.

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N80-27494# Pittsburgh Energy Technology Center, Pa.
THE 2ND INTERNATIONAL SYMPOSIUM ON COAL-OIL MIXTURE COMBUSTION, VOLUME 1

1979 595 p refs Symp. held at Danvers, Mass., 27-29 Nov. 1979 Sponsored by DOE 2 Vol. (CONF-791160-Vol-1) Avail: NTIS HC A25/MF A01

The status of various coal-oil mixture (COM) programs is assessed, including production, conversion from conventional systems, and demonstration pilot plants. Additional topics include efficiency of both the COM and boilers, combustion byproducts and their environmental effects as well as effects on boilers, and storage tanks.

N80-27495# Electric Power Development Co. Ltd. (Japan).
OVERVIEW OF R&D STATUS ON COM TECHNOLOGY IN JAPAN

Yasuyuki Nakabayashi *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 p 1-13

Avail: NTIS HC A25/MF A01

General trends referring to commercialization of coal-oil mixtures (COM) in Japan are presented. Progress in research and development on COM, public interest, and government support is summarized. E.D.K.

N80-27496# Canadian Combustion Research Lab.-CANMET, Chatham (New Brunswick).
CURRENT STATUS OF THE CANADIAN COAL-OIL MIXTURE PROGRAM

H. Whaley *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 13 p refs

Avail: NTIS HC A25/MF A01

A description is given of the status of four projects together with an outline of other related COM work currently being undertaken or planned in Canada. The projects include: (1) a small COM utility boiler demonstration plant, (2) determination of the rheological properties of coal-oil slurries, (3) research and development study of the preparation combustion and emission characteristics of beneficiated coal-oil mixtures, and (4) development of coal-oil slurry fuels for blast furnace injection. E.D.K.

N80-27497# Tsinghua Univ., Beijing (China). Dept. of Thermal Engineering.

PRELIMINARY CONSIDERATIONS OF THE USE OF COM IN THE EXPERIMENTAL POWER PLANT OF TSINGHUA UNIVERSITY AS AN ENERGY FUEL

Lin Hao *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 17 p refs

Avail: NTIS HC A25/MF A01

The peculiarity of the Chinese energy fuels and fuel systems are described. For converting an oil fired boiler to COM, problems that may be encountered and alternative projects to be taken into consideration are discussed. Test results, of viscosities and burning profiles are introduced, as well as the scheme of a COM production system and a principal sketch of an experimental power plant's burner. E.D.K.

N80-27498# New Brunswick Electric Power Commission, Fredericton.

COAL-OIL MIXTURE COMBUSTION APPLIED TO CANADIAN UTILITY BOILERS

P. J. Whalen, F. W. Davies, L. K. Lee, M. Natarajan (Montreal Engineering Co., Ltd.), and R. L. Wang (Montreal Engineering Co., Ltd.) *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 17 p refs

Avail: NTIS HC A25/MF A01

Operating experience on coal in COM relating to combustion stability, boiler efficiency, boiler slagging/fouling, and equipment erosion are reported. On line oil agglomeration coal beneficiation process is discussed. Based on a nation wide survey conducted on all oil fired canadian utility boilers, cost/benefit analyses of

COM conversion for several unit sizes were carried out. Potential oil savings were predicted and a correlation between boiler sizes and break even points for benefit against cost was discussed. A candidate boiler of 100 MW capacity was selected for testing COM process and combustion. E.D.K.

N80-27499# New England Power Service Co., Westborough, Mass.

STARTUP AND INITIAL FEASIBILITY TESTING ON THE SALEM HARBOR COM DEMONSTRATION

Richard M. Dunn *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 16 p refs

Avail: NTIS HC A25/MF A01

An 80 MW coal fired boiler which had been converted to burn No. 6 oil was equipped with new burners and accessories to burn coal-oil mixture. A description of the 30% coal and 70% oil mixture preparation facility is given. Results of initial coal-oil mixture (COM) blending, combustion, and stack emission tests are presented along with a discussion of initial startup problems encountered. Recommendations are made for additional COM research and product development to improve reliability. R.C.T.

N80-27500# Coaliquid, Inc., Louisville, Ky.

OPERATION OF A CENTRAL PREPARATION PLANT FOR COAL-OIL-WATER MIXTURES

G. T. Hawkins *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 16 p

Avail: NTIS HC A25/MF A01

A commercial scale, preparation plant for coal oil water mixtures was constructed. The facility is capable of producing 2,500 GPH at start up, and is expandable to up to 5000 GPH, with little additional expense. Various aspects of its operation are discussed. R.C.T.

N80-27501# Tennessee Valley Authority, Chattanooga.

INVESTIGATIONS OF COAL-OIL MIXTURES AS A UTILITY BOILER LIGHT-OFF FUEL

Stephen R. Smith, Randy M. Cole, Ronald B. Cox (Tenn. Univ., Chattanooga), T. C. Derbridge (Acurex Corp., Mountain View, Calif.), R. J. Schreiber (Acurex Corp., Mountain View, Calif.), and A. K. Yasuda (Acurex Corp., Mountain View, Calif.) *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 144 p refs

Avail: NTIS HC A25/MF A01

The fluid properties of unstabilized and stabilized coal-oil-water mixtures were investigated and the economics of converting light off system of a large (2600-MW) coal fired utility boiler to coal-oil-mixture firing were examined. An experimental agitator was used to determine the following: viscosity; stability; and mixing characteristics of Nos. 2, 4, and 6 fuel oil with pulverized coal. Agitation is required to obtain useful suspensions. A stabilized coal-oil-water emulsion was tested for long-term storage stability. Over a 6-month period, there was no indication of settling. An economic analysis was performed that compares COM costs to the present system using No. 2 oil and the sensitivity of COM economics to significant variables. R.C.T.

N80-27502# Tennessee Valley Authority, Chattanooga.

COAL/OIL/WATER MIXTURE STABILITY, APPENDIX A

R. H. Carty and T. T. Coburn *In* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 33 p refs

Avail: NTIS HC A25/MF A01

The stability of a coal-oil-water mixture prepared by an ultrasonic agitation method for stabilization of the mixture was examined. A one quart sample of this mixture was obtained to determine the test procedure for analyzing other samples for stability. Test procedures as well as the results are given. R.C.T.

N80-27503# British Petroleum Co. Ltd., Sunbury-on-Thames (England).

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STABLE COAL/FUEL OIL DISPERSIONS

C. J. Veal, D. R. Wall, and A. J. Groszek /*n* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 23 p refs

Avail: NTIS HC A25/MF A01

A novel method was developed for preparing very stable coal/fuel oil dispersions without the use of additives. The dispersions were handled like and substituted for fuel oils. Such dispersions have been shown to be stable at 100 C for periods of at least 13 weeks and also at higher temperatures (150 C) for at least a week. A total of 52 000 litres of such a dispersion were prepared, handled, stored and fired in a system designed primarily for heavy fuel oil. R.C.T.

N80-27504# Pittsburgh Energy Technology Center, Pa. COMBUSTION OF COAL-OIL MIXTURES IN A 700 HP WATERTUBE BOILER

Y. S. Pan, G. T. Bellas, M. P. Mathur, and D. Bienstock /*n* its The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 27 p refs

Avail: NTIS HC A25/MF A01

Coal-oil mixtures containing up to 50 percent coal by weight were successfully burned in a 700 high pressure watertube boiler, designed for oil firing, with no derating occurring. Carbon conversion efficiencies were above 98 percent and boiler efficiencies were the same as when firing No. 6 fuel oil. Combustion tests were conducted with No. 6 fuel oil mixed with Pittsburgh Seam coal pulverized to a coal particle size of 90 percent minus 200 mesh. Test results related to boiler performance, pollutant emissions, and ash deposition are presented. The equipment, instrumentation, and data acquisition system of the combustion test facility are described. The modest changes required to adapt the facility designed for oil firing to utilize coal-oil mixtures are discussed. Additional combustion tests needed to assess bottom ash accumulation and the corrosion, erosion, and fouling behavior inherent in the long duration operability of coal-oil mixtures in an oil fired boiler are underway. R.E.S.

N80-27505# Mitre Corp., Bedford, Mass. A TEST PLAN FOR THE NEPSCO COAL-OIL MIXTURE COMBUSTION PROJECT

Oliver K. Foo, Edward M. Jamgochian, and Alberto J. Sabadell /*n* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 32 p refs

Avail: NTIS HC A25/MF A01

Test objectives include the collection of technical and economic data to evaluate system performance, operability/maintainability, availability/reliability, and costs. A continuous 12 month test period was established. Superimposed on this period are four structured test periods during which the boiler load will be maintained at preselected levels while performance tests on the preparation plant and boiler are conducted. The end use of the data collected will provide a technical and economic data base to satisfy regulatory requirements and contribute to the commercialization of COM technology. E.D.K.

N80-27506# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).

DESIGN CONSIDERATION OF FINE COM STORAGE

Morio Kubota, Yashuhiko Kamijo (Tsukishima Kikai Co., Ltd.), and Koichi Tamura (Satake Chemical Equipment Mfg., Ltd.) /*n* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 38 p

Avail: NTIS HC A25/MF A01

Conclusions affecting design and method of using storage tanks for COM are presented. Test items referred to include (1) an agitation test to prevent COM from setting in the tank; (2) fluidization test of CQM settled in the tank; (3) still storage test of COM without agitation; (4) heat transfer in the tank; and (5) corrosion testing to determine suitable tank materials. E.D.K.

N80-27507# Hitachi, Ltd., Tokyo (Japan). REPORT ON PUMPING CHARACTERISTIC TESTS AND

PIPING PRESSURE LOSS MEASUREMENT TESTS FOR FINE COM

Isao Koyama /*n* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 28 p

Avail: NTIS HC A25/MF A01

Data were established for transport of coal-oil mixtures (COM) and developing a design for an actual plant. The tests were carried out with two types of pumps to determine their characteristics and illuminate the pressure loss characteristics for piping transportation of COM. Four types of COM, characterized by the coal brand, coal concentration, and brand of additive mixed in the COM to prevent precipitation of coal particles, were used. The results show that pump handling of the COM is possible. R.C.T.

N80-27508# Mitsui Engineering and Shipbuilding Co. Ltd., Tokyo (Japan).

PILOT PLANT TEST ON COARSE COM SYSTEM. TESTS ON TRANSPORTATION, DE-OILING AND COMBUSTION OF COARSE COM

Kenichi Nagata, Akira Shiozawa, and Isao Koyama (Babcock-Hitachi K. K., Tokyo) /*n* Pittsburgh Energy Technol. Center The 2d Intern. Symp. on Coal-Oil Mixture Combust., Vol. 1 1979 41 p refs

Avail: NTIS HC A25/MF A01

The major characteristics of the coarse coal-oil-mixtures (COM) system are described. Themes for the development and status of the COM system are addressed. Design specifications and implementation procedures for the pilot plant and other test equipment are given. R.C.T.

N80-27509*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

USE OF PETROLEUM-BASED CORRELATIONS AND ESTIMATION METHODS FOR SYNTHETIC FUELS

A. C. Antoine Jun. 1980 23 p refs
(NASA-TM-81533; E-485) Avail: NTIS HC A02/MF A01 CSCL 21D

Correlations of hydrogen content with aromatics content, heat of combustion, and smoke point are derived for some synthetic fuels prepared from oil and coal syncrudes. Comparing the results of the aromatics content with correlations derived for petroleum fuels shows that the shale-derived fuels fit the petroleum-based correlations, but the coal-derived fuels do not. The correlations derived for heat of combustion and smoke point are comparable to some found for petroleum-based correlations. Calculated values of hydrogen content and of heat of combustion are obtained for the synthetic fuels by use of ASTM estimation methods. Comparisons of the measured and calculated values show biases in the equations that exceed the critical statistics values. Comparison of the measured hydrogen content by the standard ASTM combustion method with that by a nuclear magnetic resonance (NMR) method shows a decided bias. The comparison of the calculated and measured NMR hydrogen contents shows a difference similar to that found with petroleum fuels. Author

N80-27510*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

ADVANCED FUEL SYSTEM TECHNOLOGY FOR UTILIZING BROADENED PROPERTY AIRCRAFT FUELS

G. M. Reck Jun. 1980 23 p refs Proposed for presentation at 12th Congr. of the Intern. Council of the Aeron. Sci., Munich, 13-17 Oct. 1980

(NASA-TM-81538; E-492) Avail: NTIS HC A02/MF A01 CSCL 21D

Possible changes in fuel properties are identified based on current trends and projections. The effect of those changes with respect to the aircraft fuel system are examined and some technological approaches to utilizing those fuels are described. R.C.T.

N80-27513# Virginia Polytechnic Inst. and State Univ., Blacksburg.

THE 1H AND 13C FOURIER TRANSFORM NMR CHARAC- TERIZATION OF JET FUELS DERIVED FROM ALTERNATED

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ENERGY SOURCES Final Progress Report, 23 Mar. 1978 - 30 Aug. 1979

H. C. Dorn 30 Aug. 1979 80 p refs
(Contract N00173-78-C-0424)

(AD-A084169) Avail: NTIS HC A05/MF A01 CSCL 07/4

Initially, four jet samples were examined in this phase of the study using gel permeation liquid chromatography. We have previously discussed these results in the six month Progress Report. Although the gel permeation approach has the advantage of nearly quantitative recovery from the chromatography column (typically greater than 95%) and high preparative loading, it suffers from two drawbacks in studies of the present jet fuels. In general, the molecular weight and/or size of the compounds present in typical jet fuels do not cover a broad range. This is an obvious result of the relatively narrow distillation range(s) used to generate the jet fuels. That is, the gel permeation approach is more ideally suited in separations involving mixtures with a broad range in size and/or molecular weight (e.g., 100-1000 MW), whereas, the jet fuels have a more narrow range (e.g., 100-250MW).

GRA

N80-27514# Puerto Rico Univ., Rio Piedras. Agricultural Experiment Station.

PRODUCTION OF SUGARCANE AND TROPICAL GRASSES AS A RENEWABLE ENERGY SOURCE Annual Report, 1978 - 1979

1979 134 p refs

(Contract ET-78-S-05-5912)

(ORO-5912-T2; AR-2) Avail: NTIS HC A07/MF A01

The agronomic and economic feasibility of mechanized, year round production of solar dried biomass, through the intensive management of sugarcane and napier grass as tropical forages were investigated. Alternate tropical grasses as potential sources for intensive biomass production were also examined. The selection and breeding of new sugarcane progeny having superior biomass productivity as their principal attribute were considered.

R.C.T.

N80-27515# Institute of Gas Technology, Chicago, Ill. RESEARCH AND DEVELOPMENT OF RAPID HYDROGENATION FOR COAL CONVERSION TO SYNTHETIC MOTOR FUELS, RISER CRACKING OF COAL Quarterly Report, 1 Jul. - 30 Sep. 1979

D. A. Duncan, J. L. Beeson, and R. D. Oberle Dec. 1979 23 p refs

(Contract EX-76-C-01-2307; Proj. 61001)

(FE-2307-58) Avail: NTIS HC A02/MF A01

The technology of short residence time hydrolysis of lignites and coals for optimized yields of high octane gasoline blending stock constituents was developed. The design, construction, and operation of a bench scale unit (5 to 10 lb/hr) and a process development unit (50 to 100 lb/hr) were surveyed. The technical and economic aspects of large scale operation were evaluated.

R.C.T.

N80-27516# Institute of Gas Technology, Chicago, Ill. RESEARCH AND DEVELOPMENT OF RAPID HYDROGENATION FOR COAL CONVERSION TO SYNTHETIC MOTOR FUELS, RISER CRACKING OF COAL Quarterly Report, 1 Apr. - 30 Jun. 1979

D. A. Duncan and J. L. Beeson Nov. 1979 28 p refs

(Contract EX-76-C-01-2307)

(FE-2307-55) Avail: NTIS HC A03/MF A01

The effect of heating rate on the conversion of feed carbon was studied and the distribution of products among gases, hydrocarbon liquids, and spent char was evaluated. A comparison was then made of product distribution obtained by hot hydrogen processing and by concurrent heating of the lignite and hydrogen to pyrolysis temperatures. The distribution of feed carbon among carbon oxides, methane, ethane, and hydrocarbon liquids were similar, and the yield of hydrocarbon liquids was practically identical. Equipment problems encountered thus far were minor and were easily corrected. An equipment flow sheet for a process plant was developed and various processing options were evaluated.

DOE

N80-27517# Institute of Gas Technology, Chicago, Ill. RESEARCH AND DEVELOPMENT OF RAPID HYDROGENATION FOR COAL CONVERSION TO SYNTHETIC MOTOR FUELS, RISER CRACKING OF COAL Annual Report, 1 Apr. 1978 - 31 Mar. 1979

D. A. Duncan, J. L. Beeson, and R. D. Oberle Sep. 1979 128 p refs

(Contract EX-76-C-01-2307; Proj. 61001)

(FE-2307-50) Avail: NTIS HC A07/MF A01

The effects of operating pressure and heating rate on reactor performance were studied. Several techniques for processing caking coals were explored and trails of bentonite clay and iron oxide as catalysts were made. Certain aspects of the process development unit in the operation of the preheater as well as in the operation of the combustor sections were clarified. The major observations and results are reported.

DOE

N80-27524# McKee (Arthur G.) and Co., Cleveland, Ohio. COAL: AN ALTERNATE FUEL FOR THERMAL ENHANCED OIL RECOVERY STEAM GENERATION Final Report Aug. 1979 98 p

(Contract EX-76-C-01-2418)

(SAN-2418-1) Avail: NTIS HC A05/MF A01

The technical and economic aspects of using coal to replace lower tier crude oil as fuel for thermal enhanced oil recovery steam generation is examined. Three coal technologies were evaluated: coal-oil mixtures; coal gasification; and fluidized bed combustion. Coal-oil mixtures and coal gasification were evaluated for retrofit application. Fluidized bed combustion was evaluated from the standpoint of providing replacement or future steam generating capacity.

DOE

N80-27526# National Technical Information Service, Springfield, Va.

COAL GASIFICATION TECHNOLOGY. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979 - Apr. 1980

Diane M. Cavagnaro Apr. 1980 224 p Supersedes NTIS/PS-79/0516 and NTIS/PS-77/0305

(PB80-808090; NTIS/PS-79/0516; NTIS/PS-77/0305) Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 07A

Research reports on coal gasification are cited. They cover the techniques and processes of the conversion of coal to chemicals or fuels. Coal desulfurization, cleaning, or preparation, which do not involve conversion to gaseous fuels or chemical, are not covered. Also excluded are in-situ gasification studies. This updated bibliography contains 217 abstracts, 172 of which are new entries to the previous edition.

GRA

N80-27526# National Technical Information Service, Springfield, Va.

COAL LIQUEFACTION TECHNOLOGY. CITATIONS FROM THE NTIS DATA BASE Progress Report, May 1978 - Apr. 1980

Diane M. Cavagnaro Apr. 1980 227 p Supersedes NTIS/PS-79/0375 and NTIS/PS-77/0305

(PB80-808108; NTIS/PS-79/0375; NTIS/PS-77/0305) Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 07A

A bibliography containing 217 citations on the techniques and processes of the conversion of coal to liquid chemicals or fuels is given. Most aspects of the processes including design, performance evaluation, cost analysis, and plant equipment are covered.

GRA

N80-27527# National Technical Information Service, Springfield, Va.

COAL GASIFICATION TECHNOLOGY. CITATIONS FROM THE NTIS DATA CENTER Progress Report, May - Dec. 1978

Diane M. Cavagnaro Apr. 1980 152 p

(PB80-808082) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 07A

This bibliography cites research reports on coal gasification technology. The citations discuss the techniques and processes of the conversion of coal to chemicals or fuels coal desulfurization, cleaning, or fuels on chemicals, are not covered. Also excluded are in-situ gasification studies. This updated bibliography contains

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145 abstracts, none of which are new entries to the previous edition. GRA

N80-27535# Enviro Control, Inc., Rockville, Md.
CRITERIA FOR A RECOMMENDED STANDARD: OCCUPATIONAL EXPOSURES IN COAL GASIFICATION PLANTS

Sep. 1978 206 p refs Sponsored in part by EPA
(Contract PHS-210-76-0171)
(PB80-164874; DHEW/PUB/NIOSH-78-191) Avail: NTIS
HC A10/MF A01 CSCL 06J

The criteria and standards applicable to exposure of employees to toxicants and hazardous operating conditions in commercial coal gasification plants are reported. Several aspects of preventative maintenance are discussed with specific emphasis on employee workplace monitoring and medical surveillance.

R.C.T.

N80-27536# Enviro Control, Inc., Rockville, Md.
RECOMMENDED HEALTH AND SAFETY GUIDELINES FOR COAL GASIFICATION PILOT PLANTS Interagency Energy-Environment Research and Development Program Report

Jan. 1978 240 p refs
(Contract PHS-210-76-0171)
(PB80-164890; DHEW/PUB/NIOSH-78-120;
EPA-600/7-78-007) Avail: NTIS HC A11/MF A01 CSCL
06J

Potential hazards to workers in coal gasification pilot plants are identified and hazard control strategies are presented. Worker protection measures such as safe work practices, personal protective equipment and clothing, industrial and personal hygiene, workplace and medical monitoring, labeling and posting, hazard information and awareness, and recordkeeping are emphasized. Although this document is specific for pilot scale coal gasification plants, many of the potential hazards and research and development needs identified are transferable to those of bench or demonstration scale coal gasification or coal liquefaction facilities. GRA

N80-27703# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

HYDROLYZED WOOD SLURRY FLOW MODELING

J. Wrathall and Sabri Ergun Nov. 1979 9 p Presented at the Thermochem. Conversion Contractor's Meeting, Rolla, Mo., 7 Nov. 1979

(Contract W-7405-eng-48)
(LBL-10090) Avail: NTIS HC A02/MF A01

The catalytic conversion of hydrolyzed wood slurry to fuel oil is considered. A process to convert Douglas Fir chips into a pumpable fuel at costs comparable to current spot prices for Middle Eastern crude oil was designed. Operating difficulties that have developed at the pilot plant, include the production and handling of a pumpable, nonclogging hydrolyzed slurry as feedstock for a liquefaction process. A flow system was set up to investigate the properties of the hydrolyzed slurry in hopes of acquiring proficiency in control of slurry flow and development of conditions and correlations that will be of general usefulness to the chemical engineering community. Operating directives will be issued based on the research which will be of value in solving some of the problems encountered. DOE

N80-27795# NEUS, Inc., Santa Monica, Calif.
BIORESOURCES DIGEST, A JOURNAL ON BIOMASS UTILIZATION, VOLUME 1, NO: 2

Harry Sobel, ed. Apr. 1979 73 p refs
(Grant NSF PFR-77-12500)
(PB80-157662; NSF/RA-790175) Avail: NTIS
HC A04/MF A01 CSCL 10A

The management and uses of marine resources are considered including current and potential developments in ocean farming which utilize the giant kelp (*Macrocystis pyrifera*). This rapidly growing species may be converted anaerobically into substitute natural gas and additionally produce enormous quantities of minerals, fertilizers, and livestock and human feed. It also enhances local fish crops. Preliminary cost estimates show this process of gas production to be competitive with alternate gas supply sources.

Some of the technical and economic factors of ocean farming are discussed as well as methods for obtaining chemicals from a northern kelp. Books and papers received, grants awarded by NSF, DOE, and USDA, pertinent patents, NTIS publications, research announcements, and future meetings are listed. GRA

N80-27824# Idaho Univ., Moscow. Water Resources Research Inst.

UNDEVELOPED HYDROPOWER AS A POTENTIAL ENERGY SOURCE IN IDAHO

C. C. Warnick and L. F. Heitz Nov. 1979 28 p refs
(PB80-157399; W80-03918; OWRT-A-057-IDA(2)) Avail:
NTIS HC A03/MF A01 CSCL 10B

The potential energy available in both regulated and unregulated streams in Idaho and the Pacific Northwest through the use of small scale hydro development was surveyed. For the survey a technique was developed to find low duration information along reaches of streams that do not have flow records due to inadequate gaging. Also a method for estimating flow duration curves for regulated streams was developed and applied. To determine head for power computations the difference in elevation at the inflow and outflow points of a reach was used. A preliminary social, political, and environmental feasibility evaluation was also made for each reach with theoretical energy potential. Summaries of the survey results are included. GRA

ENERGY CONVERSION

Includes photovoltaic, thermoelectric, geothermal, ocean thermal, and wind energy conversion. Also includes nuclear reactors and magnetohydrodynamic generators.

A80-32743 Longitudinal baffling in Faraday generators. R. E. Elkins, III, T. A. Trovillion (Florida, University, Gainesville, Fla.), and E. R. Lindgren (Florida, University, Gainesville, Fla.; Kungl. Tekniska Hogskolan, Stockholm, Sweden). *Physics of Fluids*, vol. 23, Apr. 1980, p. 838, 839. Contract No. N00014-76-C-410.

The effect of inserting insulating baffles parallel to the flow along the insulating walls in Faraday generators on the generator efficiency is examined for a range of moderate Hartmann numbers using a PRADI integration scheme for finite Faraday generators. The results of the computer experiments indicate no efficiency gain due to the insulating baffles. This conclusion is in agreement with the analysis of Shercliff (1977) but differs from the results obtained by Yakhot and Levin (1978). V.L.

A80-32758 Microprocessor-controlled digital shunt regulator. P. R. K. Chetty, W. M. Polivka, and R. D. Middlebrook (California Institute of Technology, Pasadena, Calif.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-16, Mar. 1980, p. 191-201.

The hardware and software details of a microprocessor-controlled digital shunt regulator (DSR) for solar power systems are presented. The DSR is briefly described, solar cell array section simulators are outlined, the operation and design of the dissipative analog shunt regulator are given, and the description and design of shunt current comparators are presented. In addition, the need for a special timing function and its design is discussed. Attention is given to the description of the microprocessor-controller, hardware implementation, software programs, and interfacing. The operation of the complete DSR system is summarized. Experimental results of the model system are presented. Some possible extensions are suggested. In conclusion, for solar power systems a digital shunt regulator is superior to other types of shunt regulators, and the use of a microprocessor for the control of the digital shunt regulator results in improved system performance. System flexibility is the chief advantage of a microprocessor-based system. S.D.

A80-32892 # Diagnostic techniques for combustion MHD systems. S. A. Self (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics, International Meeting and Technical Display on Global Technology 2000, Baltimore, Md., May 6-8, 1980, Paper 80-0926*. 21 p. 51 refs. NSF Grant No. ENG-77-23932; Contract No. DE-AC01-80ET-15611.

Methods for the measurement of important parameters in combustion MHD systems are reviewed, with emphasis on the determination of the properties of the plasma-flow interior to the flow train. The techniques discussed are limited to those that have actually been used in MHD systems and are illustrated mainly by the work of the High Temperature Gasdynamics Laboratory at Stanford, and of the High Temperature Institute in Moscow. The principal parameters whose measurement is discussed include the average flow velocity and turbulence intensity, the temperature, the seed concentration, the electrical conductivity, the electron concentration and mobility, the positive ion concentration and, for pulverized fuel, the ash droplet size and concentration. The merits of the various techniques are assessed with reference to their accuracy, spatial and temporal resolution, and the relative ease with which they can be implemented. (Author)

A80-32893 # An assessment of magnetic fusion research. J. R. Roth (Tennessee, University, Knoxville, Tenn.). *American Institute of Aeronautics and Astronautics, International Meeting and Technical Display on Global Technology 2000, Baltimore, Md., May 6-8, 1980, Paper 80-0928*. 13 p. 16 refs.

An evaluation of magnetic fusion research is presented which considers the tokamak approach as the most promising method for the industrialized countries. In the U.S., this work will achieve a milestone in 1983 when the Tokamak Fusion Test Reactor (TFTR) will first demonstrate a scientific breakeven fusion reaction. However, the fusion reaction in tokamaks or other magnetic containment configurations poses an environmental threat because of its tritium inventory, and presents difficult materials problems associated with high fluxes; this may produce a proliferation of hybrid reactors which use neutrons for the production of fissionable material. It is proposed that an international agreement be reached which would rule out the use of DT fusion reaction for any but research reactors. A.T.

A80-32957 # Production of a small nuclear battery (Opit za s'zdavane na malogabaritna iadrena bateriia). N. P. Kosev, M. G. Marinov, and B. A. Popov (B'lgarska Akademiia na Naukite, Institut za Iadreni Izsledvaniia i Iadrena Energetika, Sofia, Bulgaria). *Iadrena Energiia*, no. 11, 1980, p. 63-69. 9 refs. In Bulgarian.

The paper describes an experiment for producing a small nuclear battery based on promethium-147. The choice of this type of a double transformation battery was substantiated, and the characteristics of luminophores and photoelements were investigated. Finally, characteristics of the battery are discussed with a view of improving its efficiency. A.T.

A80-33042 Tokamak reactors and structural materials. R. W. Conn (Wisconsin, University, Madison, Wis.). (*ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.*) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 9-16. 33 refs. Research supported by the U.S. Department of Energy and Wisconsin Electric Utilities Research Foundation.

The present status of tokamaks is reviewed, emphasizing a trend towards more compact units, higher power density and neutron wall loading in the range 2-4 MW/sq m. Criteria for selecting first wall materials are discussed, including radiation damage and lifetime, compatibility with coolants and tritium, and mechanical and thermal properties. Also examined is the interrelationship between first wall and blanket materials and reactor design. The primary choice for the structure is a steel or a nickel-based alloy, with vanadium and titanium alloys as the logical backup. L.M.

A80-33043 Mirror fusion reactor design. W. S. Neef, Jr. and G. A. Carlson (California, University, Livermore, Calif.). (*ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.*) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 17-28. 18 refs.

The major differences between mirror and toroidal fusion systems are described. Mirror optimization leading to 'tandem' and 'field reversed' systems results in enhanced plasma efficiency and reactor power balance. Blanket designs are reviewed which depend on a mirror's simple axisymmetric geometry. Coolants are discussed and pressurized helium favored for mirror reactors. Materials problems of both the first wall and neutral beam sources are reviewed along with neutron thermal loads on cryopanel pumps and direct converters. Superconducting magnets may have to be made of Niobium-Tin due to high field strength requirements. Recent data supporting Nb-Sn's use is included. Quadrupole fields require unusual magnet designs. (Author)

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A80-33044 Materials implications of fusion-fission reactor designs. K. R. Schultz (General Atomic Co., San Diego, Calif.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 29-36. 23 refs. Contract No. EY-76-C-03-0167-PA-38.

In this paper the fusion-fission reactor concept is briefly reviewed. The potential operating modes for fusion-fission systems are reviewed with emphasis on their materials environments, and the materials implications of the assumed mainline fuel producing materials are discussed from the reactor designer's point of view. The impact of materials performance on hybrid reactor design is assessed and it is suggested that although materials performance is of vital concern and further materials evaluation work is needed, the materials requirements of the hybrid are an overlap of fusion and fission requirements and appear to be less demanding than those of fission and fusion systems alone. (Author)

A80-33046 A comparative study of the performance and economics of advanced and conventional structural materials in fusion systems. M. A. Abdou and Z. El-Derini (Georgia Institute of Technology, Atlanta, Ga.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 57-64. 10 refs.

The impact of the neutron wall load and the lifetime and operating temperature of the structural material on tokamak reactor economics was investigated and a comparative study of stainless steel and vanadium alloys was performed. Economically attractive tokamak reactors produce a neutron wall load of 3-4 MW/sq m for 3000 MW thermal power. The cost of energy is optimized by an operating temperature of the structural material in the wall/blanket in the range 475-500 C for stainless steel and 620-660 C for vanadium alloys. The gain in electric power due to higher operating temperatures is not sufficient to offset the penalty in the capital cost associated with the vanadium alloys as compared to stainless steel. Therefore, the vanadium alloy must exhibit a significant lifetime advantage over stainless steel to be economically competitive. (Author)

A80-33050 First wall protection schemes for inertial confinement fusion reactors. G. L. Kulcinski (Wisconsin, University, Madison, Wis.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 87-97. 39 refs. Contract No. ET-77-S-02-4296.

The successful containment of thermonuclear yields ranging from 100-4000 MJ has presented a challenge to the fusion reactor designer. It is shown that the thermal pulses associated with such pellet design can exceed the melting temperature in first walls unless the chamber size is made unreasonably large or the energy spectra of the pellet debris is modified. The various approaches to absorbing the photons and slowing down the charged particles and neutrons are reviewed. Fluidized walls and low pressure gases show promise for protection of the cavity surfaces, but there are critical experiments that need to be performed on both of these concepts before a decision on their use in reactors can be made. (Author)

A80-33051 Materials problems with inertial confinement fusion targets. E. H. Farnum, R. J. Fries, and J. E. Barefield, II (California, University, Los Alamos, N. Mex.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 99-102. Research supported by the U.S. Department of Energy.

The fabrication of advanced laser fusion targets requires careful attention to materials properties that are unimportant in target design. Specific problems encountered in the fabrication of high-Z pusher shells of a typical three-shell high-yield target are discussed. Electroplated gold and chemical-vapor-deposited tungsten were not usable, although both produced as-deposited coatings that met design criteria. It was observed that hydrogen permeability of chemical-vapor-deposited tungsten decreases drastically for coatings thicker than 25 microns. (Author)

A80-33052 Fabrication of glass sphere laser fusion targets. C. D. Hendricks, A. Rosencwaig, R. L. Woerner, J. C. Koo, J. L. Dressler, J. W. Sherohman, S. L. Weinland, and M. Jeffries (California, University, Livermore, Calif.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 107-111. 13 refs. Contract No. W-7405-eng-48.

Processes were developed for mass producing the high quality glass microspheres required for current laser fusion targets. The methods and the materials used in the liquid-droplet and dried-gel systems are described. Glass microspheres ranging from 70-600 microns OD, with walls from 0.5 to 18 microns thick, and which satisfy the exacting surface and symmetry specifications of targets for high density experiments are now produced routinely. (Author)

A80-33053 Low pressure gas filling of laser fusion microspheres. J. Koo, J. Dressler, and C. Hendricks (California, University, Livermore, Calif.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 113-115. 5 refs. Contract No. W-7405-eng-48.

In laser fusion microsphere production, large, thin gel-microspheres are formed before the chemicals are fused into glass. In this transient stage, the gel-microspheres are highly permeable to argon and many other inert gases. When the gel transforms to glass, the argon gas is trapped within to form argon filled, fusion target quality, glass microspheres. On the average, the partial pressure of the argon fills attained in this process is around 20,000 Pa at room temperature. (Author)

A80-33054 Mass spectrometer determination of argon contents in laser fusion target pellets. C. M. Ward (California, University, Livermore, Calif.) and L. E. Bergquist (Martin Marietta Aerospace, Denver, Colo.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 117-120. 6 refs. Contract No. W-7405-eng-48.

A80-33055 Cryogenic laser fusion target material design considerations. J. R. Miller, R. J. Fries, and W. J. Press (California, University, Los Alamos, N. Mex.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 121-125. 16 refs. Research supported by the U.S. Department of Energy.

Laser fusion target designs exhibit improved performance when the fusion fuel, a deuterium-tritium (DT) mixture, is frozen into a

uniform, solid shell. The formation of such a shell requires rapid isothermal cooling of the target to cryogenic temperatures. The cooling rate must be sufficiently fast to prevent significant, gravitationally driven downward flow of the DT as it passes from the gaseous through the liquid state. Because it is not possible to measure the uniformity of a solid DT layer in opaque, multishell targets, we have modeled such targets to calculate the cooling rate and, hence, the expected thickness uniformity of the DT shell. The presented results provide target designers with practical guidelines for the selection of materials and configurations, which will assist in the fabrication of high-quality cryogenic targets. (Author)

A80-33056 A review of lifetime analyses for tokamaks. S. D. Harkness (Argonne National Laboratory, Argonne, Ill.) and B. Cramer (McDonnell Douglas Astronautics Co., St. Louis, Mo.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 135-145. 28 refs. Research supported by the U.S. Department of Energy.

System studies have shown that economic fusion power can best be achieved from the use of long lived components. The stresses generated in a first wall module are a complex function of its geometry, the chosen structural material and the tokamak burn cycle characteristics. A means of applying ASME Code Case 1592 to preliminary design has been established. Methods of incorporating some of the material property changes expected from irradiation are discussed. Cyclic stresses imposed by tokamak operation are expected to cause fatigue related properties to govern the life of the structure. Stress assisted bubble growth is also discussed. This may be the critical mechanism in establishing the creep rupture life of a fusion first wall component. (Author)

A80-33057 Structural performance of plasma chamber materials for a power generating tokamak. M. J. Delaney, B. A. Cramer, and C. A. Trachsel (McDonnell Douglas Astronautics Co., St. Louis, Mo.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 165-169. 5 refs. Contract No. EY-76-C-03-167-PA-38.

This paper compares Inconel 625, titanium 6242S, and 316 stainless steel as candidate plasma chamber first wall structural materials. Factors which have a significant effect on plasma chamber design are identified. Results are based on studies conducted for the Power Generating Fusion Reactor (PGFR) having a peak plasma power of 650 MW. The analyses use unirradiated material properties. Properties important in the design are discussed. The effect of material properties and load conditions on life of the plasma chamber is also addressed. (Author)

A80-33058 Evaluation of materials for EPR power generation. R. F. Mattas, H. C. Stevens, and B. Misra (Argonne National Laboratory, Argonne, Ill.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 171-175. 12 refs. Research supported by the U.S. Department of Energy.

The blanket materials employed for heat generation in the Argonne Experimental Power Reactor (EPR) are evaluated. The EPR blanket consists of annealed Type 316 stainless steel sections cooled by pressurized water and Inconel 718 sections cooled by steam. The predicted lifetimes of the two blanket sections is 2 years of normal operation for the Inconel 718 and 3.5 years for Type 316 stainless steel sections. The lifetime of Type 316 stainless steel is limited by swelling considerations, while the lifetime of Inconel 718 is limited by ductility changes. (Author)

A80-33059 The application of martensitic stainless steels in long lifetime fusion first wall/blankets. S. N. Rosenwasser, P. Miller, J. A. Dalessandro, J. M. Rawls, W. E. Toffolo, and W. Chen (General Atomic Co., San Diego, Calif.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 177-182. 18 refs. Contract No. EY-76-C-03-0167-PA-38.

An assessment is made of the feasibility and design impact of using a ferromagnetic martensitic steel such as HT-9 in first wall/blanket structures. A preliminary analysis indicates that HT-9 may offer significantly greater wall lifetimes than 20% cold worked type 316 stainless steel for temperatures below about 520 C. Exploratory measurements and calculations suggest that the presence of ferromagnetic material does not significantly affect the operational characteristics of tokamak power reactors. (Author)

A80-33060 Thermal fatigue failures in candidate refractory materials for use as protective plates in tokamaks. A. Tobin (Grumman Aerospace Corp., Bethpage, N.Y.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 197-201.

SEM was used to investigate thermal fatigue failures in W, W-ThO₂ and Mo subjected to thermal cycling that simulated tokamak operations. Significant evidence for surface melting, recrystallization, intergranular cracking and striation formation was observed. These results suggest that thermal fatigue is a serious problem in candidate refractory metallic protective plates. (Author)

A80-33062 Composite materials for tokamak wall armor, limiters, and beam dump applications. R. E. Riley, T. C. Wallace, and J. M. Dickinson (California, University, Los Alamos, N. Mex.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 221-224. 5 refs. Research sponsored by the U.S. Department of Energy.

A new generation of composite materials, graphite fiber reinforced metal carbides and borides, is being developed. These materials have high strengths and excellent chemical and mechanical stability. Their properties can be tailored over wide ranges to meet service requirements. By using components such as boron, silicon or titanium, these composites offer promise as low Z number materials for limiters, wall armor, beam stops, etc., in tokamaks. (Author)

A80-33063 Material studies related to TFTR limiters and wall armor. M. Ulrickson (Princeton University, Princeton, N.J.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 231-235. 5 refs. Contract No. EY-76-C-02-3073.

Candidate materials for use as limiters and wall armor in the Tokamak Fusion Test Reactor (TFTR) device have been evaluated under heat flux conditions similar to those expected in TFTR. The materials were first screened for thermal shock resistance using an electron beam gun to irradiate small test samples of each material. The best materials from the thermal shock tests were then subjected to thermal fatigue tests of up to 5000 cycles. Most of the materials subjected to the fatigue tests were also prepared in a size comparable to TFTR limiter and wall armor designs and exposed to neutral beam bombardment to establish the validity of the small tests. The results indicate that moulded graphites and carbon based composites should be given serious consideration for limiter and wall armor applications. (Author)

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A80-33077 Void growth characteristics in laser fusion reactor first walls. N. M. Ghoniem (California, University, Los Angeles, Calif.) and G. L. Kulcinski (Wisconsin, University, Madison, Wis.). (ANS, DOE, EPRI, AIME, and ASM, Topical Meeting on Fusion Reactor Materials, 1st, Miami Beach, Fla., Jan. 29-31, 1979.) *Journal of Nuclear Materials*, vol. 85-86, Dec. 1979, pt. A, p. 547-552. 10 refs. Research supported by the U.S. Department of Energy.

The damaging effects of microexplosion products on void behavior in unprotected stainless steel laser fusion first walls are analyzed using the Dynamic Rate Theory. The preliminary results from this work indicate that in the zones where the temperature excursions are the highest, gas bubbles will be the predominant defect and the dislocation loops and voids will be annealed out. As one moves farther into the first wall, the growth or shrinkage of voids depends on the ambient temperature and the magnitude of the displacement rate. (Author)

A80-33290 # Performance evaluation of wind turbines. R. E. Akins (Virginia Polytechnic Institute and State University, Blacksburg, Va.). (American Society of Civil Engineers, Convention and Exposition, Boston, Mass., Apr. 2-6, 1979.) *ASCE, Transportation Engineering Journal*, vol. 106, Jan. 1980, p. 19-29. 7 refs. Contract No. AT(29-1)-789.

Due to the random nature of the environment in which wind turbines are expected to operate, full-scale testing is necessary to verify performance predictions. A relatively straightforward technique, termed the method of bins, is developed for determining the average output characteristics of a particular wind turbine. The technique is applicable to a wind turbine of any size or type. The output power as a function of wind speed can be combined with either a knowledge or an estimate of the wind characteristics at a particular location to predict the annual power produced by the turbine. This approach of estimating the annual power production of a wind turbine in some assumed environment is a useful tool for evaluating both different machines and the effects of locating a particular machine at different sites. S.D.

A80-33553 Improved heat pump model for TRNSYS. P. J. Hughes and J. H. Morehouse (Science Applications, Inc., McLean, Va.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 817-821. 6 refs. Contract No. DE-8C04-78CS-34261.

A new TRNSYS-compatible heat pump model has been developed which overcomes several shortcomings of previous models of residential heat pumps. In the cooling mode, the effect of indoor entering wet bulb temperature on total capacity and on sensible/latent load ratio is considered. In the heating mode, performance degradation due to defrost is handled in a consistent manner. The model also has the capability of estimating performance degradation due to start-up thermal transients. In addition, the model is formulated to interface with the rest of the simulation via temperature level control so that control dynamics can be studied and thermal comfort restraints imposed, using the resulting system mode. (Author)

A80-33770 Operational characteristics of an ac commutator generator for wind power conversion. V. I. John (Queen's University, Kingston, Ontario, Canada). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2262-2266.

A three phase commutator motor of the Schrage type is used in the generating mode to produce constant voltage, constant frequency power output. A digitally operated automatic control system is used

to assure generator operation for a wide range of speeds. Operational characteristics including power output, efficiency, developed torque and power factor are determined by actual tests. An equivalent circuit for the machine is developed and the performance of the machine is calculated for both motoring and generating modes to assess the feasibility of AC Commutator Generator (ACCG) for Variable Speed Constant Frequency (VSCF) wind power systems. (Author)

A80-33773 Performance modeling of the vertical axis wind turbine. L. F. Jesch and D. Walton (Birmingham, University, Birmingham, England). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2277-2281. 6 refs.

The aerodynamic performance of the vertical axis wind turbine (VAWT) using troposkein shaped blades is analyzed. The effects of blade numbers, blade geometry, chord length, rotor solidity and parasitic drag on performance are investigated singly and in combinations. A new feature of the computer model is that it considers the effect of variable Reynolds number on performance. This makes it possible to get much closer agreement between theory and wind tunnel tests. A comparison with published test data shows the importance of including variable Reynolds number in the analysis. (Author)

A80-33774 Application of probability methods to evaluate the reliability of a combined wind-electric and conventional generation system. R. Ramakumar (Oklahoma State University, Stillwater, Okla.) and R. G. Deshmukh. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2282-2286. 7 refs. Research supported by the Oklahoma State University.

The models, approaches and the major parameters influencing the application of probability methods to evaluate the reliability of a combined wind-electric and conventional generation system feeding a common load are discussed. Capacity outage probability tables and Markov models are presented for a wind-electric conversion system. These models, in conjunction with suitable load models, are employed in the reliability evaluation of wind-assisted utility systems. Methods to include transmission lines are discussed and their implications are outlined. The results, discussion and the methodology should be of assistance in planning the incorporation of wind-electric conversion systems in the generation mixes of the future. (Author)

A80-33775 Electro-wind energy system with oversynchronous cascade and simple adaptive maximal power control. J. D. van Wyk (Rand Afrikaans University, Johannesburg, Republic of South Africa). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2291-2295. 16 refs. Research supported by the South African Council for Scientific and Industrial Research.

The conversion of mechanical energy from a wind turbine into electrical energy by using an induction generator with feed back of its rotor power to the supply system via a supply commutated inverter is investigated. It is shown that in comparison to VSCF systems using a synchronous generator and inverter, the power electronic equipment in the present system has only half the rated power. Advantages concerning running up of wind turbines on weak systems, as well as controllability and simplicity is pointed out, while

disadvantages concerning power factor and harmonics are investigated. An overriding adaptive maximal power controller to extract maximum power from the wind at each wind speed is described. Some preliminary experimental results on a scaled down 5kW, 380V oversynchronous cascade is presented. Regarding compatibility with supply networks and dynamic response many questions are still open to be investigated under varying wind speed conditions. (Author)

A80-33776 A design procedure for wind powered heating systems. J. F. Manwell and J. G. McGowan (Massachusetts, University, Amherst, Mass.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979, Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2296-2300. 5 refs. Research supported by the U.S. Department of Energy.

This paper presents a generalized design procedure for the month-by-month prediction of performance of wind powered residential heating systems. In its initial form, the technique is restricted to the simulation of residential heating systems using conventional horizontal axis wind turbines that dissipate their output into water based thermal storage systems (via electrical resistance heaters or fluid dissipation devices). This procedure, using a graphical formulation (WF-chart) is designed to give the monthly heating energy fraction supplied by a wind heating system with a minimum of site, wind turbine, and system input parameters. Such information is useful for simple performance studies or as input for economic assessment of wind heating systems. (Author)

A80-34123 Heat pumps in the PESAG supply district (Wärmepumpen im PESAG-Versorgungsgebiet). A. Osterhus (Paderborner Elektrizitätswerk und Strassenbahn AG, Paderborn, West Germany). *Energiawirtschaftliche Tagesfragen*, vol. 30, Apr. 1980, p. 262-266. In German.

The paper examines the feasibility of using large scale heat pumps in the PESAG (Paderborner Elektrizitätswerk und Strassenbahn AG) power supply district. It is shown that due to favorable geological factors in the district which allow the tapping of ground water, the market share for heat pumps will increase steadily. Topics discussed include: calculation of electricity consumption, operating experiences with heat pumps in one- and two-family houses, heat pumps in multifamily houses, and industrially used systems. M.E.P.

A80-34311 Calculation of a low-frequency electromagnetic field due to MHD machines inside a common shielding shell. S. M. Apollonskii. (*Magnitnaia Gidrodinamika*, July-Sept. 1979, p. 83-86.) *Magnetohydrodynamics*, vol. 15, no. 3, Jan. 1980, p. 296-299. 5 refs. Translation.

The paper develops a method for calculating the electromagnetic fields of two or more MHD machines encapsulated in a common housing, with consideration of the mutual field interaction. Some results are presented on the field interaction of two MHD pumps in a common housing, taking into account ferromagnetic and screening effects. B.J.

A80-34312 Simultaneous calculation of the transverse and longitudinal fringe effects in the channel of a plane induction-type MHD pump. L. M. Dronnik, S. Iu. Reutskii, and A. I. El'kin. (*Magnitnaia Gidrodinamika*, July-Sept. 1979, p. 87-93.) *Magnetohydrodynamics*, vol. 15, no. 3, Jan. 1980, p. 300-305. 10 refs. Translation.

The paper proposes a mathematical model of a plane MHD induction pump that makes it possible to investigate simultaneously longitudinal and transverse edge effects on flow parameters in the channel. An analytical solution is obtained for steady laminar flow in a channel with insulation barriers at the inlet and outlet. It is found that the longitudinal edge effect affects velocity in the central part of the channel, but has no influence on reverse flow at the walls. B.J.

A80-34313 MHD generator of the conduction type with reciprocal motion of the composite working element. S. E. Kuznetsov and V. I. Andreev. (*Magnitnaia Gidrodinamika*, July-Sept. 1979, p. 97-104.) *Magnetohydrodynamics*, vol. 15, no. 3, Jan. 1980, p. 308-314. 5 refs. Translation.

A conduction-type MHD generator with a hybrid working material, liquid metal and a solid conductor (a metallic plate), has been designed in an effort to reduce the total internal resistance of the system. The operating characteristics of an MHD generator with back-and-forth motion of a working material consisting of mercury and a copper plate are analyzed. B.J.

A80-34315 Determination of the geometry of the transition region of a series MHD generator. G. P. Bazarov, E. N. Kufa, and S. A. Medin. (*Magnitnaia Gidrodinamika*, July-Sept. 1979, p. 140-142.) *Magnetohydrodynamics*, vol. 15, no. 3, Jan. 1980, p. 347-349. Translation.

The paper considers the characteristics of the series channels of a MHD generator for a wide range of loads with zero field strength at connections between channels. Particular attention is given to the effects of the geometry of transition regions between channels on the power output characteristics of the generator. B.J.

A80-34559 Design of an isobutane binary cycle geothermal generation system. K. Aikawa (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan). *Energy Developments in Japan*, vol. 2, Jan. 1980, p. 193-209.

A 1000-kW binary cycle geothermal power plant with isobutane as the working medium, which uses geothermal steam and hot water, was successfully run for the first time at Otake, Kyushu, in 1978. The paper discusses the development of this plant, the features of the Otake pilot plant, the outline of the plant, and the main components. The technological feasibility of a future large operating plant is established. Factors such as economy, reliability, and social and environmental acceptability, etc. should be considered before constructing the binary cycle power generation system. S.D.

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A80-34614 # The characteristics of a nonhomogeneous helical MHD dynamo (Neodnorodnaia model' vintovogo dinamo). A. Gailitis and Ia. Freiberg. *Magnitnaia Gidrodinamika*, Jan.-Mar. 1980, p. 15-19. 5 refs. In Russian.

An inhomogeneous model of a helical dynamo is presented. The self-excitation of a magnetic field with a rigid helical movement of a circular cylinder is investigated in a kinematic approximation taking the finite extension in the radial direction and different electric conductivities of moving and stationary media into account. The dispersion relation of the model for the three cylindrical regions whose characteristics and movements are considered constant is presented; the relation of self-excitation characteristics and the relative thickness and electrical conductivity of the pipe walls and the helical movement pitch is computed by a dispersion equation.

A.T.

A80-34619 # The decreased detrimental effect of the Hall effect on the characteristics of an MHD generator (Ob umen'shenii vrednogo vliianiia tokov Kholla na kharakteristiki MGD-generatora). A. A. Beloglazov, V. A. Bashkatov, and E. E. Shpil'rain. *Magnitnaia Gidrodinamika*, Jan.-Mar. 1980, p. 99-104. In Russian.

The paper proposes methods of decreasing parasitic effects of Hall currents by designing the channel cross-section and the magnetic field. The results show the practicality of additional development of these methods.

A.T.

A80-34620 # A numerical investigation of three-dimensional effects in an MHD generator segmented duct with series-connected electrodes (Chislennoe issledovanie nekotorykh trekhmernykh effektov v sektionirovannom kanale MGD-generatora s posledovatel'nyim vklucheniem elektrodov). A. V. Gubarev and V. L. Ovchinnikov. *Magnitnaia Gidrodinamika*, Jan.-Mar. 1980, p. 105-110. 18 refs. In Russian.

A80-34647 # Efficient ion heating of tokamak plasma by application of positive and negative current pulse in TRIAM-1. K. Toi, N. Hiraki, K. Nakamura, Y. Kawai, S. Itoh (Kyushu University, Fukuoka, Japan), and O. Mitarai. *Kyushu University, Research Institute for Applied Mechanics, Reports*, vol. 27, Feb. 1980, p. 111-123. 21 refs.

The efficient heating of bulk ions of tokamak plasma is observed by application of the pulsed toroidal electric field much higher than the Dreicer field with the positive and negative polarities for the ohmic heating field. No deleterious effect on the confinement properties of tokamak plasma appears by the heating. The decay time of ion temperature raised by the heating pulse agrees well with the prediction by the neoclassical transport theory. The magnitude of the current induced by the pulsed electric field with the positive polarity is limited by the violent current disruption. In the case of the negative polarity, this is limited by lack of the MHD equilibrium due to vanishing the total plasma current. The ratio of drift velocity to electron thermal velocity attains around 0.5, which suggests that the efficient ion heating may be due to the current-driven turbulence. (Author)

A80-34648 # Ion temperature measurement by neutral energy analyzer in high-field tokamak TRIAM-1. K. Nakamura, N. Hiraki, K. Toi, and S. Itoh (Kyushu University, Fukuoka, Japan). *Kyushu University, Research Institute for Applied Mechanics, Reports*, vol. 27, Feb. 1980, p. 125-146. 26 refs.

The measurement of the ion temperature of the TRIAM-1 tokamak plasma is carried out by using a seven-channel neutral energy analyzer. The temporal and spatial variations of the ion temperature have been obtained with the spatial resolution of plus or minus 4.3 mm and the temporal resolution of 100 microseconds. The energy range of the analyzed neutral particles is from 0.2 to 8 keV. The energy spectrum in the TRIAM-1 plasma without the strong gas puffing usually consists of two-component Maxwellian; the one represents the thermal part which is a superposition of the contribution from a hot region (ion temperature of 100-300 eV) and that from an edge region (ion temperature of 50 eV), and the other represents the superthermal part (ion temperature of 1 keV). The neutral particle energy spectra at several vertical positions are obtained by scanning the analyzer in the vertical direction. From those spectra, the radial profile of the ion temperature is derived by means of the nonlinear optimization method. (Author)

A80-34649 # Electron density measurements in the TRIAM-1 tokamak. O. Mitarai, H. Nakashima, K. Nakamura, N. Hiraki, K. Toi, Y. Kawai, and S. Itoh (Kyushu University, Fukuoka, Japan). *Kyushu University, Research Institute for Applied Mechanics, Reports*, vol. 27, Feb. 1980, p. 147-158. 7 refs.

A80-34749 Three-dimensional reconstruction of the X-ray emission in laser imploded targets. G. N. Minerbo, J. G. Sanderson, D. B. van Hulsteyn, and P. Lee (California, University, Los Alamos, N. Mex.). *Applied Optics*, vol. 19, May 15, 1980, p. 1723-1728. 12 refs. Research sponsored by the U.S. Department of Energy.

To investigate the uniformity of compression of spherical targets irradiated with high-energy CO₂ lasers, an array of pinhole cameras has been set up to obtain 2-D views from four different directions. To reconstruct the 3-D source a computer code based on a maximum entropy algorithm was derived. With synthetic input data the code gives acceptable reconstructions provided the source is smooth and has a simple shape. A set of serial slices through the reconstructed X-ray emission distribution in a glass microsphere imploded with the LASL two-beam CO₂ laser is presented. (Author)

A80-34865 Current constriction near the anode in a combustion products plasma. R. V. Ganefel'd (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). (*Teplofizika Vysokikh Temperatur*, vol. 17, July-Aug. 1979, p. 703-710.) *High Temperature*, vol. 17, no. 4, Jan. 1980, p. 592-599. 10 refs. Translation.

In the present paper, the current constriction at the anode in a combustion-product plasma in the presence of applied and induced electric fields is analyzed on the basis of a boundary-layer heat balance equation. The parameters obtained for the transition of a diffuse discharge to a constricted mode are found to correlate well with the experiment. V.P.

A80-34873 Simulation of nonequilibrium physicochemical processes for supersonic flow of combustion products in an open-cycle MHD generator. N. M. Prusova (Academy of Sciences, Siberian Energy Institute, Irkutsk, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 17, July-Aug. 1979, p. 849-857.) *High Temperature*, vol. 17, no. 4, Jan. 1980, p. 712-718. 20 refs. Translation.

A80-34874 Measurement of energy emitted by the working medium of an MHD generator. I. A. Vasil'eva, Iu. Z. Rastegaeva, and A. S. Urinson (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*,

vol. 17, July-Aug. 1979, p. 860-862.) *High Temperature*, vol. 17, no. 4, Jan. 1980, p. 722-724. 9 refs. Translation.

An experimental determination is made of the energy emitted by the working medium of an MHD generator over a wide spectral range; in particular, data is obtained concerning the energy of radiation incident on the walls of the exit cone of the Ustanovka U-25 steam generator. Attention is given to the pyroelectric radiation detector used to detect the emitted energy, statistical errors in measuring the emission, and the absorption of radiation by water vapor and carbon dioxide in the layer of air between the window and the detector. It is found that the contribution of emission from the wall to the registered radiation does not exceed 10%, and that the total systematic error of measurement due to intensification and absorption between the plasma and receiver is on the order of 10%.
J.P.B.

A80-34875 Effect of voltage losses near the electrodes on development of boundary layers in an MHD channel. A. M. Vasiutkin (Scientific-Industrial Union Energiia, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 17, July-Aug. 1979, p. 874-876.) *High Temperature*, vol. 17, no. 4, Jan. 1980, p. 736-738. 6 refs. Translation.

A80-34970 Submillimeter interferometry of high-density plasmas. D. Véron (EURATOM and Commissariat à l'Énergie Atomique sur la Fusion, Département de Physique du Plasma et de la Fusion Contrôlée, Fontenay-aux-Roses, Hauts-de-Seine, France). In: *Infrared and millimeter waves. Volume 2*. New York, Academic Press, Inc., 1979, p. 67-135. 37 refs.

Principles of density measurements with electromagnetic radiation are discussed. Phase modulation and modulation techniques are covered. Special requirements for large plasma machine interferometers, Gaussian beam propagation, and components are considered. Specific systems are described and sources of errors analyzed. Future development of laser sources and components is outlined. V.T.

A80-34973 Electron cyclotron heating of tokamaks. W. M. Manheimer (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: *Infrared and millimeter waves. Volume 2*. New York, Academic Press, Inc., 1979, p. 299-352. 65 refs.

A brief discussion of tokamaks is presented. Emphasis is placed on propagation and deposition of millimeter wave energy. A simple treatment of plasma heating with millimeter waves is discussed along with a full wave treatment. Recent experimental works are reviewed, and potentially important theoretical issues are outlined. V.T.

A80-34978 * Numerical studies of new stellarator concepts. F. Bauer, O. Betancourt, and P. Garabedian (New York University, New York, N.Y.). *Journal of Computational Physics*, vol. 35, May 1980, p. 341-355. 6 refs. Grant No. NsG-1579; Contract No. EY-76-C-02-3077.

A three-dimensional computer code has been developed to study the magnetohydrodynamic equilibrium and stability of a diffuse or sharp boundary plasma in toroidal geometry. It is shown how equilibria with net toroidal current identically zero can be determined and how growth rates of instabilities can be calculated. Applications are made to an $l = 2, 3$ stellarator configuration that offers the possibility of achieving a critical value as high as 10% for the plasma parameter.
(Author)

A80-34989 # Electrical nonuniformities in diagonally connected generators. S. Kuo, B. Cheo, and E. Levi (New York, Polytechnic Institute, Farmingdale, N.Y.). *Journal of Energy*, vol. 4, Mar.-Apr. 1980, p. 88-94. Contract No. ET-78-C-01-3084.

Experimental data show that stationary nonuniformities may occur at much longer wavelengths than the unstable ones predicted by the linear theory. A nonlinear analysis shows that the mechanism of mode coupling may be responsible for this occurrence. It is found that the instability regime extends over a much wider parameter range than previously determined. Analyses also show that over

sections of the channel, the Hall field may diminish or even reverse.
(Author)

A80-34990 # High electrical conductivity and high Hall coefficient in MHD generator. H. Yamasaki, S. Shioda (Tokyo Institute of Technology, Yokohama, Japan), S. Saito, and Y. Shimazu. *Journal of Energy*, vol. 4, Mar.-Apr. 1980, p. 95, 96. 5 refs.

The results of power generation experiments in a nonequilibrium MHD generator are reported. With a magnetic field of 1.43 T and a seed fraction of 0.00011, the highest effective conductivity was 200 mho/m, which is close to the ideal value, and the highest effective Hall coefficient was 8.5, or 80% of the ideal value. No saturation of the effective conductivity and the effective Hall coefficient has been observed at electron densities above 10 to the 14th per cu cm. The results confirm the recovery of the effective conductivity and the effective Hall coefficient in a nonequilibrium MHD generator in the regime of fully ionized seed and suggest a significant increase in the isentropic efficiency of the generator. V.L.

A80-35161 Ocean engineering for OTEC; Proceedings of the 1980 Energy-Sources Technology Conference and Exhibition, New Orleans, La., February 3-7, 1980. Conference sponsored by the American Society of Mechanical Engineers. Edited by O. M. Griffin (U.S. Navy, Naval Research Laboratory, Washington, D.C.) and J. G. Giannotti (Giannotti and Associates, Annapolis, Md.). New York, American Society of Mechanical Engineers (Ocean Engineering Symposia Series. OED Volume 9), 1979. 91 p. \$14.

The papers deal with engineering problems associated with the OTEC main platform, the mooring system, and the pipe required to raise cold water from large ocean depths. Among the topics covered are methods for predicting the static and dynamic response of the cold water pipe and the main plant platform to the forces of waves and currents; at-sea determination of a large diameter steel cold water pipe to the ocean environment; and approaches to the prediction of wave drift forces acting on OTEC platforms. V.P.

A80-35162 # NOAA's cold-water pipe at-sea test program. J. A. Pompa, M. C. Komelasky, J. M. Schneider, and J. R. Buck (ORI, Inc., Silver Spring, Md.). In: *Ocean engineering for OTEC; Proceedings of the 1980 Energy-Sources Technology Conference and Exhibition, New Orleans, La., February 3-7, 1980*. New York, American Society of Mechanical Engineers, 1979, p. 1-6.

The paper deals with a project concerning the design, deployment, and instrumentation of a one-third scale model of an OTEC cold water pipe (CWP). The organizational structure involved in the CWP at-sea test program is described, along with the role of the test integration management in coordinating the various activities of the test engineering group and maintaining liaison between NOAA's Office of Ocean Engineering and the participants in the project. A plan established for validating the CWP analytic model is outlined.
V.P.

A80-35163 # The NOAA/DOE frequency-domain methods for analysis of OTEC plant CWP and CWP/platform static and dynamic response. P. Y. Chang and R. A. Barr (Hydronautics, Inc., Laurel, Md.). In: *Ocean engineering for OTEC; Proceedings of the 1980 Energy-Sources Technology Conference and Exhibition, New Orleans, La., February 3-7, 1980*. New York, American Society of Mechanical Engineers, 1979, p. 7-20. 13 refs.

A frequency-domain method for analyzing the at-sea dynamic and static behavior of the OTEC cold water pipe (CWP) and platform/CWP designs is described. In this method, the CWP is treated as a linear elastic beam, making allowance for the coupling between the CWP and the platform. The documentation, validation, and capabilities of the method are discussed. Some relative merits of frequency-domain and time-domain methods are noted.
V.P.

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A80-35164 # An equivalent linear representation of the forces exerted on the OTEC CW pipe by combined effects of waves and current. J. R. Paulling (California, University, Berkeley, Calif.). In: Ocean engineering for OTEC; Proceedings of the 1980 Energy-Sources Technology Conference and Exhibition, New Orleans, La., February 3-7, 1980. New York, American Society of Mechanical Engineers, 1979, p. 21-28. Research supported by Giannotti and Associates.

A80-35165 # Structural analysis of a cold water pipe for a 40MWe spar OTEC platform. W. K. Jawish, III (Giannotti and Associates, Inc., Annapolis, Md.) and W. P. Deuchler (Gibbs and Cox, Inc., Arlington, Va.). In: Ocean engineering for OTEC; Proceedings of the 1980 Energy-Sources Technology Conference and Exhibition, New Orleans, La., February 3-7, 1980. New York, American Society of Mechanical Engineers, 1979, p. 29-46. 11 refs.

A80-35166 # At-sea test of a large diameter steel, cold water pipe. R. W. Blevins, H. L. Donnelly, J. T. Stadter, R. O. Weiss (Johns Hopkins University, Laurel, Md.), and L. Perez y Perez (Deep Oil Technology, Inc., Irvine, Calif.). In: Ocean engineering for OTEC; Proceedings of the 1980 Energy-Sources Technology Conference and Exhibition, New Orleans, La., February 3-7, 1980.

New York, American Society of Mechanical Engineers, 1979, p. 47-65. Research supported by the U.S. Department of Energy.

During December 1978 and January 1979, a series of tests were conducted off Santa Catalina Island, California, on a large-diameter steel pipe. The pipe was 5 ft (1.52 m) in diameter and made up in 20-ft (6.10 m) sections to obtain a total length up to 500 ft (152.4 m). Deep Oil Technology's X-1 semi-submersible platform was used to support the pipe through a gimbal joint and the platform was moored with spring buoys in 1000 ft (304.8 m) of water. The objectives were to evaluate the at-sea performance of various configurations and to use the test results to verify or improve existing time and frequency domain analyses of cold-water pipes for Ocean Thermal Energy Conversion (OTEC) plants. The configurations tested were platform alone; platform with 120-ft (36.58 m) pipe, with 300-ft (91.44 m) pipe, with 500-ft (152.4 m) pipe and with 384-ft (117.0 m) pipe including a U-joint at 162 ft (49.38 m). The results of the analyses indicate that the frequency locations of the spectral peaks are generally well predicted, but comparison of the peak values is in poorer agreement. (Author)

A80-35167 # Comparative evaluation of various methods for the prediction of wave drift forces on OTEC platforms. J. C. Oliver, III (Giannotti and Associates Inc., Annapolis, Md.). In: Ocean engineering for OTEC; Proceedings of the 1980 Energy-Sources Technology Conference and Exhibition, New Orleans, La., February 3-7, 1980. New York, American Society of Mechanical Engineers, 1979, p. 67-87. 26 refs.

The present comparative evaluation of approaches to the prediction of wave drift forces acting on floating bodies was motivated by the disparities in the predictions of two contractors for the OTEC platform designs. A number of theories and methods for the calculation of mean and slowly varying drift forces have been evaluated, on the basis of specially devised criteria, to select the methods (and organizations) which provide the highest probability for accurate prediction of stationkeeping subsystem loading. V.P.

A80-35379 # On the low frequency drift wave and the pseudoclassical diffusion. C.-F. Zhang (Peking University, Peking, Communist China). *Acta Physica Sinica*, vol. 29, Feb. 1980, p. 214-224. 5 refs. In Chinese, with abstract in English.

The relationship between the low frequency drift wave and the empirical law of anomalous transport in Tokamak pseudo-classical diffusion is discussed. It is shown that it is the collisionless drift wave, rather than the dissipative wave, which corresponds to the pseudoclassical diffusion. If the linear unstable collisionless drift wave is saturated mainly by the quasilinear relaxation process, it can lead to a diffusion of the pseudo-classical type. The range of the

parameters in which the above mentioned mechanism may be effective is discussed. (Author)

A80-35403 MHD direct channel from heat to electricity. N. Lihach. *EPRI Journal*, vol. 5, Apr. 1980, p. 21-25.

The potential benefits and difficulties of the development and operation of a combined MHD/steam electric generating plant are assessed. The concept of MHD power generation by the passage of extremely hot, pressurized coal combustion gases ionized by a seeding material through the field of a superconducting magnet, coupled with conventional steam generation using the MHD exhaust gases as a heat source, is outlined, and areas of MHD technology requiring extensive development are indicated. Recent research on these areas is reviewed, and achievements in MHD channel durability, superconducting magnets, power inverters and the planned start-up of a 40-50 MW component development and integration facility are noted. Development strategies to ensure the competitiveness of MHD with other advanced power systems are discussed, and means of ensuring reliability are indicated. The economic potential of MHD is considered, and it is noted that MHD may also be coupled with future fusion and high-temperature nuclear reactors. A.L.W.

A80-35434 Numerical study of propagation and damping of lower hybrid wave in tokamak plasmas. T. Maekawa, Y. Terumichi, and S. Tanaka (Kyoto University, Kyoto, Japan). *Physical Society of Japan, Journal*, vol. 48, Mar. 1980, p. 965-972. 25 refs. Research supported by the Japan Society for the Promotion of Science.

Incident lower hybrid waves propagate toward the center of the plasma in a spiral form in the poloidal and the toroidal sections and finally are absorbed by the ion and/or the electron Landau damping within the limited spatial region in accordance with the refractive index parallel to the magnetic field, N_{\parallel} , which is varied considerably along the trajectory, because of the toroidicity and the rotational transform. The scaling law of the wave trajectories on plasma parameters is proposed, which shows that the control of N_{\parallel} or the applied frequency is necessary during the lower hybrid heating. These wave trajectories and damping based on the unmagnetized ion model are compared with those based on the magnetized ion model. (Author)

A80-35438 Time evolution of the elongation ratio and Mirnov oscillation under the different current profiles in a non-circular tokamak. S. Shinohara, K. Sakuma, S. Tsuji, and H. Toyama (Tokyo, University, Tokyo, Japan). *Physical Society of Japan, Journal*, vol. 48, Mar. 1980, p. 1051, 1052.

A80-35439 Role of runaway electrons in the formation of arcing on the electrically isolated target in tokamak. S. Yamamoto, Y. Shimomura, K. Ohasa, H. Kimura, S. Sengoku, K. Odajima, T. Matsuda, H. Matsumoto, H. Ohtsuka, and H. Maeda (Japan Atomic Energy Research Institute, Tokai, Ibaraki, Japan). *Physical Society of Japan, Journal*, vol. 48, Mar. 1980, p. 1053, 1054. 8 refs.

The role of runaway electrons in the formation of arcing on the electrically isolated target in the scrape-off layer of tokamaks is discussed. Runaway electrons offer the sufficient sheath potential to produce an arc spot and supply the circulating current to sustain an arc in the current rising phase and in the disruptive phase of tokamak discharge. (Author)

A80-35499 * # An exploratory survey of noise levels associated with a 100 kW wind turbine. J. R. Balombin (NASA, Lewis Research Center, Cleveland, Ohio). *Acoustical Society of America, Meeting, 99th, Atlanta, Ga., Apr. 21-25, 1980, Paper*. 18 p.

During performance tests of a 125-foot diameter, 100 kW wind turbine at the NASA Plum Brook Station near Sandusky, Ohio, the opportunity arose to make exploratory noise measurements and results of those surveys are presented. The data include measurements as functions of distance from the turbine, and directivity angle, and cover a frequency range from 1 Hz to several kHz.

Potential community impact is discussed in terms of A-weighted noise levels relative to background levels, and the infrasonic spectral content. Finally, the change in the sound power spectrum associated with a change in the rotor speed is described. The acoustic impact of this size wind turbine is judged to be minimal. (Author)

A80-35574 * # **Advanced Gas Turbine Powertrain System Development Project.** H. E. Helms (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). *U.S. Department of Energy and NASA, International Automotive Propulsion Systems Symposium, 5th, Dearborn, Mich., Apr. 14-18, 1980, Paper, 27 p.* Contract No. DEN3-168.

A progress report on the Advanced Gas Turbine Powertrain System Development Project being performed under contract from NASA Lewis is presented. The goals and objectives of the project are described noting that funds from the DOE, Office of Transportation Programs are used to sponsor the project. Among the demonstration objectives are attaining a fuel economy of 42.5 miles per gallon in a 1985 Pontiac Phoenix, multifuel capability, and emission levels within the federal standards. Design objectives examined include competitive reliability and life as well as competitive initial and life cycle costs. Finally, it is stressed that high risk and key elements in this advanced powertrain project are the development of ceramic turbine engine components and the aerodynamic development of small size turbine components. M.E.P.

A80-35685 **Effect of current constriction at electrodes on MHD generator characteristics.** V. A. Biturin and G. A. Liubimov (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 17, Sept.-Oct. 1979, p. 1069-1081.) *High Temperature*, vol. 17, no. 5, Mar. 1980, p. 879-888. 19 refs. Translation.

Relations are obtained which close the hydraulic system of equations for calculating flows in MHD generator channels which allow for the arc character of the discharge at the electrodes. These relations are the components of Ohm's law averaged in a special way with allowance for the essentially three-dimensional character of the distributions of the electrodynamic parameters in the presence of arcs on the electrodes. Possible computational procedures are discussed, or alternatively, a set of experimental data, which make it possible to determine all the required quantities in the relations obtained. (Author)

A80-35717 # **Atmospheric considerations for design of WECS.** R. W. Thresher (Oregon State University, Corvallis, Ore.). In: *Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings.* Boston, Mass., American Meteorological Society, 1979, p. 13-27; Discussion, p. 29.

Interrelationships between atmospheric criteria and wind turbine design are investigated. Attention is given to the characteristics of the site and to quasi-steady structural design requirements. As an example, the problem of determining the tower design for a specific wind turbine is considered; the tower is a uniform circular steel tower and the turbine is a 200 kW system. B.J.

A80-35718 # **Analysis of wind speed characteristics for design criteria development in the Kaman/DOE 40-kW wind turbine generator program.** M. A. Bowes and R. Perley (Kaman Aerospace Corp., Bloomfield, Conn.). In: *Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings.* Boston, Mass., American Meteorological Society, 1979, p. 31-44; Discussion, p. 45. Research sponsored by the U.S. Department of Energy.

A80-35724 # **Data analysis at the Rocky Flats Wind Systems Test and Development Center.** A. C. Hansen (Rockwell International Corp., Rocky Flats, Colo.). In: *Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings.* Boston, Mass., Ameri-

can Meteorological Society, 1979, p. 103-110; Discussion, p. 111, 112.

At the Rocky Flats Wind Systems Test and Development Center, data analysis techniques are in use that make possible the interpretation of every instant in the operation of wind energy conversion systems in random winds. This paper discusses three of the methods in use and gives examples of their application using samples of data from Energetech 1500 and Jacobs 3-kW systems. The method-of-bins is shown to be the proper method for obtaining a system power curve and a useful method for examining a variety of system parameters. Joint probability distribution methods are useful for visually displaying system behavior and for the identification of hysteresis. Frequency domain analyses are essential to understanding the transient response of wind systems to a turbulent wind input. B.J.

A80-35725 # **Some meteorological activities in the National Swedish Wind Energy Program.** T. Faxen (Uppsala, Universitet, Uppsala, Sweden). In: *Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings.* Boston, Mass., American Meteorological Society, 1979, p. 113-130. 10 refs.

Two major projects of the National Swedish Wind Energy Program are described: (1) the meteorological field station at the 60-kW windmill at Kalkugnen, and (2) the Gotland-Skane project, intended to determine sites for two 1-2 MW prototype windmills. A preliminary study indicates that the meteorological project at Kalkugnen is likely to give data of great use for wind energy technology. Continuous recording is a necessary condition for the performance evaluation of the windmill and its dependence on wind speed, wind direction, and stability. The second study gives a good example of what can be accomplished with ordinary pibal trackings; the result is an extensive data set of high quality that can be used not only for its original purpose but also for future studies and tests. B.J.

A80-35726 # **Turbulence and WTG performance.** R. H. Kirchoff (Massachusetts University, Amherst, Mass.). In: *Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings.* Boston, Mass., American Meteorological Society, 1979, p. 131-137; Discussion, p. 139.

The UMass 25-kW wind turbine (Cromack et al. 1977) has been instrumented to determine its steady state and dynamic operating characteristics. The results presented in this paper focus on the dynamic response of the turbine. R. M. Young Gill-type anemometers are used to measure the turbulent wind characteristics. Generator output and other response characteristics of interest are recorded on FM tape. These data are digitized and eventually processed using the Biomedical Statistical Package. The results reported herein are an analysis of two time series. (Author)

A80-35727 # **Wind turbine dynamic blade loads due to wind gusts and wind direction changes.** W. Stoddard (U.S. Windpower Associates, Burlington, Mass.). In: *Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings.* Boston, Mass., American Meteorological Society, 1979, p. 141-150.

A80-35730 * # **The use of wind data with an operational wind turbine in a research and development environment.** H. E. Neustadter (NASA, Lewis Research Center, Cleveland, Ohio). In: *Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings.* Boston, Mass., American Meteorological Society, 1979, p. 179-188; Discussion, p. 189. 9 refs.

It is noted that in 1976, 17 candidate sites were identified for detailed evaluation as potential sites for installation of large, horizontal axis Wind Turbines (WT). Attention is given to the Mod-OA, a 200 kW WT located in Clayton, New Mexico. The discussion covers the meteorological data collected, some of the

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analyses based on these wind data as well as additional areas currently being investigated in relation to these data. M.E.P.

A80-35738 # **Manufacturers' view of wind resource assessments.** W. Wiesner (Boeing Engineering and Construction, Seattle, Wash.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 285-291.

A typical analysis of wind resource data by a manufacturer of large wind turbines is presented. Apart from general region surveys, the analysis includes an exploratory survey of potential sites which results in wind speed frequency distributions based on one year of data, and detailed site surveys over two years or more which provide accurate wind gradient (shear) data, variability of wind direction and magnitude information, and wind direction frequency distribution. This information is necessary for determining the layout of wind turbines in a cluster, and for determining how well the turbines can provide electricity to the utility grid. The use of wind data is illustrated by examples. V.L.

A80-35739 # **Agricultural applications of wind resource assessments.** G. L. Johnson (Kansas State University of Agriculture and Applied Science, Manhattan, Kan.) and J. Wagner (Development Planning and Research Associates, Inc., Manhattan, Kan.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 293-301, 303. 6 refs.

A80-35748 # **WECS site screening by physical modeling.** R. N. Meroney (Colorado State University, Fort Collins, Colo.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 393-404. 11 refs. Contracts No. EG-77-S-06-1043; No. EY-76-S-06-2438.

Results of the physical modeling of the interactions of wind and topography to be used in wind-power generator site selection are presented. The modeling involved the measurement of air velocity and turbulence over a scale model of selected terrain features placed in a simulated atmospheric flow. Measurements of wind speed, turbulence intensity, static pressure, skin friction and spectra made for a number of generic two-dimensional model hill shapes are discussed, and methods for the prediction of mean wind velocities over actual ridge crests and turbulence effects on the basis of model distributions are indicated. Comparisons of wind velocities calculated from laboratory simulations with field measurements obtained at Rakaiia Gorge, New Zealand and Kahuku Point, Oahu are presented which demonstrate the validity and usefulness of physical modeling in wind prediction and wind power system siting. A.L.W.

A80-35750 # **Status of the Large Wind Turbine Siting Handbook.** T. R. Hiester and W. T. Pennell (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Conference and Workshop on Wind Energy Characteristics and Wind Energy Siting, Portland, Ore., June 19-21, 1979, Proceedings. Boston, Mass., American Meteorological Society, 1979, p. 417-428. Contract No. EY-76-C-06-1830.

A80-36048 **RF feedback stabilization of a thin line cusp magnetoplasma sheath.** R. Jones (Natal, University, Durban, Republic of South Africa). *Plasma Physics*, vol. 22, Apr. 1980, p. 355-359. 9 refs. Research supported by the South African Atomic Energy Board.

The stabilization of naturally occurring plasma microinstabilities in magnetoplasma line cusps by RF feedback is investigated as a means of recovering plasma leaks in a cusp-confined plasma. Langmuir and capacitance probes were used to detect and launch RF signals in and around the subject line cusp used for surface magnetic

confinement in the ion source of a double plasma device. The ambient plasma noise is observed to vary with the phase of feedback amplification, leading to a widening of the plasma cusp channel upon positive feedback. When negative feedback is applied, a thinner cusp channel is obtained, corresponding to a width only slightly greater than the theoretical hybrid leak width. It is also noted that plasma flow speed into the cusp remains constant as the cusp width is modified, while the effects of sheath narrowing on central plasma density have not been determined. A.L.W.

A80-36397 **Evolution of flux-conserving tokamak equilibria with preprogrammed cross sections.** J. A. Holmes and Y.-K. M. Peng (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Journal of Computational Physics*, vol. 36, June 1980, p. 35-54. 24 refs. Contract No. W-7405-eng-26.

A model and associated procedures are presented which provide a method for studying the time evolution of MHD equilibria subject to various particle and energy source terms. It is demonstrated that the numerical results obtained with these procedures satisfy satisfactory convergence criteria as well as consistency between the one-dimensional and two-dimensional parts of the problem. Further, through the use of a fixed boundary equilibrium routine, it is possible to prescribe the evolution of the plasma boundary to permit the treatment of cases in which the plasma cross section changes significantly and in which precise plasma positioning and shaping are required, without the necessity of using external fields and coils. Finally, the method is applied to the neutral beam heating of a prototypical reactor plasma to ignition. M.E.P.

A80-36430 # **The helical hydromagnetic dynamo (O vintovom gidromagnitnom dinamo).** Iu. B. Ponomarenko. *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, Mar.-Apr. 1980, p. 22-28. 9 refs. In Russian.

The analysis deals with the steady-state electrodynamic in a conducting fluid in which external forces maintain a velocity field. In earlier studies of self-sustaining dynamos, it has been shown that, in a helical geometry, a magnetic field is excited by discontinuous axisymmetric motion of an electrically conducting fluid. In the present paper, the question whether the solutions hold in the case where the axisymmetric motion is continuous is examined. The problem is formulated as the excitation of a magnetic field by the helical motion of a conducting fluid in which the angular and axial velocities are constant within a cylinder of unit radius, are inversely proportional to the square of the radius beyond the cylinder, and are discontinuous on the cylinder. In the case of continuous motion, the number of eigenvalues with a positive increment is shown to increase indefinitely with increasing angular velocity. V.P.

A80-36590 **Influence of base resistivity on the temperature characteristics of silicon photoconverters.** V. G. Doroshenko, M. B. Zaks, G. I. Klimova, E. S. Russkikh, and Z. A. Stepanova. (*Geliotekhnika*, vol. 15, no. 5, 1979, p. 23-29.) *Applied Solar Energy*, vol. 15, no. 5, 1979, p. 16-22. 13 refs. Translation.

The paper demonstrates that the efficiency and no-load voltage of silicon photoconverters (PC) have an increased sensitivity to temperature effects. There is a reduction in the temperature coefficient of short-circuit current as the resistivity of the photoconverter base increases in the 100-400 K range. The investigated PC's were fabricated from p-type silicon; the n⁺/p and n⁺/p-p⁺/p⁺ structures were produced by diffusion of phosphorus and boron from doping solutions to depths of 0.7 and 1 micron. It is concluded that for sufficiently large instantaneous rates of change in PC temperature during thermal cycling, destruction of the contact system of the device is not limited to the doped layer of the PC, but develops in the base region of the specimen. A.T.

A80-36714 **Derivation of CGL theory with finite Larmor radius corrections.** R. K. Chhajlani and S. C. Bhand (Vikram University, Ujjain, India). *Journal of Plasma Physics*, vol. 23, Apr. 1980, p. 205-208. 16 refs.

A method has been developed for the derivation of Chew-Goldberger-Low (CGL) theory for a collisionless plasma in the presence of a strong magnetic field. The pressure tensor in the pressure tensor equation is expanded in the inverse power of Larmor frequency. In the zeroth order, CGL equations are obtained and, in the higher order, finite Larmor radius corrections to CGL equations are derived. (Author)

A80-36726 On the validity of a hydrodynamic description of laser-driven fusion. D. N. Lowy (New South Wales, University, Kensington, Australia) and H. J. Kreuzer (New South Wales, University, Kensington, Australia; Alberta, University, Edmonton, Canada). *Journal of Plasma Physics*, vol. 23, Apr. 1980, p. 357-381. 32 refs.

The validity of hydrodynamic approximations for non-equilibrium plasmas is examined, with emphasis on applications to laser-driven fusion pellets. Typical density-temperature trajectories of such pellets, as predicted by hydrodynamic calculations in the published literature, are shown to lie sometimes outside the region of validity of hydrodynamic theory, which is an unsatisfactory situation. In view of this, certain criteria which can be easily used to test the self-consistent validity of any hydrodynamic result are discussed. Finally, it is noted that in the low-density, low-temperature plasma region, hydrodynamics initially breaks down because of a breakdown in conventional microscopic linear response theory. A modified microscopic theory is proposed with continues to be valid in the region. This may correspondingly extend the validity of hydrodynamics to plasmas of somewhat lower temperatures and densities. (Author)

A80-36831 Maximum refrigerating capacity of thermoelectric cooling devices. R. V. Koval'skii (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, no. 4, 1979, p. 19-24.) *Applied Solar Energy*, vol. 15, no. 4, 1979, p. 16-20. 6 refs. Translation.

The paper investigates conditions under which a thermoelectric refrigerator with constant working-fluid temperature and a specified cold-generation capacity has minimum size, weight, and amount of thermoelectric material. The effect of switching losses on device optimization is considered, and an analytical relationship for determining optimal branch height of thermoelectric elements is proposed. B.J.

A80-36936 * Photoemission measurements of interface barrier energies for tunnel oxides on silicon. P. V. Dressendorfer and R. C. Barker (Yale University, New Haven, Conn.). *Applied Physics Letters*, vol. 36, June 1, 1980, p. 933-935. 18 refs. Navy-NASA-supported research.

Internal photoemission measurements of the Si/SiO₂ and Al/SiO₂ barrier heights on oxides of tunneling thickness (43-56 Å) are compared with measurements on thick oxides (310 Å and greater) and the barrier heights are found to be the same. The results suggest that substantially thinner oxides, grown by the same method, can be characterized by the same barrier heights. Limits to the experimental technique posed by photovoltaic and displacement currents, and transport of hot carriers in the tunnel oxide are discussed. (Author)

A80-37004 Surface area loss of platinum supported on carbon in phosphoric acid electrolyte. G. A. Gruver, R. F. Pascoe, and H. R. Kunz (United Technologies Corp., Power Systems Div., South Windsor, Conn.). (*Electrochemical Society, Meeting, Pittsburgh, Pa., Oct. 15-20, 1978.*) *Electrochemical Society, Journal*, vol. 127, June 1980, p. 1219-1224. 25 refs.

An experimental study was conducted to determine the surface area loss of platinum supported on carbon in a 191 C phosphoric acid fuel cell environment and to define the mechanism for this process. The surface area was found to decline rapidly initially; but remains above 20 sq m/g for 20,000 hr, the longest time period investigated. A study of the effect of operating potential, trans-

mission electron microscope studies of electrodes, and Pt deposited on a carbon film, and the results of other previous studies indicate that crystallite migration and coalescence are the major mode by which Pt surface area is lost in this situation. (Author)

A80-37006 Metal film semiconductor photoelectrochemical cells. S. Menezes, A. Heller, and B. Miller (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Electrochemical Society, Journal*, vol. 127, June 1980, p. 1268-1273. 12 refs.

Voltammetric and light-to-electrical energy conversion characteristics of metallized semiconductor Schottky junctions with redox solution contacts are reported. Electrodeposited noble metal films on n-GaAs establish contacts to reversible aqueous redox couple solutions that can sustain solar photocurrent levels with low loss, requiring only a thin metal layer adequate to photovoltaic barrier formation. Possible advantages in lateral conductivity, relative to solid-state Schottky devices, and in surface stability and redox electrolyte independence, relative to semiconductor-liquid junction solar cells, are weighed against both the absorptive losses in the metal layer and the practicalities of obtaining sufficient integrity in the film to serve the semiconductor corrosion protection function. Gold, platinum, and rhodium plated n-GaAs with carbon counter-electrodes and ferro-ferricyanide solutions give 2-6% conversion efficiency under solar irradiance. (Author)

A80-37007 Influence of electrolyte composition on electrode kinetics in the molten carbonate fuel cell. P. G. P. Ang and A. F. Sammells (Institute of Gas Technology, Chicago, Ill.). *Electrochemical Society, Journal*, vol. 127, June 1980, p. 1287-1294. 22 refs.

A80-37008 Glassy electrolyte galvanic cells. T. Minami, T. Katsuda, and M. Tanaka (Osaka Prefecture, University, Sakai, Japan). *Electrochemical Society, Journal*, vol. 127, June 1980, p. 1308-1310. 10 refs. Research supported by the Asahi Glass Foundation for the Contribution of Industrial Technology.

The AgI-Ag₂O-MoO₃ and AgI-Ag₂O-P₂O₅ glass systems used in galvanic cells are examined for their electrolytic properties. The measured initial open-circuit voltages of 687.0, 687.0, and 685.4 mV for three different compositions are very close to the theoretical value, 687.3 mV, for the standard emf. These values are stable and decrease by 1-2 mV in 30 days. Current densities of 1 mA/sq cm are obtained without significant polarization. The discharge parameters are found to be comparable to those of the cells with crystalline electrolytes. V.L.

A80-37181 Review of the ISX-B experimental program. M. J. Saltmarsh (Oak Ridge National Laboratory, Oak Ridge, Tenn.). (*American Vacuum Society, National Symposium, 26th, New York, N.Y., Oct. 1-5, 1979.*) *Journal of Vacuum Science and Technology*, vol. 17, Jan.-Feb. 1980, p. 260-267. 23 refs. Contract No. W-7405-eng-26.

The ISX-B tokamak is a modestly sized device that is designed to explore questions closely related to the design of future tokamak devices, such as the Engineering Test Facility (ETF). The major program emphasis is on high-beta plasma operation using neutral beams to heat plasmas with noncircular cross sections. In addition, substantial efforts are under way or planned in the areas of plasma-wall interactions, coated limiter studies, electron-cyclotron heating, ripple injection, impurity flow reversal, pellet injection, and the application of a bundle divertor. The current status and future plans for these programs are reviewed. (Author)

A80-37182 Design and operational characteristics of the cryopump high-vacuum system for the 25000-l target chamber of the Helios Laser Facility. N. G. Wilson (California, University, Los Alamos, N. Mex.) and K. N. Watts (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). (*American Vacuum Society, National Symposium, 26th, New York, N.Y., Oct. 1-5, 1979.*) *Journal of Vacuum Science and Technology*, vol. 17, Jan.-Feb. 1980, p. 270-273. Research sponsored by the U.S. Department of Energy.

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A80-37185 # Transient getter scheme for the tokamak fusion test reactor. J. L. Cecchi, S. A. Cohen (Princeton University, Princeton, N.J.), and J. J. Sredniawski (Grumman Aerospace Corp., Bethpage, N.Y.). (*American Vacuum Society, National Symposium, 26th, New York, N.Y., Oct. 1-5, 1979.*) *Journal of Vacuum Science and Technology*, vol. 17, Jan.-Feb. 1980, p. 294-297. 15 refs. Contract No. EY-76-C-02-3073.

A method has been developed of utilizing SAES Zr/Al getter modules, which obviates the need for frequent interruptions of machine operation by using the pulsed operation of TFTR. These interruptions are required for regeneration of the absorbed tritium after as few as 50 machine pulses. With the Zr/Al getter at 500-600 C it is possible to achieve a quasisteady state in tritium loading where the quantity of tritium desorbed between pulses is equal to the quantity which is absorbed during a pulse. Since frequent thermal cycling is not required, this scheme also reduces the possibility of Zr/Al getter material fatigue. A.T.

A80-37812 # Pulsed power for fusion. T. H. Martin (Sandia Laboratories, Albuquerque, N. Mex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 2-8. 9 refs. Contract No. DE-AC04-76DP-00789.

The modular ICF pulsed power concept which can provide systems to 1000 TW and 30 MJ with improvements in technology and reliability is presented. The pulsed types of accelerators are 30 to 50% efficient, and they can provide an approach to economically feasible 200 MW power reactor for ion outputs in the 1 to 3 MJ range. Repetitive pulsing of the pulsed power system for more than 10 to the 9th short lifetimes must be solved along with ion beam concentration, bunching, and drifting. A.T.

A80-37815 # Accelerator module of 'Angara-5'. S. V. Basenkov, O. A. Gusev, Iu. A. Istomin, Iu. V. Koba, G. M. Latmanizova, A. M. Pasechnikov, B. P. Pevchev, O. P. Pecherskii, A. S. Perlin, and L. I. Rudakov (Akademiiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 25-30. 9 refs.

Design of the inertial confinement fusion multi-module 'Angara-5' accelerator is considered. The computed output parameters of an individual module are presented, and the predicted output was compared with the pulse-shaping line mock-up measurements. According to these measurements the end-on section contributes 21% of the total pulse-shaping line capacitance. The end-on capacitance was accounted for in computations via transmission line sections with appropriate impedance values. The reasonable choice of the pulse-shaping equivalent circuit was confirmed by experimental data and was in agreement with calculations based on system design features. A.T.

A80-37818 # The near and long term pulse power requirement for laser driven inertial confinement fusion. W. L. Gagnon (California, University, Livermore, Calif.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 49-54. 14 refs. Contract No. W-7405-eng-48.

The paper examines pulse power requirements for laser driven inertial confinement fusion. At the Lawrence Livermore Laboratory emphasis has been placed on the development of large Nd:glass laser systems in order to solve the basic physics problems associated with light driven fusion targets. A parallel program is aimed at the development of lasers which exhibit higher efficiencies and shorter wavelengths and thus are more suitable as drivers for fusion power plants. The paper discusses the pulse power technology developed to meet the needs of the laser fusion program at Livermore. A.T.

A80-37820 # Repetitively pulsed electron beam diode lifetime and stability. M. T. Buttram (Sandia Laboratories, Albuquerque, N. Mex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 61-64. Contract No. DE-AC04-76DP-00789.

Repetitively pulsed vacuum beam diodes will be required for most projected inertially confined fusion systems. Yet data on the operation of diodes under repetitive pulsing is sparse. This paper discusses the operation of a 250 kV, 1.5 kA/sq cm diode at repetition rates to 30 Hz for sustained runs. Short term stability is typically 3 percent (standard deviation). In a longer term there is a drift toward higher impedance at the start of the pulse. Details on this drift and a comparison of this process for a blunt versus sharp edged cathode are presented. (Author)

A80-37824 # Fundamental limitations and design considerations for compensated pulsed alternators. W. F. Weldon, W. L. Bird, M. D. Driga, K. M. Tolk, H. G. Rylander, and H. H. Woodson (Texas, University, Austin, Tex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 76-82. 5 refs. Research supported by the Texas Atomic Energy Research Foundation; Contracts No. EG-77-S-05-5594; No. N60921-78-C-A249.

Fundamental limitations imposed on the design of a compensated pulsed alternator by the mechanical, thermal, magnetic, and electrical properties of the materials used are discussed. Based on these limitations, power and energy available from such a machine are calculated as functions of machine dimensions. New design approaches are suggested, which extend the operating limits of a compulsator concept. V.T.

A80-37825 # Use of transformers in producing high power output from homopolar generators. W. H. Lupton, R. D. Ford, D. Conte, H. B. Lindstrom, and I. M. Vitkovitsky (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 83-86. 6 refs. Research supported by the U.S. Defense Nuclear Agency.

Analysis is presented for systems using high current pulse transformers to exploit the high energy storage capability of homopolar generators or other limited current sources. The stepped-up secondary current can be established either by current interruption when the primary is also used for energy storage or by commutation of current into the primary from a separate storage inductor. For high-power pulse generators the primary insulation and power supply are protected by subsequent crowbaring of the primary. An example is given of a design for matching the NRL homopolar generator with 1.46 mH inductor to 1-microH megavolt level inductive pulse generator. (Author)

A80-37854 # A large-area cold-cathode grid-controlled electron gun for Antares. W. R. Scarlett, K. R. Andrews, and H. Jansen (California, University, Los Alamos, N. Mex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 261-264. Research sponsored by the U.S. Department of Energy.

The CO₂ laser amplifiers used in the Antares inertial confinement fusion project require large-area radial beams of high-energy electrons to ionize the laser medium before the main discharge pulse is applied. A grid-controlled, cold-cathode electron gun with a cylindrical anode having a window area of 9.3 sq m has been designed. A full diameter, 1/4 length prototype of the Antares gun has been built and tested. The design details of the Antares electron gun are presented as well as test results from the prototype. Techniques used for the prevention and control of emission and breakdown from the grid are also discussed. (Author)

A80-37855 # The Antares laser power amplifier. R. D. Stine, G. F. Ross, and C. Silvermail (California, University, Los Alamos, N. Mex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers.

Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 265-268. 5 refs. Research sponsored by the U.S. Department of Energy.

The overall design of the Antares laser power amplifier is discussed. The power amplifier is the last stage of amplification in the 100-kJ Antares laser. In the power amplifier a single, cylindrical, grid-controlled cold-cathode, electron gun is surrounded by 12 large-aperture CO₂ electron-beam sustained laser discharge sectors. Each power amplifier will deliver 18 kJ and the six modules used in Antares will produce the required 100 kJ for delivery to the target. A large-scale interaction between optical, mechanical, and electrical disciplines is required to meet the design objectives. Significant component advances required by the power amplifier design are discussed. (Author)

A80-37867 # Safety grounding switches in large experiments - General considerations and the TEXT application. P. Wildi (Texas, University, Austin, Tex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers.

Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 355-358. Research supported by the U.S. Department of Energy.

The electrical installations of large fusion experiments present many potential dangers such as residual charges on capacitor banks and cables, power rectifiers, and other related power supplies. The paper reviews practices commonly employed to reduce such dangers and discusses the adequacy and safety of various grounding devices. The safety grounding scheme for the TEXT tokamak is described. Specially designed switches, their contact and operating mechanisms, and the integration of the switches in the overall control and safety system are discussed. B.J.

A80-37871 # Magnet optimization for pulsed energy conversion. W. K. Tucker, E. C. Cnare, W. P. Brooks (Sandia Laboratories, Albuquerque, N. Mex.), R. E. Wilcox, and W. D. Markiewicz (Intermagnetic General Corp., Guilderland, N.Y.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers.

Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 381-384. 6 refs. Contract No. AT(29-1)-789.

PULSAR, a flux compression generator, is being developed to meet power requirements for future fusion reactors. This paper presents results of a study performed to design a suitable superconducting magnet for PULSAR. The systems analysis, parameter study, magnet design, and cost estimates are reviewed. It is shown that designs of three different sizes have been developed, allowing flexibility in the armature-generator configuration. The basic differences in the designs are of geometry and field. B.J.

A80-38012 Sow wind turbines and reap the wind. O. J. M. Smith (California, University, Berkeley, Calif.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 4.

New York, Pergamon Press, Inc., 1980, p. 1796-1833.

7 refs.

A 6-meter-diameter wind turbine has been designed and constructed, which is easy to fabricate and maintain, has low weight, high strength, and low cost. The turbine, which is a modification of the traditional multibladed farmer windmill pump, is intended for rural areas and can be used to feed power directly into the existing A.C. distribution and transmission system. The turbine can deliver 10 KW in a 45 km/hr wind and 17 KW in a 60 km/hr wind. In a region with a 30 km/hr average wind speed, the turbine can deliver 105 KWH per day at a cost of only one cent per KWH. The turbine uses a low-cost mass-produced 2-speed squirrel-cage induction generator (or motor), and a wheel with a front and rear bearing, instead of a cantilevered shaft; it can be manufactured for \$5000 each. V.L.

A80-38283 Review - Materials aspects of wave energy converters. J. A. Hudson, D. C. Phillips, and N. J. M. Wilkins (Atomic Energy Research Establishment, Harwell, Oxon, England). *Journal of Materials Science*, vol. 15, June 1980, p. 1337-1363. 38 refs.

A review of the device concepts for renewable energy sources in the UK is presented. The device concepts and the materials aspects of the full-scale Wave Energy Converter (WEC) development are described, with the emphasis on generic problems. The present estimates indicate high costs, so that future efforts will be directed at reducing them, particularly those of the main structure and the mooring system. The optimum use of materials will be essential; in certain areas gaps in existing materials have been identified and experimental programs initiated. A.T.

A80-38289 Muon catalysis for energy production by nuclear fusion. Iu. V. Petrov (Leningrad Nuclear Physics Institute, Gatchina, USSR). *Nature*, vol. 285, June 12, 1980, p. 466-468. 16 refs.

Jackson (1957) has arrived at a negative conclusion in his study of the possibility of using muon-catalyzed deuterium-tritium fusion (dt-fusion) for energy production. However, results obtained by Sakharov and Zeldovich (1960) indicate that muons may be suitable as catalysts of dt-fusion. A reevaluation of this situation, in the present paper, showed that the use of muon-catalyzed dt-fusion in combination with the fissile nuclides blanket can well provide a positive energy gain. V.P.

A80-38482 Optical performance of the Gemini carbon dioxide laser fusion system. V. K. Viswanathan, J. J. Hayden, and I. Liberman (California, University, Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 165-171. 7 refs. Research sponsored by the U.S. Department of Energy.

The performance of the Gemini two beam carbon dioxide laser fusion system was recently upgraded by installation of optical components with improved quality in the final amplifier. A theoretical analysis was conducted in conjunction with measurements of the new performance. The analysis and experimental procedures, and results obtained are reported and compared. Good agreement was found which was within the uncertainties of the analysis and the inaccuracies of the experiments. The focal spot Strehl ratio was between 0.24 and 0.3 for both beams. (Author)

A80-38483 Beam simultaneity in multi-terawatt CO₂ laser fusion systems. R. L. Carlson, D. E. Casperson, J. Hanlon, J. S. Ladish, R. Quicksilver, and C. Smith (California, University, Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 172-177. Research sponsored by the U.S. Department of Energy.

A system to determine the relative time of arrival of intense, subnanosecond, CO₂ laser pulses on a fusion target is described. It is now installed on the Helios CO₂ laser system, a 10 kJ, 20 TW, eight-beam CO₂ facility. This beam simultaneity system is inexpensive, easy to use, and has a resolution of less than + or - 5 ps. (Author)

A80-38484 Optimization of a multicomponent gaseous saturable absorber for the Helios CO₂ laser system. R. F. Haglund, Jr., D. E. Casperson, S. J. Czuchlewski, C. J. Elliott, J. C. Goldstein, J. S. Ladish, and A. V. Nowak (California, University, Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 178-185. 7 refs. Research sponsored by the U.S. Department of Energy.

A multi-component gaseous saturable absorber has been developed and modified to prevent the onset of parasitic oscillations

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coupling laser-fusion targets and the power amplifiers in the Helios CO₂ laser system. This absorber mix greatly increases the extractable short-pulse energy of the laser system. A computer model that predicts the behavior of multi-component saturable absorbers has been tested against the measured performance of two different absorber gas mixes used in the Helios system. The successes and shortcomings of the model are discussed, and large and small-signal transmission data for the saturable absorber mixes and their constituent gases (used as input to the model) are presented.

(Author)

A80-38485 Helios target positioning system. R. D. Day; C. E. Cummings, J. A. Hanlon, H. E. Tucker, and R. W. Teasdale (California, University, Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 191-196.

The Los Alamos Scientific Laboratory Helios laser fusion system focuses eight powerful CO₂ laser beams onto a tiny (typical 300-micron-diam) DT-filled target. The focusing is accomplished inside a vacuum chamber that is 3.5 m in diameter by 3.5 m high. The target positioning system places the target to within 5.0 microns of a predetermined point in space. This is accomplished by using two orthogonal autocollimating telescopes to determine the center of a precisely located surrogate sphere. The target is then placed at the common focal point of the two telescopes. The Helios target positioning system has been meeting or exceeding its design requirements for about one year with minimal maintenance. It has proven to be a very effective system.

(Author)

A80-38486 Design of Helios beam diagnostics. J. D. Seagrave, I. J. Bigio, S. V. Jackson, and A. M. Laird (California, University, Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 197-206. Research sponsored by the U.S. Department of Energy.

Verification of satisfactory operation of the HELIOS eight-beam laser system requires measurement of many parameters of each beam on each shot. Fifty-joule samples of each of the eight 1250-J, subnanosecond 34-cm-diameter beams of the HELIOS system are diverted to a gallery of eight folded telescopes and beamsplit to provide diagnostic measurements. Total pulse energy, and prepulse and postpulse energy of each beam are measured; pulse shape details and a wavelength spectrum of a selected beam from each shot are measured; and provision is made for repulse measurement and optical quality monitoring. All data are recorded digitally in a local screen room, with control and communication through a fiberoptic link to the main HELIOS computer.

(Author)

A80-38489 Antares Power Amplifier optical system. C. J. Silvernail (California, University, Los Alamos, N. Mex.) and K. C. Jones (California, University; EG & G, Inc., Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 225-231. Research sponsored by the U.S. Department of Energy.

The optical systems of the six Antares Laser Power Amplifiers is described. These assemblies are preceded by the front-end optics and followed by the target system. Each power amplifier receives an annular input beam and divides it into 12 beams which are then directed to double pass them through 12 gain regions surrounding a central electron gun. Provisions are being made for spatially filtering each beam and for the possibility of adding saturable absorbers. Two keys to the successful completion of the power amplifier are: (1) the avoidance of unwanted lasing modes and hot spots in the wavefronts, and (2) the maintenance of alignment throughout the entire laser system, including the internal alignment of the Power Amplifier. The

goal has been to minimize alignment problems by careful and simplistic design of the mountings, stressing modular assemblies and accessibility. Average energy densities of 2.0 J/sq cm for salt windows and 3.0 J/sq cm on copper mirrors have been accomplished, while extracting the largest possible energy from the volume of gas which is electrically pumped.

(Author)

A80-38490 LOTS analysis of optical diffraction in Antares. P. N. Wolfe, A. C. Saxman (California, University, Los Alamos, N. Mex.), and G. Lawrence (California, University, Los Alamos, N. Mex.; Arizona, University, Tucson, Ariz.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 232-237. Research sponsored by the U.S. Department of Energy.

Diffraction and aberration effects are calculated for the power-amplifier and target-system portions of the 100-kJ Antares laser fusion facility, using LOTS, a fast-Fourier-transform propagation code incorporating a model for saturating gain in CO₂. Energy losses due to diffraction are found to be small compared to other losses. Diffraction 'hot spots' usually typical of propagation at low Fresnel numbers are effectively suppressed in the Antares power amplifier by gain saturation. Taking account of diffraction and aberrations over the whole optical train, the code predicts a target focal spot that has 82% of its energy in a 150-micron-diameter circle, a result essentially identical to what would be expected of the final focus mirror alone.

(Author)

A80-38491 Applications of the laser optical train simulations /LOTS/ computer code to laser fusion systems and other physical optics problems. G. Lawrence (Arizona, University, Tucson, Ariz.) and P. N. Wolfe (California, University, Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 238-242. 7 refs. Research sponsored by the U.S. Department of Energy and University of Arizona.

A80-38492 Infrared Smartt interferometer as an alignment tool for carbon dioxide laser fusion systems. V. K. Viswanathan and P. D. Bolen (California, University, Los Alamos, N. Mex.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 243-250. 7 refs. Research sponsored by the U.S. Department of Energy.

A80-38493 Use of adaptive optics element for wavefront error correction in the Gemini CO₂ laser fusion system. V. K. Viswanathan, J. V. Parker (California, University, Los Alamos, N. Mex.), T. A. Nussmier, C. J. Swigert (California, University, Los Alamos, N. Mex.; Hughes Research Laboratories, Malibu, Calif.), W. King, A. S. Lau, and K. Price (California, University, Los Alamos, N. Mex.; Hughes Aircraft Co., Culver City, Calif.). In: Los Alamos Conference on Optics, University of California, Los Alamos, N. Mex., May 23-25, 1979, Proceedings. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 251-257. 8 refs. Research sponsored by the U.S. Department of Energy.

The Gemini two beam CO₂ laser fusion system incorporates a complex optical system with nearly 100 surfaces per beam, associated with the generation, transport and focusing of CO₂ laser beams for irradiating laser fusion targets. Even though the system is nominally diffraction limited, in practice the departure from the ideal situation drops the Strehl ratio to 0.24. This departure is caused mostly by the imperfections in the large (34 cm optical clear aperture diameter) state-of-the-art components like the sodium chloride windows and micromachined mirrors. While the smaller optical components also contribute to this degradation, the various possible misalignments and nonlinear effects are considered to contribute very little to it. Analysis indicates that removing the static

or quasi-static errors can dramatically improve the Strehl ratio. A deformable mirror which can comfortably achieve the design goal Strehl ratio of not less than 0.7 is described, along with the various system trade-offs in the design of the mirror and the control system. (Author)

A80-38758 # Modeling of safe-life tests of thermoelectric batteries (Modelirovanie resursnykh ispytanii termobatarei). V. M. Babaev, E. M. Namazov, and A. S. Okhotin. In: Materials and processes for use in space technology. Moscow, Izdatel'stvo Nauka, 1980, p. 200-202. In Russian.

Long-term testing of thermoelectric generators, designed for use in SNAP-type systems to provide power for space manufacturing experiments, is described. Generator power requirements are reviewed, and problems associated with the development of thermoelectric generators designed for several years of operation are considered. Finally, methods for modeling accelerated life tests of such generators are analyzed. B.J.

A80-38902 * # Advanced component technologies for energy-efficient turboprop engines. N. T. Saunders (NASA, Lewis Research Center, Cleveland, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1086*. 11 p. 6 refs.

The paper reviews NASA's Energy Efficient Engine Project which was initiated to provide the advanced technology base for a new generation of fuel-conservative engines for introduction into airline service by the late 1980s. Efforts in this project are directed at advancing engine component and systems technologies to a point of demonstrating technology-readiness by 1984. Early results indicate high promise in achieving most of the goals established in the project. V.P.

A80-38964 # Turbopropulsion combustion - Trends and challenges. K. N. Hopkins (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1199*. 11 p. 6 refs.

Combustor and related engine cycle parameters are surveyed using data from 23 military engines produced between 1956 and 1979. Expected combustor related challenges resulting from normal engine advancements required for future fighter applications are addressed. Future problems are discussed with emphasis on compact combustors and improved liner cooling in a high pressure, high temperature engine environment with stringent durability requirements. (Author)

A80-39014 # A perspective on closed-cycle gas turbines applied to naval-ship propulsion. T. L. O. Horton, S. C. Kuo, H. T. Shu, C. W. Deane, and E. R. Fisher (United Technologies Research Center, East Hartford, Conn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1304*. 7 p. 7 refs. Contract No. N00014-77-C-0735.

This paper presents the results of a systems study to evaluate the potential performance, suitability, impact and development requirements of closed-cycle gas turbines (CCGT) when applied to naval ship propulsion. The performance and design characteristics of CCGT systems are estimated based on a fossil-fired heater using marine diesel fuels. The impact of the CCGT system on payload is presented for a selected most-attractive ship type. The potential development requirements (in terms of technology, time and cost) for the entire advanced propulsion system are then projected. (Author)

A80-39539 Breakeven for thermonuclear fusion in the hot-ion mode. S. E. Segre (EURATOM and Comitato Nazionale per l'Energia Nucleare sulla Fusione, Frascati, Italy). *Nuovo Cimento B, Serie 11*, vol. 57 B, May 11, 1980, p. 50-58. 6 refs.

The condition for fusion breakeven is derived for the hot-ion mode in which the ion temperature considerably exceeds the electron temperature. It is found that the conditions for breakeven in

this mode are greatly eased compared to the case of equal ion and electron temperatures. The critical value of the electron temperature is strongly reduced indicating the possibility of reaching breakeven with relatively weak additional heating. (Author)

A80-39642 * # Comments on TEC trends. J. F. Morris (NASA, Lewis Research Center, Cleveland, Ohio). *Institute of Electrical and Electronics Engineers, International Conference on Plasma Science, Montreal, Canada, June 4-6, 1979, Paper. 26 p. 54 refs.*

The paper comments on published and projected thermionic-energy-conversion (TEC) performance trends. This commentary includes graphs and an appendix relating TEC performance parameters, plots of predicted and actual TEC trends, a figure relating projected cost of electricity to overall efficiency for TEC topping, and a discussion of the implications of these relationships. V.T.

A80-39746 Discharge and corrosion characteristics of slagging metal electrodes for MHD power generators. J. K. Koester (Stanford University, Stanford, Calif.) and R. A. Perkins (Lockheed Metallurgy and Composites Laboratory, Palo Alto, Calif.). *Journal of Materials for Energy Systems*, vol. 1, Sept. 1979, p. 41-54. 8 refs. Research sponsored by the Electric Power Research Institute.

The behavior of slag coated electrodes under applied transverse discharges at MHD generator duct conditions was investigated for various metal electrodes and two different coals. The critical current density for diffuse mode operation was an order of magnitude larger for iron (1018 steel) than for stainless steel or nickel electrodes. The erosion rate was large for iron anodes, but negligible for iron cathodes. Slag layers were found to have ionic as well as electronic conductivity with iron and potassium as the mobile species. This test was used to screen several electrode materials, including both active and noble metals. The polarization effects were orders of magnitude more severe for the noble materials. (Author)

A80-39763 # Heavy-ion-driven fusion. *Energy and Technology Review*, Mar. 1980, p. 16-23. 12 refs.

The possibility of driving inertial confinement fusion (ICF) implosions with beams of heavy ions is investigated with special reference to the adaptation of conventional high-energy accelerator technology to the purpose of inertial fusion power production. High-energy accelerators are reliable, have long lifetimes, high repetition rates (1 Hz and higher), and can be quite efficient (about 25%); this makes heavy-ion accelerators appear well suited as drivers for ICF power plants. Major design considerations are examined together with operating parameters, and criteria of driver choice. However, further experimental work is necessary to substantiate the theoretical promise of the heavy-ion approach to-ICF. V.L.

A80-39899 A new design of Stirling engine for automotive application. C. Caputo and V. Naso (Roma, Università, Rome, Italy). *International Journal of Vehicle Design*, vol. 1, May 1980, p. 239-256. 17 refs. Research supported by the Consiglio Nazionale delle Ricerche.

The advantages and disadvantages of the Stirling engine vis a vis conventional engines for automotive power are discussed. The paper describes a new Stirling engine design constructed by the authors, the essential feature of which is two interlocking pistons moving at right-angles. Details of the mechanical arrangement and functioning are given. Tests are in progress to determine the efficacy of seals and balancing. (Author)

A80-40335 * # Modified aerospace R&QA method for wind turbines. W. E. Klein (NASA, Lewis Research Center, Cleveland, Ohio). In: Annual Reliability and Maintainability Symposium, San Francisco, Calif., January 22-24, 1980, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 254-258.

This paper describes the Safety, Reliability and Quality Assurance (SR&QA) approach developed for the first large wind turbine

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generator project, MOD-OA. The SR&QA approach to be used had to assure that the machine would not be hazardous, would operate unattended on a utility grid, would demonstrate reliable operation, and would help establish the quality assurance and maintainability requirements for wind turbine projects. The final approach consisted of a modified Failure Modes and Effects Analysis (FMEA) during the design phase, minimal hardware inspections during parts fabrication, and three documents to control activities during machine construction and operation. (Author)

A80-40337 Safety analysis of an advanced energy system facility. J. R. Lance, G. A. Mutone (Westinghouse Electric Corp., Pittsburgh, Pa.), and E. F. Bjoro (U.S. Department of Energy, Washington, D.C.). In: Annual Reliability and Maintainability Symposium, San Francisco, Calif., January 22-24, 1980, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 268-274.

This paper describes a safety analysis methodology and documentation system applied to the U.S. Department of Energy's 'first of a kind' Magnetohydrodynamic (MHD) Component Development and Integration Test Facility (CDIF). A modified Failure Mode and Effects Analysis (FMEA) is used. The CDIF FMEA approach begins with failure modes at the functional component level and analyzes the effects of propagated failure modes in interfacing systems. The results of this safety analysis have resulted in design and equipment changes, operation and maintenance requirements, and requirements for personnel exclusion areas. The safety analysis approach used is rigorous and comprehensive, but is economical in terms of effort and is particularly well suited to complex projects involving multiple contractors and organizations. The approach described herein has also been applied successfully to a later, more complex magnetohydrodynamic test facility design which is still in the concept development phase. (Author)

A80-40338 * # Photovoltaic power system reliability considerations. V. R. Lalli (NASA, Lewis Research Center, Cleveland, Ohio). In: Annual Reliability and Maintainability Symposium, San Francisco, Calif., January 22-24, 1980, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 283-286.

This paper describes an example of how modern engineering and safety techniques can be used to assure the reliable and safe operation of photovoltaic power systems. This particular application was for a solar cell power system demonstration project in Tangaye, Upper Volta, Africa. The techniques involve a definition of the power system natural and operating environment, use of design criteria and analysis techniques, an awareness of potential problems via the inherent reliability and FMEA methods, and use of a fail-safe and planned spare parts engineering philosophy. (Author)

A80-40716 Experimental aspects of the thermochemical conversion of solar energy - Decarbonation of CaCO₃. G. Flamant (CNRS, Laboratoire des Ultra-Réfractaires, Odeillo, Pyrénées-Orientales; Toulouse III, Université, Toulouse, France), D. Hernandez, C. Bonet (CNRS, Laboratoire des Ultra-Réfractaires, Odeillo, Pyrénées-Orientales, France), and J.-P. Traverse (Toulouse III, Université, Toulouse, France). *Solar Energy*, vol. 24, no. 4, 1980, p. 385-395. 14 refs.

The feasibility of thermochemical conversion of concentrated solar energy is investigated. Consideration is given to heterogeneous systems in the range 500-1500 C. A reaction volume is on a laboratory scale about 30 cu cm. An experimental set-up selected is a fluid bed and a rotary kiln. An endothermic reaction, namely, decarbonation of CaCO₃, is selected as a possible application for solar power plants. V.T.

A80-40719 Characteristics of axicon concentrators for use in photovoltaic energy conversion. U. H. Kurzweg (Florida, University, Gainesville, Fla.). *Solar Energy*, vol. 24, no. 4, 1980, p. 411, 412.

The concentration and cost characteristics of axicon concentrators when used in photovoltaic energy conversion are discussed. Attention is given to the semi-vertex angle of an outer cone required for minimum energy conversion cost. It is shown that it is possible to use truncated axicon concentrators to economic advantage in the photovoltaic conversion of solar energy. V.T.

A80-41032 Fluctuations in output from wind turbine clusters. N. H. Lipman (Reading, University, Reading; Science Research Council, Rutherford Laboratory, Chilton, Oxon, England), E. A. Bossanyi, P. D. Dunn, P. J. Musgrove, G. E. Whittle (Reading, University, Reading, England), and C. Maclean (Science Research Council, Rutherford Laboratory, Chilton, Oxon, England). *Wind Engineering*, vol. 4, no. 1, 1980, p. 1-7. 7 refs.

The effects of short-period wind speed fluctuations on the power output of wind turbine clusters are investigated. Wind speed is described as the sum of a constant mean speed and a normally distributed fluctuation (period less than an hour) of standard deviation related to the turbulence intensity at frequencies below the response time of the wind turbine, and mean power is expressed as an integral function of the power output function at a given velocity and the probability distribution of wind speed fluctuations. Modifications to the power-velocity relations of single and clustered wind turbines are calculated in terms of annual output and load factor for a single turbine and a 20-turbine cluster and in terms of the power fluctuations to be expected for a single turbine, many widely spaced (uncorrelated) turbines, many correlated turbines and an infinite cluster of turbines. It is shown that the variability of output is smaller where the power-velocity characteristic is flatter and decreases as the number of turbines increases, although correlations in wind field increase the variability. A.L.W.

A80-41033 Sailing Darrieus rotors. P. S. Revell and K. W. Everitt (Warwick, University, Coventry, England). *Wind Engineering*, vol. 4, no. 1, 1980, p. 11-31. 10 refs.

Recently published data for a number of simply constructed sailings has been used in a numerical analysis of the performance of flexible bladed Darrieus rotors. To facilitate comparisons, the analysis has been repeated using data for a solid aerofoil. An improved understanding of the operation of sailing rotors has been gained and some criteria for their design are reached. It is concluded that such rotors can reliably self-start and achieve a higher power coefficient than so far reported, although still rather lower than can be obtained with solid blades, but that their full potential will not be realized in very small scale applications. (Author)

A80-41034 Experimental study for the optimization of the performance of the Filippini Vertical Axis Wind Rotor. D. V. Nguyen (Thiès, Ecole Polytechnique, Thiès, Senegal). *Wind Engineering*, vol. 4, no. 1, 1980, p. 43-47.

Experimental measurements of the performance of models of the simplified Filippini Vertical Axis Wind Rotor (FVAWR), in which straight splitter plates are used instead of curved ones, employing five different bucket to swept diameter ratios are reported. Variations of rotor torque coefficient and power coefficient with tip speed ratio were determined by a Prony brake system with the rotor placed in an open-jet wind tunnel. The peak power coefficient was obtained generally at a tip speed ratio of 0.7, with a bucket diameter/swept diameter ratio of 0.3 producing the highest power coefficient at this ratio which is noted to be about 26 percent higher than that obtained for a Savonius rotor. A.L.W.

A80-41074 Space-time solutions of the linearized coupled-mode equations. K. Rypdal (Tromsø, Universitetet, Tromsø, Norway). *Physica Scripta*, vol. 22, no. 2, 1980, p. 141-146. 9 refs.

The linearized coupled-mode equations for parametric instability are solved exactly for various cases. The exact evolution of a localized wave-pulse in an unbounded interaction region is used to illustrate the relationship between damping rates, group velocities and instability. It is shown that boundaries create 'kinks' in the

pulse-profile traveling back and forth at the group velocities, and that the overall effect of finiteness is to reduce the instability growth. Finally, it is demonstrated that a mismatch in frequency or wave number will produce frequency and wave number shifts, but does not otherwise change the growth of the instability. M.E.P.

A80-41330 # Non-linear oscillations in wave power machines. P. C. Parks (Royal Military College of Science, Shrivenham, Wilts., England) and A. Tondl (Statni Vyzkumny Ustav Konstrukce Strojů, Bechovice, Czechoslovakia). In: International Conference on Nonlinear Oscillations, 8th, Prague, Czechoslovakia, September 11-15, 1978, Proceedings. Volume 1. Prague, Academia, 1979, p. 69-86. 8 refs.

The paper examines nonlinear oscillations in wave power machines. It presents a view of wave energy research in the UK, with a brief description of the more promising wave power machines. It is theoretically possible to build a device which absorbs 100% of the energy in an incoming wave train, and two possible devices for which this is possible are reviewed using linear theory. Many of the devices proposed, however, involve nonlinear processes for energy extraction, and two nonlinear problems are investigated: (1) conversion of reciprocating to rotary motion using a crank mechanism, and (2) direct pumping by a plate which in turn is subjected to forces in the sea. A.T.

A80-41570 # Studies of MHD generator performance with oxygen enriched coal combustion. J. Wormhoudt, V. Yousefian, C. E. Kolb, and M. Martinez-Sánchez (Aerodyne Research, Inc., Bedford, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1343.* 12 p. Contract No. EX-76-C-01-2478.

This paper presents calculations made using the Aerodyne PACKAGE (Plasma Analysis, Chemical Kinetics, and Generator Efficiency) computer code which bear on two questions which arise in connection with choices between oxygen enrichment and air preheating to attain the high combustion temperatures needed for open-cycle, coal-fired MHD power generation. The first question is which method produces the highest enthalpy extraction per unit channel length. The second is, in test facilities intended to study tradeoffs between oxygen enrichment and preheated air, can good generator performance be obtained from the same physical channel for different combustor compositions. The answer to the first question is found to depend on what combustor conditions are taken to be comparable. As for the second question, it is found that operation with channel input from off-design combustor conditions can cause serious problems, which can be partially alleviated by changing the channel load factors. (Author)

A80-41732 # Study of the operation of a pneumatic wave-energy converter (Issledovanie raboty pnevmaticheskogo volnovogo preobrazovatel'ia). I. A. Babintsev, V. V. Shcherbakov, A. I. Suzdal'tsev, and L. P. Fedosenko (Akademiiia Nauk Ukrainkoi SSR, Institut Gidromekhaniki, Kiev, Ukrainian SSR). *Gidromekhanika*, no. 42, 1980, p. 23-26. In Russian.

The analysis deals with the design and principle of a pneumatic wave-energy converter which has no moving parts. The nature of the pressure variation in the converter is studied for cylindrical and conical static heads as a function of the converter diameter and the immersion depth. V.P.

A80-41745 Ignition and thermal stability characteristics of advanced-fuel tokamak plasmas with empirical scaling. J. H. Schultz (MIT, Cambridge, Mass.; Westinghouse Electric Corp., Pittsburgh, Pa.), L. Bromberg, and D. R. Cohn (MIT, Cambridge, Mass.). *Nuclear Fusion*, vol. 20, June 1980, p. 703-709. 18 refs. Contract No. EG-77-S-02-4183-A002.

A80-41748 Generalization of Connor and Hastie's ripple-trapping coefficient, $G(\alpha)$. R. J. Goldston and H. H. Towner (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 20, June

1980, p. 781-783. 6 refs. Contract No. DE-AC02-76CH-03073.

Previous work on the effects of poloidal variation of the magnetic-field ripple in tokamaks is generalized to the case of high-beta, noncircular plasma configurations. The calculations are based on the ripple-trapping coefficient, $G(\alpha)$, of Connor and Hastie (1973). The generalized $G(\alpha)$ is calculated for arbitrary ripple intensity by a method developed by Goldston and Towner (1980), which is valid as long as the ripple intensity does not vary significantly over a ripple period along a magnetic field line. V.L.

A80-41851 Electrochemistry, power sources and energy science. A. K. Vijh (Hydro-Québec, Institut de Recherche, Varennes, Canada). *Journal of Power Sources*, vol. 5, June 1980, p. 145-172. 43 refs.

The status of modern electrochemistry is reviewed, and its impact on energy science is considered. Some of the important electrochemical interfaces (i.e., metal-electrolyte, semiconductor-electrolyte, demetallized surface-electrolyte, and metal-plasma) in energy device situations are described. In addition, a brief review of the current status of electrochemical power sources - fuel cells, batteries, and photoelectrochemical cells - is presented. B.J.

A80-41949 Performance study of an OTEC system. E. N. Ganic (Illinois, University, Chicago, Ill.) and L. Moeller (Sargent and Lundy Engineers, Chicago, Ill.). *Applied Energy*, vol. 6, July 1980, p. 289-299. 15 refs.

The paper describes studies of the performance of an Ocean Thermal Energy Conversion (OTEC) system. The objective function A/W sub net, where A is the total heat exchanger area and W sub net is the network output of the system, was used for the parametric and optimization studies; by using the objective function, the heat exchangers were directly related to the remaining OTEC components, making it possible to evaluate the combined effects on the OTEC power plant. The effects of the ocean fluid velocity through the exchanger, long-mean temperature differences of the heat exchangers, the heat transfer enhancement, and the cold seawater pipe diameter on system performance were investigated. It was concluded that for a 1 MWe OTEC power plant, the net output of the plant becomes zero when the temperature difference between the hot and cold streams approaches 12.80 C. A.T.

A80-42056 # Reliability prediction techniques for second generation marine and industrial gas turbines. R. B. Spector (General Electric Co., Marine and Industrial Projects Dept., Evendale, Ohio). *American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-3.* 9 p. 6 refs. Members, \$1.50; nonmembers, \$3.00.

The paper discusses reliability prediction techniques for second generation marine and industrial gas turbines. A technique to provide an 'early look' at the reliability of equipment and a means of projecting its reliability growth used for the LM2500 gas turbine is examined; this technique, employing a 'family concept' to reliability growth supplements the Failure Mode, Effect and Criticality Analysis (FMECA), providing a tool for earlier assessments of the reliability potential. This new prediction technique can also be applied to the selection of the most reliable power plant and to identifying the condition when a gas turbine is sufficiently mature for release. The paper compares the features of these two methods as they were applied to the LM2500 turbine. A.T.

A80-42157 # Differential split power transmissions for a single shaft passenger car gas turbine engine. D. L. Carriere (Ford Motor Co., Dearborn, Mich.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-19.* 6 p. Members, \$1.50; nonmembers, \$3.00.

A80-42162 # Selection of a closed Brayton cycle gas turbine for an intermediate-duty solar-electric power plant. G. L. Vieth and

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D. F. Plummer (Boeing Co., Seattle, Wash.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-27.* 12 p. Members, \$1.50; nonmembers, \$3.00.

Subsystem and system analyses were performed to select the preferred working gas, performance characteristics and size of a closed cycle gas turbine for an intermediate-duty solar-electric power plant. Capital costs for all major subsystems were evaluated, but the principal selection criterion was the projected cost of electricity produced by the plant. Detailed analyses of the power conversion loop were conducted for both air and helium systems. Since the plant was intended for use on an intermediate-duty cycle, thermal storage was required. The coupling of the storage and power conversion loops in combination with the daily operating cycle influenced plant performance and energy costs in addition to the selection of the power conversion cycle. (Author)

A80-42233 # Aerodynamic and geometric design criteria for the performance of low powered vehicular gas turbines. O. E. Balje. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-117.* 10 p. 20 refs. Members, \$1.50; nonmembers, \$3.00.

A study of the design criteria for the performance of small single and two-spool vehicular gas turbines using metallic rotors shows that the acceleration capability, i.e., component inertia and the net power output, determine to a large degree the obtainable cycle efficiency. Fluid viscosity effects and manufacturing limitations cause the cycle efficiency to decrease with decreasing net powers. When fast acceleration capability is desired, aerodynamically compromised component designs may have to be selected which causes an efficiency penalty. It is found that the blade height of the compressor turbine in two-spool designs is a significant parameter for this penalty. One interesting result of the calculations is that single spool designs using metallic radial inflow turbine rotors can be quite competitive with two-spool designs using ceramic rotors in regard to efficiency. They suffer, however, from a comparatively high rotor inertia, i.e., reduced acceleration capability. Areas of uncertainties remain for the loss relations so that the calculated performance values must be viewed as trend data. The prime performance parameter used in this study is the flow path efficiency. The thermal cycle efficiency is presented only for constant values of heat exchanger effectiveness and mechanical efficiency. (Author)

A80-42242 # Diagnostic development for advanced power systems. J. C. F. Wang, W. L. Flower, and D. R. Hardesty (Sandia Laboratories, Livermore, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-128.* 12 p. 48 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

The high temperatures, pressures, and particulate densities present in coal-fired advanced power systems place severe limitations on conventional probe techniques for thermometry, velocimetry, and gas and particulate analysis. Although laser-based techniques for measuring gas temperature, velocity, and composition have been demonstrated in relatively clean flame gases, little is known regarding their applicability to measurements in the product streams from coal-fired combustors. Hence, a program has been established at Sandia to develop and assess advanced physical sampling and laser-based optical diagnostic techniques. This paper describes some of the techniques under development, including a small-angle near-forward scattering optical arrangement for particle sizing and a system for making Raman-scattering measurements of gas temperature using a pulsed laser and a gated detection system. Also described is the atmospheric combustor exhaust simulator (ACES) facility being constructed as the test bed for the diagnostic techniques. (Author)

A80-42248 # Closed-cycle gas turbine working fluids. J. C. Lee, J. Campbell, Jr., and D. E. Wright (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). *American Society of*

Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-135. 11 p. 21 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. EF-77-C-01-2612.

Characteristic requirements of a closed-cycle gas turbine (CCGT) working fluid were identified and the effects of their thermodynamic and transport properties on the CCGT cycle performance, required heat exchanger surface area and metal operating temperature, cycle operating pressure levels, and the turbomachinery design were investigated. Material compatibility, thermal and chemical stability, safety, cost, and availability of the working fluid were also considered in the study. This paper also discusses CCGT working fluids utilizing mixtures of two or more pure gases. Some mixtures of gases exhibit pronounced synergetic effects on their characteristic properties including viscosity, thermal conductivity and Prandtl number, resulting in desirable heat transfer properties and high molecular weights. Typical examples of such synergetic gas mixture are helium-xenon and helium-carbon dioxide. (Author)

A80-42265 # Organic Rankine-cycle turbine power plant utilizing low temperature heat sources. V. Maizza (Bari, Università, Bari, Italy). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-153.* 10 p. 14 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the Consiglio Nazionale delle Ricerche.

Utilizing and converting of existing low temperature and waste heat sources by the use of a high efficiency bottoming cycle is attractive and should be possible for many locations. This paper presents a theoretical study on possible combination of an organic Rankine-cycle turbine power plant with the heat pump supplied by waste energy sources. Energy requirements and system performances are analyzed using realistic design operating condition for a middle town. Some conversion systems employing working fluids other than water are being studied for the purpose of proposed application. Thermodynamic efficiencies, with respect to available resource, have been calculated by varying some system operating parameters at various reference temperature. With reference to proposed application equations and graphs are presented which interrelate the turbine operational parameters for some possible working fluids with computation results. (Author)

A80-42294 Voltage losses in fuel cell cathodes. R. P. Iczkowski and M. B. Cutlip (Connecticut, University, Storrs, Conn.). *Electrochemical Society, Journal*, vol. 127, July 1980, p. 1433-1440. 7 refs.

A model of the air diffusion electrode used in fuel cells was developed which accounts for the diffusion of oxygen in the gas-filled pores as well as diffusion into the liquid-filled pores, electrochemical reaction, and electrical conduction. The model was applied to a PTFE-bonded, platinum-on-carbon cathode in acid electrolyte to evaluate the relative contribution of these effects. Gas diffusion contributed 38% and ohmic loss in the electrolyte contributed 48% to the voltage loss other than activation. Knudsen diffusion was found to be as important as molecular diffusion. Diffusion of dissolved oxygen and ohmic conduction produced small voltage losses. Diffusion contributes to the utilization loss, especially at high oxygen utilizations, but ohmic effects do not. (Author)

A80-42295 The effect of ammonia on hydrogen-air phosphoric acid fuel cell performance. S. T. Szymanski, G. A. Gruver, M. Katz, and H. R. Kunz (United Technologies Corp., Power Systems Div., South Windsor, Conn.). *(Electrochemical Society, Meeting, Pittsburgh, Pa., Oct. 15-20, 1978.) Electrochemical Society, Journal*, vol. 127, July 1980, p. 1440-1444.

Laboratory experiments and tests conducted on phosphoric acid fuel cells have indicated that ammonia, when present as an impurity in either the fuel or oxidant streams, will react with the electrolyte to form $(\text{NH}_4)\text{H}_2\text{PO}_4$. Ammoniation of the acid to greater than 0.2 mole percent resulted in a loss in performance due primarily to a lowering in the rate of O_2 reduction on the cathode catalyst.

Complete recovery of the performance loss was achieved after the removal of the contaminant source. The degree of electrolyte conversion and, hence, steady-state performance loss were found to be dependent on the rate of ammonia addition to the cell relative to the rate of ammonium ion oxidation at the cathode. This oxidation process was found to be potential dependent, with an increase in cathode potential resulting in the ability of the cell to tolerate higher NH₃ concentrations in the reactant gas streams. (Author)

A80-42298 Ammonia high temperature solid electrolyte fuel cell. R. D. Farr and C. G. Vayenas (MIT, Cambridge, Mass.). *Electrochemical Society, Journal*, vol. 127, July 1980, p. 1478-1483. 13 refs. NSF Grant No. ENG-77-27500.

NH₃ was used as the fuel in a high temperature stabilized zirconia fuel cell with Pt electrodes in order to examine the product distribution of the cell and explore the possibility of NO and electric energy cogeneration. It was found that nitric oxide is the primary electrooxidation product but that the yield of NO can be severely decreased due to the catalytic side reaction between NH₃ and NO on the Pt anode. The influence of this side reaction, however, can be minimized under optimal operating conditions, and yields of NO exceeding 60% can be achieved. In addition, two dimensionless numbers have been identified which govern product selectivity and power output. J.P.B.

A80-43138 # High-power MHD system combustor development testing. D. W. Swallow, O. K. Sonju (Maxwell Laboratories, Inc., Woburn, Mass.), R. V. Burry (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.), and R. F. Cooper (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *Journal of Energy*, vol. 4, May-June 1980, p. 100-105. 8 refs. Contract No. F33615-76-C-2104.

This paper describes some of the technical accomplishments of the most recently completed phase of a multiphase program to design, construct, and test a lightweight, high-power prototype portable MHD generator system. The main objective of this phase was to demonstrate the feasibility of hot-gas flow train components of high-performance, lightweight design. Significant advances in terms of such parameters as combustor heat release density, combustion efficiency, channel power density, and energy extraction rates were made. The combustion system has a high-performance, 160-element injector, and the channel was constructed using lightweight electrode frames and a high-strength, lightweight glass-fiber-wound composite outer wall structure. The test results are compared to the theoretical predictions and are evaluated in terms of their impact on the overall goals of the High-Power MHD Systems program. The evaluation indicated that the initial program goals are achievable performance levels. (Author)

A80-43139 # Crosswind kite power. M. L. Loyd (California, University, Livermore, Calif.). *Journal of Energy*, vol. 4, May-June 1980, p. 106-111. 20 refs.

This paper describes a concept for large-scale wind power production by means of aerodynamically efficient kites. Based on aircraft construction, these kites fly transverse to the wind at high speed. The lift produced at this speed is sufficient to both support the kite and generate power. The equations of motion are developed, and examples are presented. One version, based on the C-5A aircraft, results in 6.7 MW produced by a 10-m/s wind. Extrapolation to newer technology, which is more comparable to modern wind turbines, indicates the production of 45 MW from a single machine. The detailed calculations are validated by comparison of their results with simple analytical models. The methodology used here lays the foundation for the systematic study of power-producing kites. (Author)

A80-43141 # Preliminary wind tunnel tests on the pedal wind turbine. T. Vinayalingam (University of the West Indies, St. Augustine, Trinidad and Tobago). *Journal of Energy*, vol. 4, May-June 1980, p. 142-144.

High solidity-low speed wind turbines are relatively simple to construct and can be used advantageously in many developing countries for such direct applications as water pumping. Established designs in this class, such as the Savonius and the American multiblade rotors, have the disadvantage that their moving surfaces require a rigid construction, thereby rendering large units uneconomical. In this respect, the pedal wind turbine recently reported by the author and which incorporates sail type rotors offers a number of advantages. This note reports preliminary results from a series of wind tunnel tests which were carried out to assess the aerodynamic torque and power characteristics of the turbine. (Author)

A80-43190 # CO₂ concentrations in a molten carbonate electrochemical cell. J. Winnick (Georgia Institute of Technology, Atlanta, Ga.). *American Society of Mechanical Engineers, Inter-society Environmental Systems Conference, San Diego, Calif., July 14-17, 1980, Paper 80-ENAS-14*. 15 p. 5 refs. Members, \$1.50; nonmembers, \$3.00.

The molten carbonate fuel cell is now being investigated as a possible alternative to the aqueous alkaline fuel cell which has been successfully converted into a CO₂ concentrator for use in a manned spacecraft. This high-temperature (above 500 C) device has the following potential advantages over the aqueous concentrator: any humidity from 0 to 100% can be tolerated, noble electrodes are not required, and higher current densities appear possible. During the tests of a laboratory-size cell, in both driven and hydrogen modes, high current efficiencies have been achieved, but removal efficiencies have been low. Increasing current improves the removal, but current efficiency drops, which is thought to be due to poor mass transfer characteristics inherent in the small cell. Water vapor in the cathode feed has no effect on electrical or electrochemical performance, and no CO is found in the cathode (cathin) gas stream, nor carbon in the anode. V.L.

A80-43226 # Hall effects on MHD Couette flow in a rotating system. R. N. Jana and N. Datta (Indian Institute of Technology, Kharagpur, India). *Czechoslovak Journal of Physics*, vol. B 30, no. 6, 1980, p. 659-667. 7 refs.

The combined effect of rotation and Hall current on the MHD Couette flow have been studied. The heat transfer characteristic have also been discussed on taking the viscous and Joule dissipation into account. The primary and the secondary velocity components increase with increase in Hall parameter but the primary velocity decreases with increase in rotation parameter. It is seen that the rate of heat transfer at the stationary plate is independent of both the Hall parameter and the rotation parameter. The rate of heat transfer at the moving plate increases with increase in Hall parameter, while it decreases with increase in rotation parameter. The values of the critical Eckert number at which the direction of the heat flow changes increases with increase in Hall parameter. (Author)

A80-43325 # The MHD /magneto-hydrodynamic/ two-axis Rate Sensor. V. H. Aske (Honeywell, Inc., Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1890*. 7 p.

The MHD Rate Sensor was designed to provide two axes of rate information in a small package. The instrument measures 0.7 inches in diameter by 1.8 inches long. It consists of a torus of liquid metal, located within a radial magnetic field, which provides a voltage proportional to rate about its input axis. The torus is spun at a constant rate and the inclusion of a two-phase reference generator permits demodulation of the rate signal about two defined axes. This paper discusses the theory of operation, design of the Rate Sensor for producibility, and achieved performance. (Author)

A80-43340 * # The performance of solar thermal electric power systems employing small heat engines. R. L. Pons (Ford-Aerospace and Communications Corp., Newport Beach, Calif.). *American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper*

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80-Pet-25. 8 p. 9 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. JPL-955115.

The paper presents a comparative analysis of small (10 to 100 KWe) heat engines for use with a solar thermal electric system employing the point-focusing, distributed receiver (PF-DR) concept. Stirling, Brayton, and Rankine cycle engines are evaluated for a nominal overall system power level of 1 MWe, although the concept is applicable to power levels up to at least 10 MWe. Multiple concentrators are electrically connected to achieve the desired plant output. Best performance is achieved with the Stirling engine, resulting in a system Levelized Busbar Energy Cost of just under 50 mills/kWh and a Capital Cost of \$900/kW, based on the use of mass-produced components. Brayton and Rankine engines show somewhat less performance but are viable alternatives with particular benefits for special applications. All three engines show excellent performance for the small community application. (Author)

A80-43342 # System thermodynamics of energy conversion plants for geopressured resources. J. P. Lamb and G. F. Polansky (Texas, University, Austin, Tex.). *American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper 80-Pet-31.* 7 p. 13 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by Central Power and Light, Gulf States Utilities, and Houston Lighting and Power.

Performance of conversion plants for geopressured fluids has been estimated using realistic wellhead conditions and idealized thermodynamics. Maximum output of a combined hydraulic-thermal recovery system is predicted. The performance of flash and organic Rankine cycle schemes for thermal recovery are compared and the importance of hydraulic recovery is illustrated. Rankine cycle performance using both propane and isobutane is discussed. Present results illustrate the extreme significance of recovering the gaseous component because of its effect on both energy production and related economic viability. (Author)

A80-43343 # A Stirling cycle engine for use with solar thermal-electric systems. R. L. Pons (Ford Aerospace and Communications Corp., Newport Beach, Calif.) and W. Percival (United Stirling /Sweden/, Alexandria, Va.). *American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper 80-Pet-32.* 10 p. 13 refs. Members, \$1.50; nonmembers, \$3.00.

Paper presents the background of development of the Stirling cycle engine at United Stirling of Sweden with emphasis on its applicability to solar thermal power plants. The development status of critical components is reviewed together with the modifications required to convert the engine from a fuel-burning unit to one capable of solar operation, as well as operation on other alternate energy sources. Detailed performance data are given for an engine designed to run on condensing sodium as the heat source; the influence of engine cost and efficiency on solar system cost is also shown. (Author)

A80-43345 # Compound hybrid geothermal-fossil power plants - Thermodynamic analyses and site-specific applications. R. DiPippo (Southeastern Massachusetts University, North Dartmouth, Mass.), J. Kestin (Brown University, Providence, R.I.), E. M. Avelar (Rhode Island University, Kingston, R.I.), and H. E. Khalifa (United Technologies Research Center, East Hartford, Conn.). *American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper 80-Pet-83.* 11 p. 26 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. EY-76-S-02-4051-A002.

In this paper, we extend the analysis of hybrid fossil-geothermal power plants to compound systems which combine the features of the two previously analyzed hybrid plants, the geothermal preheat and the fossil superheat systems. Compound systems of the one- and two-stage type are considered. A complete summary of formulae to assess the performance of the plants is included for completeness. From the viewpoint of thermodynamics, compound hybrid plants are superior to individual all-geothermal and all-fossil plants, and

have certain advantages over basic geothermal-preheat and fossil-superheat hybrid plants. The flexibility of compound hybrid systems is illustrated by showing how such plants might be used at several geothermal sites in the western United States. (Author)

A80-43397 An arc discharge model on electrodes of an MHD generator. V. A. Bitiurin (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR) and G. A. Liubimov (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). (*Teplotfizika Vysokikh Temperatur*, vol. 17, Nov.-Dec. 1979, p. 1299-1308.) *High Temperature*, vol. 17, no. 6, May 1980, p. 1077-1085. 8 refs. Translation.

In the present paper, the current-voltage characteristics of the electrodes of an MHD generator are analyzed quantitatively for the arc discharge mode. Closure of the equations of the current-voltage characteristics is achieved on the basis of experimental data and a solution to the two-dimensional electrodynamic problem of the current and potential distribution at the arc. V.P.

A80-43398 Theory of electrode arcs in a flow of combustion products containing an additive. A. V. Nedospasov and L. P. Poberezhskii (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). (*Teplotfizika Vysokikh Temperatur*, vol. 17, Nov.-Dec. 1979, p. 1309-1318.) *High Temperature*, vol. 17, no. 6, May 1980, p. 1086-1095. 13 refs. Translation.

A mathematical model is constructed under a number of assumptions for an arc near an electrode in a flow of combustion products containing an additive. The model consists of a system of equations containing an integral equation for conservation of energy; the system was solved numerically. As a result of the solution, the arc dimensions, temperature distribution in the arc, and voltage drop are obtained as functions of the current and parameters of the flow. It is shown that the conditions of heat transfer influence the configuration of the arc and the form of the voltage-current characteristic. Approximate models are proposed for describing the zone of overheating - a thermal dipole model in a flow for the case of an arc over a cooled surface, and a heat source for the case of an arc in a flow past an electrode. (Author)

A80-43478 Confidence interval procedures for wind turbine candidate sites. R. B. Corotis (Northwestern University, Evanston, Ill.). *Solar Energy*, vol. 24, no. 5, 1980, p. 427-433. 11 refs. Contract No. DE-AS06-76ET-20283.

Three different aspects of confidence intervals for seasonal mean wind speeds are investigated. Various techniques of establishing confidence intervals at a candidate site are discussed first and the consistency of results demonstrated for 20 sites. Next, a procedure is derived for the enhancement of candidate site confidence intervals through the use of a nearby reference site with long-term data. Proper incorporation of the spatial correlation between sites and the uncertainty in the correlation are essential to effective use of the reference site data. Finally, a technique is presented that permits the use of long-term regional data plus single-season data at a candidate site to establish confidence intervals for different seasons of the year. (Author)

A80-43481 Chromatic dispersion concentrator applied to photovoltaic systems. G. Sassi (Milano, Università, Milan, Italy). *Solar Energy*, vol. 24, no. 5, 1980, p. 451-460.

The aim of this paper is to show how it is possible to realize a chromatic dispersion concentrator which collects the different monochromatic components of the solar spectrum separately in subsequently concentric rings in the focal zone. This comes about without an increase in the energetic losses compared to any other type of concentrator. If different photovoltaic elements with energy gaps equal to the photon energy falling on the focal zone are put in the latter, energy losses due to incomplete utilization of the solar spectrum and to incomplete utilization of the energy of a single photon can be drastically reduced. How the losses due to the voltage factor and the fill-factor of the photovoltaic elements of the system can be reduced compared to the normal silicon cells is also

demonstrated. The other contributions to losses in the conversion process have only been mentioned, foreseeing their possible variation. (Author)

A80-43496 Absorption of radiation in a magnetoplasma and application to the laser-fusion process. G. W. Ford (Michigan, University, Ann Arbor, Mich.) and R. F. O'Connell (Louisiana State University, Baton Rouge, La.). *Physical Review A - General Physics, 3rd Series*, vol. 22, July 1980, p. 295-300. 26 refs. Research supported by the Louisiana State University; Contract No. DE-AS05-79ER-10459.

The general problem of absorption of laser light in a magnetoactive plasma is discussed. General results for the power absorbed is derived in terms of three basic frequencies: laser, cyclotron, and collision frequencies. These results are applied to a laser-fusion process. V.T.

A80-43502 An alternate approach to the application of MHD power generation technology in a utility environment. T. K. Fung, J. W. Griswold, and J. W. Moyer (Southern California Edison Co., Rosemead, Calif.). (*Institute of Electrical and Electronics Engineers, Summer Meeting, Vancouver, Canada, July 15-20, 1979, Paper F 79 651-1*.) *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-99, May-June 1980, p. 1306-1312; Discussion, p. 1312. 18 refs.

The magnetohydrodynamic (MHD) power generation technology offers an attractive generation potential to the electric utilities. This paper presents an alternate approach to accelerate the commercial deployment of this new technology. By retrofitting an existing generating station, the MHD system concept can be demonstrated in a utility environment as early as 1986. It is shown that this approach may be technically feasible. This accelerated approach could supplement the current national MHD program which places emphasis on large-scale, base-load applications. (Author)

A80-43503 Metallurgical coatings 1979; Proceedings of the Sixth International Conference, San Diego, Calif., April 23-27, 1979. Volumes 1 & 2. Edited by J. N. Zemel. Lausanne, Elsevier Sequoia, S.A. (*Thin Solid Films*, vol. 63-64, 1979), 1979. Vol. 1, 400 p.; vol. 2, 499 p. Price of two volumes, \$120.

The conference focused on surface modification by ion bombardment, metal and alloy coatings, solar energy, coatings for radiation environments, defects and internal stresses in coatings, erosion and wear, high temperature coatings, and vapor deposition technology. Papers were presented on improvement of properties by ion implantation, creep property improvement of titanium alloys by platinum ion plating, 304 stainless steel-carbon alloys synthesized by sputter deposition, formation of transparent heat mirrors by ion plating, carbon coatings for fusion applications, hydrogen retention and release in first-wall coatings for tokamaks, deposition of tungsten-alumina composite films by oxide evaporation, friction and wear of ion-implanted films, and hot corrosion evaluation of high-temperature metal coatings for combustion turbines. A.T.

A80-43517 Coatings for fusion reactor environments. D. M. Mattox (Sandia Laboratories, Albuquerque, N. Mex.). In: *Metallurgical coatings 1979; Proceedings of the Sixth International Conference, San Diego, Calif., April 23-27, 1979. Volume 1*. Lausanne, Elsevier Sequoia, S.A., 1979, p. 213-226. 62 refs. Contract No. DE-AC04-76DP-00789.

The internal surfaces of a toroidal magnetically confined fusion reactor control the impurity injection and gas recycling into the fusion plasma. Coating of internal surfaces may provide a desirable and possibly necessary design flexibility for achieving the temperatures, ion densities and containment times necessary for net energy production from fusion reactions. In this paper the reactor environments experienced by various components are reviewed along with possible materials responses. Characteristics of coating-substrate systems that are important to fusion applications are delineated and

the present status of coating development for fusion applications is reviewed. Coating development for fusion applications is just beginning and poses a unique and important challenge for materials development. (Author)

A80-43575 Electrical properties of polycrystalline GaAs films. J. J. J. Yang, P. D. Dapkus, R. D. Dupuis, and R. D. Yingling (Rockwell International Corp., Electronic Devices Div., Anaheim, Calif.). *Journal of Applied Physics*, vol. 51, July 1980, p. 3794-3800. 26 refs. Contract No. EY-76-C-03-1202.

The electrical properties of Se- and Zn-doped polycrystalline GaAs deposited by metalorganic chemical vapor deposition on substrates of polycrystalline alumina and glass are investigated. Attention is given to Hall-effect and resistivity measurements made over a wide range of temperature (77-420 K). The electrical activation energies are found by measuring the variation of resistivity and carrier mobility of the polycrystalline GaAs films with sample temperature. It is found that the resistivity and mobility are temperature activated over a wide temperature range, with the same activation energy applying to both properties. Finally, the results are interpreted in terms of a modified grain boundary trapping model. M.E.P.

A80-43590 Thermodynamic energy conversion efficiencies. P. T. Landsberg and G. Tonge (Southampton, University, Southampton, England). *Journal of Applied Physics*, vol. 51, July 1980, p. R1-R20. 71 refs.

The paper presents recent work on thermodynamic energy conversion efficiencies. The processes include the conversion into light in a laser or light-emitting diode, and the direct or indirect conversion of solar radiation into work. The thermodynamic limiting efficiencies of these processes are derived by applying simple balance equations to a generalized energy convertor. The new work includes the distinction between temperatures based on fluxes and temperatures based on standard thermodynamics and their application. The use of standard entropy formulas is justified without relying on thermodynamic equilibrium and the results are then applied to nonequilibrium situations in energy conversion. A.T.

A80-43740 The Nigorikawa Geothermal Pilot Plant. Y. Nakamoto (Tokyo Shibaura Electric Co., Ltd., Tokyo, Japan). *Energy Developments in Japan*, vol. 2, Apr. 1980, p. 301-317. 10 refs.

The Nigorikawa 1000-kW pilot plant utilizing geothermal hot water is described. A binary cycle power generating system is outlined, along with criteria for selection of a working fluid and equipment for experimental studies. Tests include a maximum continuous load test and static and dynamic tests, involving start/spot characteristics, load variations and follow-up characteristics, auxiliary load operation, and variable pressure/temperature operation. V.T.

A80-43757 Photovoltaic Material and Device Measurement Workshop, Arlington, Va., June 11-13, 1979, Proceedings. Part 2. Edited by D. E. Sawyer. *Solar Cells*, vol. 1, May 1980. 112 p.

Solar cells are discussed with reference to their properties, photovoltaic mechanisms, methods of investigation, and experimental techniques. Papers are presented on infrared electroluminescence as a diagnostic tool for polycrystalline GaAs solar cells, diffusion length measurements in Cu₂S, evaluation of silicon-on-ceramic using light-beam-induced currents, experimental determination of the photon economy in polycrystalline thin film photovoltaic materials and devices, and electrical transport properties in inhomogeneous media. Other papers include a study of spatial inhomogeneities in photosensitive materials using direct current and microwave techniques, noise spectral density as a device reliability estimator, and measurement of the resistivity of thin CdS films on brass substrates. V.L.

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A80-43758 Some investigations on the influence of defects/grain boundaries on photovoltaic mechanisms in polycrystalline silicon films. B. L. Sopori and A. Baghdadi (Motorola, Inc., Solar Energy Research and Development Dept., Phoenix, Ariz.). (*Photovoltaic Material and Device Measurement Workshop, Arlington, Va., June 11-13, 1979.*) *Solar Cells*, vol. 1, May 1980, p. 237-250.

Several nondestructive techniques for characterizing polycrystalline silicon films for photovoltaic applications are described. These include the surface photovoltage, current phase shift, multiple wavelength focused laser scanner and electron-beam-induced current methods. The results of some investigations of the influence of defects and grain boundaries on photovoltaic mechanisms are discussed. It is shown that polycrystalline silicon films can be characterized by an 'average' minority carrier diffusion length.

(Author)

A80-43760 Experimental determination of the photon economy in polycrystalline thin film photovoltaic materials and devices. J. A. Bragagnolo and E. A. Fagen (Delaware University, Newark, Del.). (*Photovoltaic Material and Device Measurement Workshop, Arlington, Va., June 11-13, 1979.*) *Solar Cells*, vol. 1, May 1980, p. 275-283. 15 refs. Research supported by the U.S. Department of Energy, Standard Environmental Systems, and ERDA.

The optical measurement and analysis of polycrystalline thin film solar cell materials and devices is complicated by diffuse scattering at all interfaces due to roughness and diffuse volume scattering due to grain boundaries and orientation effects. An experimental approach using directional spectral reflectance and absorbance measurements with 4 pi collection geometry is described which provides an expedient route to the determination of device photon losses, intrinsic optical properties of polycrystalline materials and the effects of layer morphology on the photon economy of solar cells. This technique is applied to the photon loss analysis of thin film CdS/Cu₂S cells and the assessment of Zn₃P₂ as a photovoltaic material. It is concluded that cell morphology is a key contributor to the high photon efficiency of polycrystalline CdS/Cu₂S cells. Also, the discrepancy between bulk and thin film absorption edge data for Zn₃P₂ is reduced and the intrinsic absorption edge of evaporated films is revealed to be exponential. Other applications of this technique are discussed.

(Author)

A80-43832 Recent progress on ducks. S. H. Salter (Edinburgh, University, Edinburgh, England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 5, June 1980, p. 308-319. 17 refs. Research supported by the Department of Energy.

The results of small-scale laboratory tests at Edinburgh are reported. It is reported that some test results show that the requirement for rigidity of the duck backbone is much lower than was predicted, and that in waves with lengths of twenty diameters and more, there are considerable benefits to be derived from controlled backbone movements. A design is described which employs high-pressure oil hydraulics, synchronous generation, ac transmission and parallel connections. Further, the design exploits the techniques of modern electronics and it is planned to achieve reliability by total hermetic sealing of the power conversion mechanism which will exclude all organisms, both marine and human.

M.E.P.

A80-43835 Advantage of incorporating geothermal energy into power-station cycles. A. A. L. White (Central Electricity Generating Board, Marchwood Engineering Laboratories, Marchwood, Hants., England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 5, June 1980, p. 330-335. 9 refs.

The generation of electricity from low-temperature geothermal sources has been hampered by the low conversion efficiencies of Rankine cycle operating below 150 C. It is shown how the electrical output derived from a geothermal borehole may be substantially improved on that expected from these cycles by incorporating the

geothermal heat into a conventional steam-cycle power station to provide feedwater heating. This technique can yield thermal conversion efficiencies of 11% which, for a well-head temperature of 100 C, is 50% greater than the output expected from a Rankine cycle. Coupled with the smaller capital costs involved, feedwater heating is thus a more attractive technique of converting heat into electricity. Although power stations above suitable geothermal resources would ideally have the geothermal heat incorporated from the design stage, experiments at Marchwood Power Station have shown that small existing sets can be modified to accept geothermal feedwater heating.

(Author)

N80-22619# Los Alamos Scientific Lab., N. Mex. **COMMUTATOR dc MACHINES USED AS MECHANICAL CAPACITORS IN A SERIES RESONANT OHMIC-HEATING CIRCUIT SIMULATION**

Philip Thullen and D. M. Weldon 1979 6 p refs Presented at the 8th IEEE Symp. on Eng. Probl. of Fusion Res., San Francisco, 13-16 Nov. 1979
(Contract W-7405-eng-36)
(LA-UR-79-3122; CONF-791102-40) Avail: NTIS HC A02/MF A01

From 8th symposium on engineering problems of fusion research: San Francisco, CA, USA (13 Nov. 1979). Rotating electrical machines, and in particular commutator dc machines can serve as a high-power energy-source for testing large, pulsed magnets. A pulsed power supply based on traction motors is described which will be used to test the LASL prototype 20-MJ superconducting Tokamak induction coil. DOE

N80-22772 Delaware Univ., Newark. **DYNAMICS AND CONTROL OF LARGE HORIZONTAL-AXIS AXISYMMETRIC WIND TURBINES** Ph.D. Thesis

Murray Steven Hirschbein 1979 471 p
Avail: Univ. Microfilms Order No. 8006484

The dynamic response of an entire rotor-tower wind turbine system was examined to provide insight into the nature and solution of dynamic problems that may be encountered during the operation of large horizontal-axis, axisymmetric wind turbines. The numerical results are presented for a 3 bladed, 300 ft. diameter wind turbine driving either constant or variable speed electrical power generating equipment. Three areas of wind turbine research were studied: steady state loading, stability and gust response. Blade pitch control was used effectively to reduce the steady fatigue loading from gravity, side winds, wind shear, and to attenuate gust loading. An integral part of this analysis was the development of an algorithmic approach to kinematics of wind turbine dynamics which allowed numerically exact equations of motion to be derived by a digital computer. Dissert. Abstr.

N80-22778*# AiResearch Mfg. Co., Phoenix, Ariz. **CONCEPT DEFINITION STUDY OF SMALL BRAYTON CYCLE ENGINES FOR DISPERSED SOLAR ELECTRIC POWER SYSTEMS** Final Report, Sep. 1978 - Jun. 1979

Lyle D. Six, Thomas L. Ashe, Frank X. Dobler, and Ron T. Elkins Jan. 1980 135 p refs
(Contracts DEN3-69; EX-76-A-29-1060)
(NASA-CR-159592; DOE/NASA/0069-79/1; AiResearch-31-3328) Avail: NTIS HC A07/MF A01 CSCL 10B

Three first-generation Brayton cycle engine types were studied for solar application: a near-term open cycle (configuration A), a near-term closed cycle (configuration B), and a longer-term open cycle (configuration C). A parametric performance analysis was carried out to select engine designs for the three configurations. The interface requirements for the Brayton cycle engine/generator and solar receivers were determined. A technology assessment was then carried out to define production costs, durability, and growth potential for the selected engine types. R.E.S.

N80-22787*# Mechanical Technology, Inc., Latham, N. Y. Stirling Engine Systems Div.

DESIGN STUDY OF A 15 kW FREE-PISTON STIRLING ENGINE-LINEAR ALTERNATOR FOR DISPERSED SOLAR ELECTRIC POWER SYSTEMS Final Report, Sep. 1978 - Aug. 1979

George R. Dochat, H. S. Chen, S. Bhate, and T. Marusak Aug. 1979 189 p refs
(Contracts DEN3-56; EX-76-A-29-1060)
(NASA-CR-159587; DOE/NASA/0056-79/1; MTI-79TR47)
Avail: NTIS HC A08/MF A01 CSCL 10B

A conceptual design of a free piston solar Stirling engine-linear alternator which can be designed and developed to meet the requirements of a near-term solar test bed engine with minimum risks was developed. The conceptual design was calculated to have an overall system efficiency of 38% and provide 15kW electric output. The free piston engine design incorporates features such as gas bearings, close clearance seals, and gas springs. This design is hermetically sealed to provide long life, reliability, and maintenance free operation. An implementation assessment study performed indicates that the free piston solar Stirling engine-linear alternator can be manufactured at a reasonable price cost (direct labor plus material) of \$2,500 per engine in production quantities of 25,000 units per year. Opportunity for significant reduction of cost was also identified. R.E.S.

N80-22840# Los Alamos Scientific Lab., N. Mex.
TECHNOLOGY ASSESSMENT OF WIND ENERGY CONVERSION SYSTEMS

R. W. Meier and T. J. Merson Sep. 1979 48 p refs
(Contract W-7405-eng-36)
(LA-8044-TASE) Avail: NTIS HC A03/MF A01

Environmental data for wind energy conversion systems (WECSs) were generated. Two candidates were chosen to characterize the WECS that might be deployed if this technology makes a significant contribution to the national energy requirements. One EECS is a large machine of 1.5-MW-rated capacity that can be used by utilities. The other WECS is a small machine that is characteristic of units that might be used to meet residential or small business energy requirements. Energy storage systems are discussed for each machine to address the intermittent nature of wind power. Cost estimates were made for both large and small systems as required for input to the strategic environmental assessment simulation computer program. Material requirements, based on current generation WECSs, are discussed and a general discussion of environmental impacts associated with WECS deployment is presented. DOE

N80-22859# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

DEVELOPMENT OF A 5.5 m DIAMETER VERTICAL AXIS WIND TURBINE, PHASE 2 Final Report

Guenther Binder, Albert Fritzsche, Arne Vollan, Anton Dekitsch, Roland Joos, Dieter Welte, Carl-C. Etzler, and Juergen Schmelzle Bonn Bundesmin. fuer Forsch. u. Technol. Jul. 1979 138 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.

(BMFT-FB-T-79-04) Avail: NTIS HC A07/MF A01; Fachinformationszentrum Energie, Phys., Math., Eggenstein-Leopoldshafen, West Germany DM 28,55

The design work for the turbine, including the aerodynamic and structural dynamic investigations was performed, and the wind turbine built and tested in a wind tunnel. The rotor diameter of 5.5 m is not only a suitable size for the tests, but indicates that the results will contribute to the experimental data required for the design of large converters. The layout of the rotor, the construction methods and choice of materials favor series production, applying advanced mass production technology, without excluding the manufacture in developing countries. The wind tunnel test performed with the two, three, and four blade version of the Darrieus-rotor and with Savonius-rotors of different heights confirmed the aerodynamic calculations. Possibilities to improve the efficiency of the Savonius-rotor and to simplify some details concerning design and manufacture were evaluated.

Author (ESA)

N80-23102*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

AN EXPLORATORY SURVEY OF NOISE LEVELS ASSOCIATED WITH A 100kW WIND TURBINE

J. R. Balombin 1980 20 p refs Presented at the 99th Meeting of the Acoustical Soc. of Am., Atlanta, 21-25 Apr.

1980

(NASA-TM-81486; E-424) Avail: NTIS HC A02/MF A01 CSCL 20A

Noise measurements of a 125-foot diameter, 100 kW wind turbine are presented. The data include measurements as functions of distance from the turbine and directivity angle and cover a frequency range from 1 Hz to several kHz. Potential community impact is discussed in terms of A-weighted noise levels relative to background levels, and the intrasonic spectral content. Finally, the change in the sound power spectrum associated with a change in the rotor speed is described. The acoustic impact of this size wind turbine is judged to be minimal. M.G.

N80-23315*# Williams Research Corp., Walled Lake, Mich.
CONCEPTUAL DESIGN STUDY OF AN IMPROVED GAS TURBINE POWERTRAIN Final Report

W. I. Chapman Mar. 1980 294 p refs
(Contracts DEN3-12; EC-77-A-31-1040)

(NASA-CR-159852; DOE/NASA/0013-80/1; WRC-78-182)
Avail: NTIS HC A13/MF A01 CSCL 21E

The conceptual design for an improved gas turbine (IGT) powertrain and vehicle was investigated. Cycle parameters, rotor systems, and component technology were reviewed and a dual rotor gas turbine concept was selected and optimized for best vehicle fuel economy. The engine had a two stage centrifugal compressor with a design pressure ratio of 5.28, two axial turbine stages with advanced high temperature alloy integral wheels, variable power turbine nozzle for turbine temperature and output torque control, catalytic combustor, and annular ceramic recuperator. The engine was rated at 54.81 kW, using water injection on hot days to maintain vehicle acceleration. The estimated vehicle fuel economy was 11.9 km/l in the combined driving cycle, 43 percent over the 1976 compact automobile. The estimated IGT production vehicle selling price was 10 percent over the comparable piston engine vehicle, but the improved fuel economy and reduced maintenance and repair resulted in a 9 percent reduction in life cycle cost. R.C.T.

N80-23400# Oak Ridge National Lab., Tenn.
MASS TRANSPORT IN MOLTEN-SALT ELECTROCHEMICAL SYSTEMS

J. U. Nwalor and A. R. Manner 24 Mar. 1979 25 p refs
(Contract W-7405-eng-26)

(ORNL/MIT-290) Avail: NTIS HC A02/MF A01

Early time behavior of the open cell potential of a Li2CO3/K2CO3 electrolysis system was investigated to identify the various regimes involved. The regimes that were identified include the IR drop, anodic and cathodic double layer decays, and the thermoelectric effects. The presence of a gaseous diffusion process was also inferred. DOE

N80-23768*# Westinghouse Research and Development Center, Pittsburgh, Pa.

CELL MODULE AND FUEL CONDITIONER DEVELOPMENT

D. O. Hoover, Jr. Jan. 1980 58 p

(Contracts DEN3-161; DE-A103-79ET-1272)

(NASA-CR-159828; DOE/NASA/0161-79/3; QR-1;

Rept-80-9E6-MARED-R1) Avail: NTIS HC A04/MF A01

Components for the first 5 cell stack (no cooling plates) of the MK-2 design were fabricated. Preliminary specifications and designs for the components of a 23 cell MK-1 stack with four DIGAS cooling plates were developed. The MK-2 was selected as a bench mark design and a preliminary design of the facilities required for high rate manufacture of fuel cell modules was developed. Two stands for testing 5 cell stacks were built and design work for modifying existing stands and building new stands for 23 and 80 cell stacks was initiated. Design and procurement of components and materials for the catalyst test stand were completed and construction initiated. Work on the specifications of pipeline gas, tap water and recovered water and definition of equipment required for treatment was initiated. An innovative geometry for the reformer was conceived and modifications of the computer program to be used in its design were stated.

R.E.S.

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N80-23769*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CELL MODULE AND FUEL CONDITIONER Quarterly Report, Jan. - Mar. 1980

D. Q. Hoover, Jr. Apr. 1980 87 p
(Contracts DEN3-161; DE-AI03-79ET-11272)
(NASA-CR-159875; DOE/NASA/O161-2; QR-2) Avail: NTIS HC A05/MF A01 CSCL 10A

Stack tests indicate that the discrepancies between calculated and measured temperature profiles are due to reactant cross-over and a lower than expected thermal conductivity of cells. Preliminary results indicate that acceptable contact resistance between cooling plane halves can be achieved without the use of paper. The preliminary design of the enclosure, definition of required labor and equipment for manufacturing repeating components, and the assembly procedures for the benchwork design were developed. Fabrication of components for a second 5-cell stack of the MK-2 design and a second 23-cell stack of the MK-1 design was started. The definition of water and fuel for the reforming subsystem was developed along with a preliminary definition of the control system for the subsystem. The construction and shakedown of the differential catalytic reactor was completed and testing of the first catalyst initiated. R.E.S.

N80-23775*# General Electric Co., Philadelphia, Pa. Space Div.
MOD-1 WIND TURBINE GENERATOR ANALYSIS AND DESIGN REPORT, VOLUME-1 Final Report

Mar. 1979 320 p
(Contracts NAS3-20058; EX-77-A-29-1010)
(NASA-CR-159495; DOE/NASA/O058-79/2-Vol-1) Avail: NTIS HC A14/MF A01 CSCL 10A

The activities leading to the completion of detail design of the MOD-1 wind turbine generator are described. Emphasis is placed on the description of the design as it finally evolved. However, the steps through which the design progressed are also traced in order to understand the major design decisions. R.E.S.

N80-23778*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE OPTIMIZATION AIR SEPARATION PLANTS FOR COMBINED CYCLE MHD-POWER PLANT APPLICATIONS
Albert J. Juhasz, Helmut Springmann, and Ralph Greenberg 1980 11 p refs Presented at the 7th Intern. Conf. on MHD Elec. Power Generation, Cambridge, Mass., 16-20 Jun. 1980
(Contracts DEN3-165; EF-77-A-01-2674)
(NASA-TM-81510; DOE/NASA/2674-80/10) Avail: NTIS HC A02/MF A01 CSCL 10B

Some of the design approaches being employed during a current supported study directed at developing an improved air separation process for the production of oxygen enriched air for magnetohydrodynamics (MHD) combustion are outlined. The ultimate objective is to arrive at conceptual designs of air separation plants, optimized for minimum specific power consumption and capital investment costs, for integration with MHD combined cycle power plants. R.E.S.

N80-23781*# National Mechanical Engineering Research Inst., Pretoria (South Africa). Aeromechanics Div.
THE AERODYNAMICS OF AXIAL FLOW WIND POWER TURBINES

W. J. VanderElst Jun. 1979 37 p refs
(CSIR-ME-1619; ISBN-0-7988-1463-2) Avail: NTIS HC A03/MF A01

A general analysis of the aerodynamics of wind power turbines of the axial flow type is presented. The design parameters appear in nondimensional form and are presented graphically. The theory is applicable to any type of wind power generator, including slow running windmills normally used for powering water pumps as well as fast running machines which are suitable for the generation of electric power. Author

N80-23783*# SRI International Corp., Menlo Park, Calif.
NAVAL FACILITY ENERGY CONVERSION PLANTS AS RESOURCE RECOVERY SYSTEM COMPONENTS Interim

Report, period ending Oct. 1979

Arlie G. Capps Port Hueneme, Calif. Civil Engineering Lab. Jan. 1980 68 p
(Contract N00123-78-C-0868)
(AD-A081232; CEL-CR-80-002) Avail: NTIS HC A04/MF A01 CSCL 21/4

This interim report addresses concepts for recovering energy from solid waste by using Naval facilities steam plants as principle building blocks of candidate solid waste/resource recovery systems at Navy installations. The major conclusions of this portion of the project are: although it is technically feasible to adapt Navy energy conversion systems to fire Waste Derived Fuels (WDF) in one or more of its forms, the optimal form selected should be a site-specific total system; near- to intermediate-term programs should probably continue to give first consideration to waterwall incinerators and to the cofiring of solid WDF in coal-capable plants; package incinerators and conversions of oil burning plants to fire a fluff form of solid waste fuel may be the options with the greatest potential for the intermediate term because waterwalls would be uneconomical in many small plants and because the majority of medium-sized oil-burning plants will not be converted to burn coal; and pyrolytic processes to produce gaseous and liquid fuels have not been sufficiently developed as yet to be specified for commercial operation. GRA

N80-23790*# Argonne National Lab., Ill. Office of Program Management Support.

WORLD ENERGY DATA SYSTEM (WENDS). VOLUME 6: INTERNATIONAL AGREEMENT PROFILES

Jun. 1979 202 p
(Contract W-31-109-eng-38)
(ANL-PMS-79-2-Vol-6) Avail: NTIS HC A10/MF A01

The World Energy Data System contains organized data on those countries and international organizations that may have critical impact on world energy. The international agreement profiled in WENDS are all energy related and are organized by energy technology. These are: coal; conservation; fusion; geothermal; nuclear fission; oil, gas, and shale; solar, wind, and ocean thermal; and other (cooperation in electrical power equipment acquisition, energy, energy research, etc.). The agreement profiles are accessible by energy technology and alphabetically by country. DOE

N80-23818*# Thermo Electron Corp., Waltham, Mass.
DOE/JPL ADVANCED THERMIONIC TECHNOLOGY PROGRAM Progress Report, Apr. - Jun. 1979

1979 73 p refs
(Contracts JPL-95509; EY-76-C-02-3056)
(NASA-CR-163134; COO-3056-41; PR-39) Avail: NTIS HC A04/MF A01 CSCL 10A

Progress made in different tasks of the advanced thermionic technology program is described. The tasks include surface and plasma investigations (surface characterization, spectroscopic plasma experiments, and converter theory); low temperature converter development (tungsten emitter, tungsten oxide collector and tungsten emitter, nickel collector); component hardware development (hot shell development); flame-fired silicon carbide converters; high temperature and advanced converter studies; postoperational diagnostics; and correlation of design interfaces. DOE

N80-23821*# Oak Ridge National Lab., Tenn. Engineering Technology Div.

SUMMARY OF THE RESEARCH AND DEVELOPMENT EFFORT ON OPEN-CYCLE COAL-FIRED GAS TURBINES
M. E. Lackey Oct. 1979 126 p refs
(Contract W-7405-eng-26)
(ORNL/TM-6253) HC A07/MF A01

Extensive experience gained with gas turbines operating not only with coal as fuel but also with dusty inlet air and with dirty fuels (such as heavy oils and blast furnace gas) as well as petroleum catalytic cracking units was reviewed. All this experience indicates that the particulate content of the hot gases fed to the turbine must be kept to less than approximately 1 ppm to keep turbine bucket erosion to an acceptable level for turbine inlet temperatures of 1500 F or more. It is shown that cyclone

separators can be used to reduce the particulate content to as low as 100 ppM under the best conditions. The only effective was, found to reduce the particulate content of blast furnace gas and gas from coal gasification units to the 1 ppM required for a high temperature gas turbines is to cool the gas and pass it through a two-stage water scrubber or equivalent before burning it. DOE

N80-23831# Rockwell International Corp., Golden, Colo. Energy Systems Group.

MILLVILLE WIND TURBINE GENERATOR: FAILURE ANALYSIS AND CORRECTIVE DESIGN MODIFICATION
C. A. Waldon, M. J. Carr, and V. K. Grotzky Jul. 1979 25 p refs

(Contract EY-76-C-04-3533)
(RFP-2992/3533/79-3) Avail: NTIS HC A02/MF A01

Fatigue cracks in the blade skins of the Millville Wind Turbine Generator were fractographically analyzed. It is believed they were caused by large flapwise deflections during a wind storm on December 4, 1978. The deflections caused the skin to buckle, which initiated rapidly growing fatigue cracks. Propagation continued to the leading edge, moving radially inward and outward along the leading edge radius. A modified blade design which incorporates several corrective techniques was then developed. DOE

N80-23839# Oak Ridge National Lab., Tenn. Chemistry Div
MOLTEN CARBONATE FUEL CELL PROGRAM. COMPOSITION GRADIENTS INDUCED BY CURRENT FLOW IN Li2CO3-K2CO3 MIXTURES Progress Report, 1 Jul. - 31 Dec. 1978

J. Braunstein, H. R. Bronstein, S. Cantor, D. E. Heatherly, J. I. Padova, T. M. Thomas, and C. E. Vallet Dec. 1979 15 p refs
(Contract W-7405-eng-26)

(ORNL/TM-7061) Avail: NTIS HC A02/MF A01

Gradients in the Li/K ratio of a LiKCO₃ electrolyte caused by current flow in a molten carbonate fuel cell is the cation mobilities are unequal were examined. Composition gradients were predicted from estimated values of mobility, activity, and diffusivity utilizing a one dimensional model. Predictions from a similar model for a system of known properties were confirmed experimentally by electrolysis-relaxation experiments. The model calculations for carbonates are consistent with electrolysis-relaxation measurements on fuel cell tiles, but clearly indicate the need for additional specific physical property data, especially the transference number. DOE

N80-23844# Argonne National Lab., Ill.

OPEN-CYCLE COAL-FIRED LIQUID-METAL MHD
E. S. Pierson, M. Petrick, F. Schreiner, and D. Cohen 1979 12 p refs Presented at the 18th Symp. on Eng. Aspects of Magnetohydrodyn., Butte, Mont., 18-20 Jun. 1979
(Contract W-31-109-eng-38)

(CONF-790640-7) Avail: NTIS HC A02/MF A01

An open-cycle, coal fired, liquid magnetohydrodynamics (MHD) concept is described and compared with the open-cycle plasma MHD cycle, and it is shown that, in the former, temperatures are much lower and the air preheater and radiant boiler are eliminated. The constraints on the electrodynamic working fluid and the choice of copper are discussed. Recent experiments with liquid copper and coal combustion gas are described, and the indicated implications for environmental impact, i.e., SO/sub x/ and NO/sub x/ control, are discussed. Initial efficiency calculations yield values comparable to those for open-cycle plasma MHD at combustor temperatures as much as 1000 K lower and MHD generator temperatures more than 1000 K lower than is the case for open-cycle plasma MHD. Significantly, the liquid metal MHD system uses components that, except for the generator, are close to or within present-day technology, and it appears that readily available containment materials are compatible with the fluids. DOE

N80-23845# West Virginia Univ., Morgantown. Dept. of Aerospace Engineering.

VERTICAL AXIS WIND TURBINE DEVELOPMENT: EXECU-

TIVE SUMMARY Final Report, 1 Mar. 1976 - 30 Jun. 1977

R. E. Walters, J. B. Fanucci, P. W. Hill, and P. G. Migliore Jul. 1979 26 p
(Contract EY-76-C-05-5135)

(ORO-5135-77-5-Summ) Avail: NTIS HC A03/MF A01

Information is presented concerning (1) the numerical solution of the aerodynamics of cross-flow wind turbines; (2) boundary layer considerations for a vertical axis wind turbine (VAWT); (3) VAWT outdoor test model; (4) low solidity blade tests; (5) high solidity blade design; (6) cost analysis of the VAWT test model; (7) structural parametric analysis of VAWT blades; and (8) cost study of current wind energy conversion systems. DOE

N80-23846# West Virginia Univ., Morgantown. Dept. of Aerospace Engineering.

VERTICAL AXIS WIND TURBINE DEVELOPMENT Final Report, 1 Mar. 1976 - 30 Jun. 1977

R. E. Walters, J. B. Fanucci, P. W. Hill, and P. G. Migliore Jul. 1979 243 p refs

(Contract EY-76-C-05-5135)

(ORO-5135-77-5) Avail: NTIS HC A11/MF A01

Theoretical and experimental research accomplished in evaluating an innovative concept for vertical axis wind turbines (VAWT) is described. The concept is that of using straight blades composed of circulation controlled airfoil sections. The theoretical analysis was developed to determine the unsteady lift and moment characteristics of multiple-blade cross-flow wind turbines. To determine the drag data needed as input to the theoretical analysis, an outdoor test model VAWT was constructed; design details, instrumentation, calibration results, and initial test results are reported. Initial testing was with fixed pitch blades having cross-sections of conventional symmetrical airfoils. Costs of building the test model are included, as well as cost estimates for blades constructed with composite materials. These costs are compared with those of other types of wind turbines. DOE

N80-23850# Foster-Miller Associates, Inc., Waltham, Mass.
RESEARCH AND DEVELOPMENT OF AN AIR-CYCLE HEAT-PUMP WATER HEATER Final Report

John T. Dieckmann, Alve J. Erickson, Andrew C. Harvey, and William M. Toscano 1 Oct. 1979 343 p refs
(Contract W-7405-eng-26)

(ORNL/SUB-7226/1) Avail: NTIS HC A15/MF A01

A prototype reverse Brayton air cycle heat pump water heater was designed and built for residential applications. The system consists of a compressor/expander, an air-water heat exchanger, an electric motor, a water circulation pump, a thermostat, and fluid management controls. A potential residential market for the new high-efficiency water heater of approximately 480,000 units/y was identified. The retail and installation cost of this water heater is estimated to be between \$500 and \$600 which is approximately \$300 more than a conventional electric water heater. As part of the design effort, a thermodynamic parametric analysis was performed on the water heater system. It was determined that to obtain a coefficient of performance of 1.7, the isentropic efficiency of both the compressor and the expander must be at least 85 percent. The selected mechanical configuration is described. DOE

N80-23860# Battelle Columbus Labs., Ohio.
ANALYSIS AND DESIGN OF A 100-KILOWATT SOLAR PHOTOVOLTAIC FLAT-PANEL POWER SYSTEM FOR A MACHINING AND METALWORKING FACILITY IN COLUMBUS, OHIO. PHASE 1: PHOTOVOLTAIC FLAT PANEL APPLICATION EXPERIMENT Final Report, 1 Oct. 1978 - 28 Feb. 1979

G. T. Noel, G. Alexander, L. H. Stember, G. H. Stickford, J. H. Broehl, and D. C. Carmichael Albuquerque, N. Mex. DOE Mar. 1979 163 p

(Contracts ET-78-C-04-5395; DE-AC04-78ET-23055)

(DOE/ET/23055-1) Avail: NTIS HC A08/MF A01

A 100kW peak flat panel photovoltaic power system to supply power to a machine shop load in Columbus, Ohio was designed. The system will provide three-phase, 240 volt ac power to a machining and metal-working facility which has 100 pieces of

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machinery and employs 50 machinists and other craftsmen. The system will operate in parallel with the utility which will supply the backup power. Due to the close match of the array power output to the workday shop load, only a small amount of the power generated is excess to the concurrent shop demand. When there is any excess, it will be fed to alternate loads at the site, rather than into the utility grid. A system performance analysis indicates that the system will supply approximately 115,000 kWh/year of electrical energy after all losses. The system uses high energy-density flat panel photovoltaic modules in a roof-mounted installation, and employs a microprocessor controlled power conditioning unit. DOE

N80-23862# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.

DYNAMICS OF A FLEXIBLE ROTOR-TOWER SYSTEM

Lennart S. Hultgren and John Dugundji Stockholm Aeronautical Research Inst. of Sweden Aug. 1979 99 p refs
(Contract SWEDBESD-5061.012)
(ASRL-TR-194-1; FFA-AU-1499) Avail: NTIS
HC A05/MF A01

The dynamics of a horizontal axis wind turbine were analyzed. Both the blades and the tower are taken to be flexible. The analysis is linear and modal. For a three bladed rotor, numerical results were obtained for free vibrations and forced oscillations due to static unbalance. Analytical solutions were constructed for forced vibrations due to gravity and wind shear.

Author (ESA)

N80-23947# Battelle Pacific Northwest Labs., Richland, Wash.
WIND CHARACTERISTICS FOR AGRICULTURAL WIND ENERGY APPLICATIONS

David S. Renne Jan. 1979 5 p refs Presented at the 14th Conf. on Agr. and Forest Meteorology, Minneapolis, 24 Apr. 1979

(Contract EY-76-C-06-1830)
(PNL-SA-7270; CONF-7904120-1) Avail: NTIS
HC A02/MF A01

The development of economically viable wind energy conversion systems (WECS) is discussed. The use of the WECS in farm and rural applications is examined. Potential applications for WECS include irrigation pumping, residential heat, control of livestock environment, crop drying, and water heating and pumping. A map outlining the wind energy resource in the United States is presented at the various wind characteristics important to WECS are delineated. A.W.H.

N80-24214# Los Alamos Scientific Lab., N. Mex.

FUEL CELL SYSTEMS FOR VEHICULAR APPLICATIONS
D. K. Lynn, J. B. McCormick, R. E. Bobbett (Arizona Univ., Tucson), W. J. Kerwin, and C. Deroquin 1980 30 p refs Presented at SAE Automotive Eng. Congr. and Exposition, Detroit, 25 Feb. 1980

(Contract W-7405-eng-36)
(LA-UR-79-2826; CONF-800202-2) Avail: NTIS
HC A02/MF A01

The phosphoric acid fuel cell was used as the base line in these evaluations. Two cell sizes (15 and 60 kW) and two fuel options (methanol and propane) were included. Four vehicle types, the city bus, highway bus, delivery van, and general-purpose consumer car were selected for evaluation. Typical drive cycles and economics for these vehicles are compiled, and the fuel cell vehicle and current internal combustion and diesel engine vehicles are compared. The initial results of detailed computer simulations to illustrate a number of the important system-design considerations in configuring a fuel cell/battery electric vehicle are presented and a fuel-cell-powered golf cart currently being used as an engineering test bed is described. DOE

N80-24620# Chrysler Corp., Detroit, Mich.

BASELINE AUTOMOTIVE GAS TURBINE ENGINE DEVELOPMENT PROGRAM Final Report

C. E. Wagner, ed. and R. C. Pampreen, ed. Apr. 1979 182 p refs Sponsored by NASA
(Contracts EY-76-C-02-2749; EC-77-A-31-1040)

(NASA-CR-159670; DOE/NASA/2749-79/1-Vol-1; COO-2749-42) Avail: NTIS HC A09/MF A01 CSCL 21A

Tests results on a baseline engine are presented to document the automotive gas turbine state-of-the-art at the start of the program. The performance characteristics of the engine and of a vehicle powered by this engine are defined. Component improvement concepts in the baseline engine were evaluated on engine dynamometer tests in the complete vehicle on a chassis dynamometer and on road tests. The concepts included advanced combustors, ceramic regenerators, an integrated control system, low cost turbine material, a continuously variable transmission, power-turbine-driven accessories, power augmentation, and linerless insulation in the engine housing. R.E.S.

N80-24621# Chrysler Corp., Detroit, Mich.

CONCEPTUAL DESIGN STUDY OF AN IMPROVED AUTOMOTIVE GAS TURBINE POWERTRAIN Final Report

C. E. Wagner, ed. and R. C. Pampreen, ed. Jun. 1979 196 p refs

(Contracts DE-AC02-76CS-52749)
(NASA-CR-159672; DOE/NASA/2749-79/3-Vol-3; COO-2749-40) Avail: NTIS HC A09/MF A01 CSCL 21A

Automotive gas turbine concepts with significant technological advantages over the spark ignition (SI) engine were assessed. Possible design concepts were rated with respect to fuel economy and near-term application. A program plan which outlines the development of the improved gas turbine (IGT) concept that best met the goals and objectives of the study identifies the research and development work needed to meet the goal of entering a production engineering phase by 1983. The fuel economy goal is to show at least a 20% improvement over a conventional 1976 SI engine/vehicle system. On the basis of achieving the fuel economy goal, of overall suitability to mechanical design, and of automotive mass production cost, the powertrain selected was a single-shaft engine with a radial turbine and a continuously variable transmission (CVT). Design turbine inlet temperature was 1150 C. Reflecting near-term technology, the turbine rotor would be made of an advanced superalloy, and the transmission would be a hydromechanical CVT. With successful progress in long-lead R&D in ceramic technology and the belt-drive CVT, the turbine inlet temperature would be 1350 C to achieve near-maximum fuel economy. A.R.H.

N80-24757# Honeywell, Inc., Minneapolis, Minn.

SPECTROPHOTOVOLTAIC ORBITAL POWER GENERATION Final Report, Aug. 1979 - Feb. 1980

Joan R. Onffroy Feb. 1980 195 p refs
(Contract NAS8-33511)
(NASA-CR-161451; HONEYWELL-80SRC8) Avail: NTIS
HC A09/MF A01 CSCL 10A

The feasibility of a spectrophotovoltaic orbital power generation system that optically concentrates solar energy is demonstrated. A dichroic beam-splitting mirror is used to divide the solar spectrum into two wavebands. Absorption of these wavebands by GaAs and Si solar cell arrays with matched energy bandgaps increases the cell efficiency while decreasing the amount of heat that must be rejected. The projected cost per peak watt if this system is \$2.50/W sub p. R.E.S.

N80-24758# Boeing Engineering and Construction, Seattle, Wash.

MOD-2 WIND TURBINE SYSTEM CONCEPT AND PRELIMINARY DESIGN REPORT. VOLUME 1: EXECUTIVE SUMMARY

Jul. 1979 31 p
(Contracts DEN3-2; DE-AI01-793T-20305)
(NASA-CR-159609; DOE/NASA/0002-80/2) Avail: NTIS
HC A03/MF A01 CSCL 10A

The configuration development of the MOD-2 wind turbine system is presented. The MOD-2 is design optimized for commercial production rates which, in multi-unit installations, will be integrated into a utility power grid and achieve a cost of electricity at less than 4 cents per kilowatt hour. R.E.S.

N80-24772# Fairchild Stratos Corp., Manhattan Beach, Calif.
NON-HEAT PIPE/P-40 STIRLING ENGINE

R. A. Haglund. *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 95-97

Avail: NTIS HC A11/MF A01 CSCL 10B

The non-heat-pipe receiver/P-40 Stirling engine system design is described. A 25 kW direct-driven induction-type alternator will be mounted directly to the P-40 engine to produce a 60 Hz, 115/230 volt output. R.E.S.

N80-24773*# Ford Aerospace and Communications Corp., Newport Beach, Calif.

THE SCSTPE ORGANIC RANKINE ENGINE

Frank P. Boda *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 99-105 refs

Avail: NTIS HC A11/MF A01 CSCL 10B

The organic Rankine cycle engine under consideration for a solar thermal system being developed is described. Design parameters, method of control, performance and cost data are provided for engine power levels up to 80 kW; efficiency is shown as a function of turbine inlet temperature in the range of 149 C to 427 C. R.E.S.

N80-24775*# United Stirling, Inc. Alexandria, Va.

THE UNITED STIRLING P40 ENGINE FOR SOLAR DISH CONCENTRATOR APPLICATION

Lars Ortegren and Lars E. Sjostedt (United Stirling A.B., Malmö, Sweden) *In* JPL Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 113-117

Avail: NTIS HC A11/MF A01 CSCL 10A

The United Stirling P40 engine is a key component in a solar concentration based energy conversion system, to be demonstrated and tested during 1980-81. The inherent characteristics of modern Stirling engines is reviewed focusing on the baseline P40 double-acting engine. The extent of modifications required for the solar application is reviewed and performance data are predicted. Finally, the potential of an advanced solar Stirling engine is briefly considered. R.E.S.

N80-24781*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PASAD ESTIMATING BRAYTON AND STIRLING ENGINES

Herbert R. Fortgang *In* its Proc. of the First Semiann. Distributed Receiver Program Rev. 15 May 1980 p 153-158

Avail: NTIS HC A11/MF A01 CSCL 05C

Brayton and Stirling engines were analyzed for cost and selling price for production quantities ranging from 1000 to 400,000 units per year. Parts and components were subjected to in-depth scrutiny to determine optimum manufacturing processes coupled with make or buy decisions on materials and small parts. Tooling and capital equipment costs were estimated for each detail and/or assembly. For low annual production volumes, the Brayton engine appears to have a lower cost and selling price than the Stirling Engine. As annual production quantities increase, the Stirling becomes a lower cost engine than the Brayton. Both engines could benefit cost wise if changes were made in materials, design and manufacturing process as annual production quantities increase. Author

N80-24809*# Galaxy, Inc., Washington, D.C.

ORGANIC RANKINE CYCLE ENGINE TECHNOLOGY IN JAPAN, A PRELIMINARY SURVEY

Oct. 1979 132 p refs
(Contract DE-AC03-79SF-10538)

(DOE/SF/10538-1) Avail: NTIS HC A07/MF A01

The state-of-the-art of the development of organic Rankine cycle engines in Japan is reviewed. With the first oil crisis as a momentum, general volition to research and development and commercialization efforts of the Rankine cycle has rapidly developed. However, practical applications by industries will be the matter of future. Recovery systems of waste heat should be designed based on availability of waste heat sources. The Rankine cycle, as one of the electric power generators, has a wider range of application and thus, especially in Japan, the development

of Rankine cycle technology is going forward. Although the presently attained thermal utilization rate is only 20%, future improvement of the rate will be considerably dependent on the contribution of the developments on specific various units, for example, the heat exchanger. R.E.S.

N80-24811*# Dayton Univ. Research Inst., Ohio.

ELECTROFLUID DYNAMIC WIND GENERATOR Final Annual Progress Report, 15 Sep. 1977 - 30 Sep. 1978

John E. Minardi, Maurice O. Lawson, and Frank L. Wattendorf May 1979 76 p refs

(Contract EY-76-S-02-4130)

(COO-4130-2: APR-3) Avail: NTIS HC A05/MF A01

The objective of the program is to conduct research leading to the development of EFD wind driven generators. In such generators, the wind blows through suitably oriented arrays of electrodes, transports charged particles against an electrical potential gradient, and thereby generates electrical power directly without moving parts. Significant progress has been made in accomplishing major research objectives. During the year, the effort was directed toward the achievement of three milestones; namely: development of a laboratory method for the production of an adequate supply of suitably low mobility charged droplets for the testing of generator performance; experimental verification of generator performance theory; and development of methods for practical production of charged droplets. DOE

N80-24812*# Rasor Associates, Inc., Sunnyvale, Calif.

ADVANCED THERMIONIC ENERGY CONVERSION Joint Highlights and Status Report, Apr. - Jun. 1979

1979 81 p refs

(Contracts JPL-955033; EY-76-C-02-2263)

(NASA-CR-163061; COO-2263-15; NSR-2-15) Avail: NTIS CSCL 10A

Developments towards space and terrestrial applications of thermionic energy conversion are presented. Significant accomplishments for the three month period include: (1) devised a blade-type distributed lead design with many advantages compared to the stud-type distributed lead; (2) completed design of Marchuk tube test apparatus; (3) concluded, based on current understanding, that residual hydrogen should not contribute to a negative space charge barrier at the collector; (4) modified THX design program to include series-coupled designs as well as inductively-coupled designs; (5) initiated work on the heat transfer technology, THX test module, output power transfer system, heat transfer system, and conceptual plant design tasks; and (6) reached 2200 hours of operation in JPL-5 cylindrical converter envelope test. DOE

N80-24834*# Massachusetts Inst. of Tech., Cambridge. Dept. of Ocean Engineering.

OCEAN THERMAL ENERGY CONVERSION: A STATE-OF-THE-ART STUDY

A. Douglas Carmichael Jul. 1979 84 p Sponsored by EPRI (EPRI-ER-1113-SR) Avail: NTIS HC A05/MF A01

A baseline ocean thermal energy conversion unit composed of eight 50 MW power modules was studied and defined. It was concluded that OTEC system is technically feasible and could operate year round in some regions of the Gulf of Mexico, off Hawaii, and off Puerto Rico. The closed Rankine cycle using ammonia as the working fluids is probably the best power plant system to utilize the small temperature differences of about 40 F between the warm surface water and the cold water taken from a depth of about 3280 ft. The most important components in the power plant are the large heat exchangers and the major technical problems are anticipated with these components. The platform will probably have a ship or barge configuration with the long cold water pipe supported, from the midships region. The estimated costs of the baseline system were established from recent design studies. The total capital investment (excluding the cables to shore) was estimated to be about \$3000 per kW. DOE

N80-24861*# South Dakota School of Mines and Technology, Rapid City.

ENERGY FROM HUMID AIR Final Report

T. K. Oliver, W. N. Groves, C. L. Gruber, and A. Cheung Feb.

05 ENERGY CONVERSION

1979 99 p refs
(Contract EX-76-C-01-2553)
(DSE-2553-79/1) Avail: NTIS HC A05/MF A01

A cost effective process to convert the energy in humid air into mechanical work to drive an electrical generator was investigated using computer modeling. Results for a natural draft tower show that it is not a cost effective way to get energy from humid air. Parametric studies are presented for expansion-compression cycles. With suitable conditions, including large amounts of cooling during compression, this cycle has an attractive network output. To avoid using all the output power to overcome machine losses, it appears necessary to use a one-machine mechanization. The most promising uses vortex flow to achieve the necessary expansion and subsequent compression with cooling. Power output and costs were estimated for a vortex plant located in Puerto Rico. DOE

N80-24864# Grumman Aerospace Corp., Bethpage, N.Y.
FURTHER INVESTIGATIONS OF DIFFUSER AUGMENTED WIND TURBINES. PART 1: EXECUTIVE SUMMARY Final Report

K. M. Foreman and B. L. Gilbert Jul. 1979 11 p
(Contract EY-76-C-02-2616)
(COO-2616-2-Pt-1-Rev-1) Avail: NTIS HC A02/MF A01

A multiphased experimental program is described which involves wind tunnel test facilities and models of several compact diffuser configurations. Screens to simulate a wind turbine and a three-bladed, fixed-pitch turbine were used with the diffuser models. A candidate baseline design is described, and some of the key technical and economic issues which can lead to future full scale implementation are discussed. DOE

N80-24875# New Mexico Energy Inst., Albuquerque.
VARIABLE SPEED CONSTANT FREQUENCY VOLTAGE GENERATOR (ALTERNATOR) Final Report
W. W. Grannemann Jul. 1979 46 p refs Sponsored by New Mexico Energy and Minerals Dept.
(PB80-141286; NMEI-44) Avail: NTIS HC A03/MF A01 CSCL 10B

The objective achieved was constructing the first prototype alternator with digital control of its output frequency for a variable shaft speed, such as a wind machine would have. The first machine is a two-pole alternator with power removed from the rotor through slip rings. The rotating field in the stationary coils of the stator is controlled by the microcircuits. Later alternators may well have the control circuits and rotating field in the rotor which would be a significant improvement since power would not need to be removed through slip rings. Except for the power amplifiers which drive the stator windings, the control and the comparison circuitry is constructed with available low cost, low power integrated circuits (IC's). Test results from the first prototype demonstrate that the alternator can successfully convert available wind power directly to usable a-c 60 hertz power to supplement line power. The power generated by the alternator can have constant frequency as determined by the local power system and the control circuitry. Variations in the mechanical speed of rotation of the alternator rotor, which are caused by changes in wind velocity, will change the power output of the alternator while the voltage and the frequency remain constant. GRA

N80-25104*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
SOME CALCULATED EFFECTS OF NON-UNIFORM INFLOW ON THE RADIATED NOISE OF A LARGE WIND TURBINE
George C. Greene and Harvey H. Hubbard May 1980 14 p refs
(NASA-TM-81813) Avail: NTIS HC A02/MF A01 CSCL 20A

Far field computations were performed for a large wind turbine to evaluate the effects of non-uniform aerodynamic loading over the rotor disk. A modified version of the Farassat/Nyström propeller noise prediction program was applied to account for the variations in loading due to inflow-interruption by the upstream support tower. The computations indicate that for the uniform inflow case, relatively low noise levels are generated and the

first rotational harmonic dominated the spectrum. For cases representing wake flow deficiencies due to the tower structure, substantially increased noise levels for all harmonics are indicated, the greatest increases being associated with the higher order harmonics. Author

N80-25161# California Univ., Livermore. Lawrence Livermore Lab.

TESTS OF HIGH-POWERED DIRECT CONVERSION ON BEAMS AND PLASMA

W. L. Barr, R. W. Moir, G. W. Hamilton, and A. F. Lietzke (Calif. Univ. Lawrence Berkeley Lab.) 6 Nov. 1979 6 p refs Presented at the 8th Symp. on Eng. Probl. of Fusion Res., San Francisco, 13 Nov. 1979

(Contract W-7405-eng-48)
(UCRL-82852; CONF-791102-31) Avail: NTIS HC A02/MF A01

Two types of direct converters at up to 100 keV were tested. A beam direct converter was tested on a reduced area TFRT source at the Lawrence Berkeley Laboratory (LBL). After surface conditioning and outgassing, the efficiency was over 60% at the beginning of a pulse. During a pulse, the efficiency decreased as the gas density built up. A single-stage plasma direct converter with immersed grids is being tested on a steady-state ion beam with 6 kW of beam power. The power density at the grids can be varied by adjusting the beam focus. Recovery efficiencies over 70% are measured and we are now studying various loss mechanisms. DOE

N80-25650# California Univ., Livermore. Lawrence Livermore Lab.

LASER PROGRAM, VOLUME 3 Annual Report, 1978

Michael J. Monsler, ed. and Brian D. Jarman, ed. Mar. 1979 266 p refs 3 Vol.
(Contract W-7405-eng-48)

(UCRL-50021-78-Vol-3) Avail: NTIS HC A12/MF A01

Progress in advanced quantum electronics, primarily the quest for advanced rep-rateable short wave length lasers with high efficiency, is documented. Application studies in electrical energy production and fissile fuel production are also described. Selected highlights of the advanced isotope separation program are also presented. DOE

N80-25666# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

COMPACT CLOSED CYCLE BRAYTON SYSTEM FEASIBILITY STUDY, VOLUME 1 Final Report, 20 May 1976 - 20 Jun. 1979

R. E. Thompson, R. L. Ammon, R. Calvo, L. R. Eisenstatt, and F. R. Spurrier Aug. 1979 204 p refs
(Contract N00014-76-C-0706)

(AD-A081379; WAES-TNR-237-Vol-1) Avail: NTIS HC A10/MF A01 CSCL 20/13

This report presents the final results from a three year study which evaluated the feasibility of a closed Brayton cycle power conversion system for compact light weight naval propulsion plants. The overall objective of the program was to conduct the analytical study and experimental research required to evaluate and to demonstrate feasibility of a closed Brayton cycle power conversion system for a low volume, light weight marine propulsion plant. Another objective was to insure relevance of power conversion system study results to all candidate applications, including recognition of the various energy sources which the Navy could desire to use in the future. The Compact Closed Cycle Brayton System (CCCBS) program has included derivation of the most stringent representative requirements for the CCCBS power conversion system, consideration of the interfaces with the ship and with other powerplant components which were outside the scope of the system under study, investigation and evaluation of the components which are most critical to feasibility, iterative definition of a reference 52.2 M Pa (17,000 HP) CCCBS design concept; extensive creep-rupture tests of candidate turbine materials in helium and in air at 927 C (1700 F), and overall evaluations and assessments. The results have shown the feasibility and attractive characteristics of a CCCBS and have indicated that no high risk developments or technology break-

hroughs are needed for the CCCBS power conversion system. The results of this program provide a valuable baseline of data for use by the Navy in defining the advanced powerplants which will enhance the capabilities of many types of naval vessels.

GRA

N80-26785* Georgia Inst. of Tech., Atlanta. Engineering Extension Lab.

PHOTOVOLTAIC SYSTEM COSTS USING LOCAL LABOR AND MATERIALS IN DEVELOPING COUNTRIES

Edward Jacobson, George Fletcher, and Gerald Hein 20 May 1980 60 p

(Grant NsG-3297)

(NASA-CR-163218) Avail: NTIS HC A04/MF A01 CSDL 10A

The use of photovoltaic (PV) technology in countries that do not presently have high technology industrial capacity was investigated. The relative cost of integrating indigenous labor (and manufacturing where available) into the balance of the system industry of seven countries (Egypt, Haiti, the Ivory Coast, Kenya, Mexico, Nepal, and the Philippines) was determined. The results were then generalized to other countries, at most levels of development. The results of the study imply several conclusions: (1) the cost of installing and maintaining comparable photovoltaic systems in developing countries is less than in the United States; (2) skills and some materials are available in the seven subject countries that may be applied to constructing and maintaining PV systems; (3) there is an interest in foreign countries in photovoltaics; and (4) conversations with foreign nationals suggest that photovoltaics must be introduced in foreign markets as an appropriate technology with high technology components rather than as a high technology system.

R.E.S.

N80-25799* Value Engineering Co., Alexandria, Va. **OTEC SUPPORT SERVICES Quarterly Technical Progress Report, 15 Nov. 1978 - 14 Feb. 1979**

28 Feb. 1979 17 p

(Contract ET-78-C-02-4931)

(COO-4931-T11; QTPR-3) Avail: NTIS HC A02/MF A01

System integration, engineering, and management support services provided for the Ocean Thermal Energy Conversion (OTEC) Program are described. The tasks include (1) survey, analysis, evaluation, and recommendation concerning program performance; (2) program technical monitoring; (3) development and implementation of methodology to identify and evaluate program alternatives; (4) technical assessments; (5) OTEC system integration; and (6) environment and siting considerations. DOE

N80-25800* Science Applications, Inc., McLean, Va. **SOLAR PHOTOVOLTAIC FLAT PANEL APPLICATIONS EXPERIMENT AT THE OKLAHOMA CENTER FOR SCIENCE AND ARTS Final Report, 30 Sep. 1978 - 31 May 1979**

31 May 1979 186 p refs

(Contracts ET-78-C-04-5403; DE-AC04-78ET-23063)

(DOE/ET-23063/1) Avail: NTIS HC A09/MF A01

A photovoltaic power system was designed for the Oklahoma Center for Science and Arts in Oklahoma City. The system, with a basic rating of 250 kW, is enhanced to a summer peak output of 350 kW through the use of augmentation glass mirror reflectors which are arranged to maximize summer output and to match the summer output to the summer load. The baseline system consists of 3780 photovoltaic collector modules, utilizing polycrystalline silicon cells, and companion mirror reflectors arranged in modular fashion on the roof of the Center. Total system output is more than 450 MWh, of which over 420 MWh is used on-site to displace about 65 percent of the current on site load, or about 43 percent of the projected (1981) load. Another 30 MWh is returned to the utility under a buyback agreement. The total amount of energy displaced per year is approximately 850 barrels of oil, or 8tu equivalent.

DOE

N80-25807* Development Planning and Research Associates, Inc., Manhattan, Kans.

WIND ENERGY APPLICATIONS IN AGRICULTURE: EXECUTIVE SUMMARY Final Report

Milton L. David, Robert J. Buzenberg, Earl F. Glynn, Gary L.

Johnson, J. Kenneth Shultis, and John P. Wagner Aug. 1979 209 p refs Sponsored in part by Dept. of Agriculture

(Contract EX-76-A-29-1026)

(DOE/SEA-1109-20401-79/2) Avail: NTIS HC A10/MF A01

An assessment is presented of the potential use of wind turbine generator systems (WTGS) in US agriculture. In particular, the number of WTGS's economically feasible for use in US agriculture and the conditions which yielded economic feasibility of WTGS's for certain agricultural applications are presented. In addition, for each case, i.e., set of assumed conditions, under which WTGS's were found to be economically feasible are identified: (1) the agricultural WTGS applications in terms of location, type and size (complete farm and dedicated-use applications); (2) the number of WTGS's by wind machine and generator size category; (3) aggregate energy conversion potential; and (4) other technical and economic WTGS performance data for particular applications. The methodology, data and assumptions used for the analysis are described.

DOE

N80-25824* Department of Energy, Washington, D. C. Office of Solar, Geothermal, Electric and Storage Systems.

OCEAN ENERGY SYSTEMS. FISCAL YEAR 1979 Program Summary Report

1979 284 p refs

(DOE/ET-0118) Avail: NTIS HC A13/MF A01

A review of ocean thermal energy conversion technology, test facilities, and research programs is given; and project summaries for DOE contracts are included. The project summaries list the contractor, contract title and number, funding, and work location and provide a brief description of the project. Also, project summaries for technologies for alternate ocean energy systems employing ocean currents, ocean waves, and salinity gradients are included. The technical status and program plans for each of the alternate technologies are discussed.

DOE

N80-25836* Westinghouse Electric Corp., East Pittsburgh, Pa. **DESIGN STUDY AND ECONOMIC ASSESSMENT OF MULTI-UNIT OFFSHORE WIND ENERGY CONVERSION SYSTEMS APPLICATIONS. VOLUME 4: METEOROLOGICAL AND OCEANOGRAPHIC SURVEYS Final Report**

14 Jun. 1979 344 p refs

(Contracts EX-76-C-01-2330; E(49-18)-2330)

(WASH-2330-78/4-Vol-4) Avail: NTIS HC A15/MF A01

The results are presented of a survey of the meteorology and oceanography of the United States offshore as they pertain to the design, cost, emplacement, operation and maintenance of offshore wind energy conversion systems (OWECS). This report is intended to define the environment in which OWECS are to be considered.

DOE

N80-25837* Westinghouse Electric Corp., East Pittsburgh, Pa. Advanced Systems Technology Div.

DESIGN STUDY AND ECONOMIC ASSESSMENT OF MULTI-UNIT OFFSHORE WIND ENERGY CONVERSION SYSTEMS APPLICATION. VOLUME 3: SYSTEM ANALYSIS Final Report

14 Jun. 1979 192 p refs

(Contract EX-76-C-01-2330)

(WASH-2330-78/4-Vol-3) Avail: NTIS HC A09/MF A01

Optimum offshore wind energy conversion systems are described. The cost and performance of these systems were developed for a variety of conditions and the tradeoff between cost and energy production was made of the wide range of scenarios considered. The impact of the many design parameters on the major subsystems are briefly reviewed and the interactions which exist between subsystems are discussed. In particular, a section is devoted to dynamic interactions which might exist between the wind turbine generator plant and the platform.

DOE

N80-25838* Westinghouse Electric Corp., East Pittsburgh, Pa. **DESIGN STUDY AND ECONOMIC ASSESSMENT OF MULTI-UNIT OFFSHORE WIND ENERGY CONVERSION SYSTEMS APPLICATION. VOLUME 2: APPARATUS DESIGNS AND COSTS Final Report**

14 Jun. 1979 310 p refs

(Contracts EX-76-C-01-2330; E(49-18)-2330)

05 ENERGY CONVERSION

(WASH-2330-78/4-Vol-2) Avail: NTIS HC A14/MF A01

Parametric designs and companion cost functions are presented for each major component of an offshore wind energy conversion system (OWECS). These are: (1) the support platforms; (2) the wind turbine generated (WTG) plants; and (3) the electrical energy collection and transmission system including (4) substations. A backup hydrogen energy delivery system for extremely remote or deep water sites was also evaluated. Costs are presented for fabricating, transporting, installing, operating, and maintaining each of these components. DOE

N80-25846# Montana Energy and MHB Research and Development Inst., Inc., Butte.

HIGH-TEMPERATURE FUEL CELL RESEARCH AND DEVELOPMENT Annual Technical Status Report, 1 Oct. 1978 - 30 Sep. 1979

30 Sep. 1979 25 p

(Contracts EC-77-C-03-1485; DE-AC03-77ET-11320)

(SAN-1485-T1) Avail: NTIS HC A02/MF A01

Materials which are chemically and physically stable in molten carbonate fuel cell electrolyte at 600 to 700 C were identified. Fibers of the identified materials were then prepared and characterized to determine the stability of the fibers in the molten carbonate electrolyte. DOE

N80-25847# Institute of Gas Technology, Chicago, Ill.

FUEL CELL RESEARCH ON SECOND-GENERATION MOLTEN-CARBONATE SYSTEMS Technical Report, 1 Oct. 1978 - 30 Jun. 1979

Oct. 1979 305 p refs

(Contract EM-78-C-03-1735)

(SAN-11276-1) Avail: NTIS HC A14/MF A01

Activities toward the development of a cell package containing cost effective cell components, having a cell performance satisfying utility requirements (125 W/ft² at 0.85 V using low Btu fuel gases), and having the capability of repeated thermal cycling with a pressure differential between the anode and the cathode are described. Structural analysis studies to identify the magnitude and the distribution of stress levels in the cell package show that differences in thermal expansion and mechanical properties of the cell components, bonding of the electrolyte tile to other cell components, and the cell design (location of supports and gas distribution channels) are extremely important. Efforts to minimize the phase transformations of the three crystalline forms of LiAlO₂ during cell operation via anion or cation doping of the LiAlO₂ for the purpose of stabilizing the LiAlO₂ surface area at some acceptable level are showing only limited success. Both baseline and development cell components were tested in laboratory and in bench scale cells. DOE

N80-25848# Montana Energy and MHB Research and Development Inst., Inc., Butte.

HIGH TEMPERATURE FUEL CELL RESEARCH AND DEVELOPMENT Final Technical Status Report, Jun. 1977 - Sep. 1978

J. J. Rasmussen and R. Guidotti 15 Oct. 1978 253 p refs

(Contract EC-77-C-03-1485)

(SAN-1485-2) Avail: NTIS HC A12/MF A01

Ceramic materials with properties which made them potential candidates for use in molten-carbonate fuel cell tiles or electrodes were investigated. Thirteen compositions were tested statically at 1000 K in a Li₂CO₃-K₂CO₃ bath under a dry CO₂ atmosphere. Four of the materials tested showed severe degradation reactions in the molten carbonate. A low temperature process for forming small diameter, high aspect ratio ceramic fibers for fuel cell use was developed. Results of a computer study on the thermodynamic analysis of fuel cell materials are discussed. The magnetohydrodynamic materials with potential use for fuel cell applications were surveyed. Laboratory facilities were established to conduct research on interfacial diffusion processes which could be detrimental to successful long term operation of the solid-electrolyte fuel cell. A variety of physical and chemical techniques were examined for the preparation of high density substituted LaCrO₃ which was one component of a diffusion couple with Y₂O₃-stabilized ZrO₂. Hydrolysis of a mixed metal nitrate solution with urea produced the most reactive powder. A final theoretical density of almost 98% was attained in cold pressed sintered discs of this material. DOE

N80-25870# General Electric Co., Philadelphia, Pa. Valley Forge Space Center.

REQUIREMENT DEFINITION AND PRELIMINARY DESIGN OF A PHOTOVOLTAIC CENTRAL POWER STATION EXPERIMENTAL TEST FACILITY Final Report

G. O'Brien, R. Pohl, and N. Turner Dec. 1979 481 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7022-Vol-1) Avail: NTIS HC A21/MF A01

The requirements and preliminary design for a photovoltaic central power station experimental test facility are described. Requirements, a preliminary design, costs and schedule were established for the facility construction. Utility participation was reviewed with selected utilities, and both a site selection methodology and a summary set of combined continental US insolation and meteorological data was prepared. The major results, the detailed technical discussion, cost and plans, for the experimental test facility as well as sets of preliminary specifications, drawings, and site selection data are given. DOE

N80-25888# Rockwell International Corp., Golden, Colo. Rocky Flats Plant.

NEW DEVELOPMENTS IN WIND SYSTEMS TECHNOLOGY R. L. Moment 1979 22 p refs Presented at 2d Intern. Conf. on Alternative Energy Sources, Miami, Beach, Fla. 10 Dec. 1979

(Contract EY-76-C-04-3533)

(RFP-3000: CONF-791204-20)

Avail: NTIS

HC A02/MF A01

Development programs for U.S. wind turbines of under 100 kW output are reviewed. The system configurations and approaches to component design are discussed. DOE

N80-25889# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

TECHNICAL AND MANAGEMENT SUPPORT FOR THE DEVELOPMENT OF SMALL WIND SYSTEMS Annual Report, 1 Oct. 1977 - 30 Sep. 1978

Feb. 1979 147 p refs

(Contract EY-76-C-04-3533)

(RFP-2974/3533-79-2) Avail: NTIS HC A07/MF A01

The FY 1978 annual report of the Rocky Flats Wind Systems Program describes the objectives, approach, and achievements of the program and each of its tasks areas during the period 1 October 1977 - 30 September 1978. During this period, additional testing of ten small wind energy conversion systems (SWECS) was conducted and the Test Center was expanded to accommodate up to 30 SWECS. Work on nine design and analysis projects for advanced prototypes in three size ranges progressed through a series of design reviews, with prototype delivery scheduled to begin in mid-1979. Supporting activities included a Systems Engineering project which analyzed the cost of SWECS components and fabrication, a task effort in technical support to standards development, and the dissemination of information. DOE

N80-25891# EIC, Inc., Newton, Mass.

NEW ELECTROLYTES FOR DIRECT METHANE FUEL CELLS Final Report, 10 Jan. 1977 - 9 Jan. 1979

S. B. Brummer, J. Foos, J. McHardy, J. McVaigh, D. Toland, and M. Turner May 1979 74 p refs

(Contracts EY-76-C-03-1363; DE-AC03-79ET-11321)

(DOE/ET-11321/T1) Avail: NTIS HC A04/MF A01

A fuel cell electrolyte for the direct oxidation of CH₄ and/or impure H₂ fuels was developed. Emphasis is placed on di and tribasic methanesulfonic acids CX₂(SO₃H)₂ and CX(SO₃H)₃ here X is H, F, or Cl. Synthetic routes to CH₂(SO₃H)₂, CH(SO₃H)₃, CCl₂(SO₃H)₂, and CCl(SO₃H)₃ were identified and optimized. The diphenyl ester of CF₂(SO₃H)₂ was prepared for the first time and various approaches to CF(SO₃H)₃ was investigated. In parallel with the synthetic program, apparatus was designed and fabricated for the testing of the electrolytes under fuel cell conditions. Electrodes with low Pt loading were developed for use in electrolyte evaluation. Optimum performance with H₃PO₄ was achieved using 1 mg Pt/cm² and 1 mg TFE 30 cu cm deposited on TFE tape, supported on a Au plated Ta screen, and sintered. Preliminary half cell tests using CH₂(SO₃H)₂

and $\text{CH}(\text{SO}_3\text{H})_3$ indicated that these acids are insufficiently stable for use as fuel cell electrolytes. DOE

N80-25893# California Univ., Livermore. Lawrence Livermore Lab.

EVALUATION OF AIR CATHODES FOR POTENTIAL USE IN DEVELOPMENT OF ALUMINUM-AIR CELLS

J. W. Pyper, B. E. Kelly, and J. F. Cooper Dec. 1979 38 p refs

(Contract W-7405-eng-48)

(UCID-18561) Avail: NTIS HC A03/MF A01

Four air cathodes representing the products of three manufacturers were tested under conditions of continuous and intermittent polarization in order to determine their suitability for testing large scale aluminum-air single cells. The W electrode performed for 312 h with a decrease of potential of 0.11 V at 1.3 kA/sq m. The X standard electrode failed to sustain continuous polarization for longer than 12 h. Both W and Z electrodes met or nearly met polarization requirements. The tests demonstrated that the W electrode is sufficiently durable and low in polarization to be used for testing 0.1 sq m aluminum-air cells. DOE

N80-25895# Argonne National Lab., Ill. Chemical Engineering Div.

ADVANCED FUEL CELL DEVELOPMENT Progress Report, Jan. - Mar. 1979

R. D. Pierce, P. A. Finn, K. Kinoshita, G. H. Kucera, R. B. Poeppel, J. W. Sim, and R. N. Singh Sep. 1979 47 p refs

(Contract W-31-109-eng-38)

(ANL-79-51) Avail: NTIS HC A03/MF A01

Advanced fuel cell research activities are discussed. The effort directed toward understanding and improving the components of molten-carbonate-electrolyte fuel cells operated at temperatures near 925 K. The primary focus of this work was the development of electrolyte structures that have good electrolyte retention and mechanical properties as well as long term stability, and on developing methods of synthesis amenable to mass production. Current electrolyte structures are comprised of LiAlO_2 particles and an eutectic of Li_2CO_3 and K_2CO_3 . DOE

N80-25897# Sandia Labs., Albuquerque, N. Mex.

AERODYNAMIC INTERFERENCE BETWEEN TWO DARRIEUS WIND TURBINES

P. R. Schatzle, P. C. Klimas, and H. R. Spahr 1980 6 p refs Presented at the Wind Energy Conf., Boulder, Colo., 9 Apr. 1980

(Contract EY-76-C-04-0789)

(SAND-79-1984C; CONF-800406-2)

Avail: NTIS HC A02/MF A01

The effect of aerodynamic interference on the performance of two curved bladed Darrieus-type vertical axis wind turbines was calculated using a vortex/lifting line aerodynamic model. The turbines have a power-to-power separation distance of 1.5 turbine diameters, with the line of turbine centers varying with respect to the ambient wind direction. The effects of freestream turbulence were neglected. For the cases examined, the calculations showed that the downwind turbine power decrement (1) was significant only when the line of turbine centers was coincident with the ambient wind direction, (2) increased with increasing tip-speed-ratio, and (3) is due more to induced flow angularities downstream than to speed deficits near the downstream turbine. DOE

N80-25899# Aluminum Co. of America, Alcoa Center, Pa.

DESIGN AND FABRICATION OF A LOW-COST DARRIEUS VERTICAL AXIS WIND TURBINE SYSTEM, PHASE 1

Mar. 1980 295 p refs

(Contract EM-78-C-04-4272)

(ALO-4272) Avail: NTIS HC A13/MF A01

The design phase of a low cost Darrieus-type vertical axis wind turbine for commercialization in the United States is presented. The system definition, cost estimates, system performance analysis, structural design analysis, and environmental considerations are described. R.E.S.

N80-25910# General Accounting Office, Washington, D. C. Energy and Minerals Div.

MAGNETOHYDRODYNAMICS: A PROMISING TECHNOLOGY FOR EFFICIENTLY GENERATING ELECTRICITY FROM COAL, REPORT TO THE CONGRESS

11 Feb. 1980 61 p refs

(PB80-143175; EMD-80-14) Avail: NTIS HC A04/MF A01 CSCL 108

The status potential, and alternative Federal strategies for development of electricity from coal are discussed. It is recommended that the Secretary of Energy: (1) evaluate the status of testing at current facilities and its effect on maintaining the pilot plant design schedule; (2) analyze the advantages and disadvantages of alternative types of pilot plants; and (3) establish a mechanism for actively involving potential users in the program. GRA

N80-25912# Research Triangle Inst., Research Triangle Park, N. C.

NOVEL CONCENTRATOR PHOTOVOLTAIC CONVERTER SYSTEM DEVELOPMENT Final Report, 24 Jan. - 30 Aug. 1979

S. M. Bedair, J. R. Hauser, M. F. Lamorte, S. Phatak, and M. L. Timmons Mar. 1980 62 p refs Prepared jointly with North Carolina Univ., Raleigh and North Carolina State Univ., Raleigh (Contract EY-76-C-04-0789)

(SAND-80-7004) Avail: NTIS HC A04/MF A01

Several material systems were investigated for their potential use in a cascade solar cell. The studies included basic materials properties as well as p-n junction studies for the top cell, tunnel junction, and bottom cell. While junctions appropriate to each individual part of the cascade cell were demonstrated, problems still remain in fabricating a high efficiency cascade solar cell because of material and growth problems with the semiconductor layers which have optimum bandgaps. DOE

N80-26167# Argonne National Lab., Ill.

POWER TAKE-OFF ANALYSIS FOR DIAGONALLY CONNECTED MHD CHANNELS

Yen-Cheng Pan and Ezzat D. Doss 1980 13 p refs Presented at 18th AIAA Aerospace Sci. Meeting, Pasadena, Calif., 14-16 Jan. 1980

(Contract W-31-109-eng-38)

(CONF-800104-8) Avail: NTIS HC A02/MF A01

The electrical loading of the power take-off region of diagonally connected MHD channels is investigated by a two dimensional model. The loading schemes typical of those proposed for the U-25 and U-25 Bypass channels are examined. The model is applicable for the following four cases: (1) connection with diodes only, (2) connection with diodes and equal resistors, (3) connection with diodes and variable resistances to obtain a given current distribution, and (4) connection with diodes and variable resistors under changing load. The analysis is applicable for the power take-off regions of single or multiple-output systems. The general behaviors of the current and the potential distributions in all four cases are discussed. The analytical results are in good agreement with the experimental data. It is found possible to design the electrical circuit of the channel in the take-off region so as to achieve a fairly even load current output under changing total load current. DOE

N80-26172# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.

MHD HIGH PERFORMANCE DEMONSTRATION EXPERIMENT Quarterly Progress Report, 1 Apr. - 30 Jun. 1979

Jul. 1979 33 p refs

(Contract ET-78-1-01-2895)

(DOE/ET-2895/5) Avail: NTIS HC A03/MF A01

The attainment of MHD performance was demonstrated on a sufficiently large scale to verify that the projected efficiency of the commercial MHD concept is attainable. To perform the experiment, an existing facility at the Arnold Engineering Development Center (USAF) was refurbished and the new systems required for performing the experiment were designed and built. In particular, the largest systems which have required the greatest expenditure of resources are the generator channel and

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the 6 Tesla (T) cryogenically cooled magnet. The pressure testing of the generator channel was completed and the channel was installed in the magnet to facilitate final alignment of the burner. The diffuser assembly operations were completed. The magnet was retested in the warm mode. No problems were encountered in the latest tests and the magnet was subsequently cooled to 165 K and pulsed to a peak field strength of 2.9T. DOE

N80-26216# Brookhaven National Lab., Upton, N. Y. Electrochemical Technology Group.

DEVELOPMENT OF FUEL CELL TECHNOLOGY FOR VEHICULAR APPLICATIONS: Annual Report, 1 Oct. 1977 - 30 Sep. 1978

J. McBreen, E. J. Taylor, K. V. Kordesch, G. Kissel, F. Kulesa, and S. Srinivasan May 1979 108 p refs (Contract EY-76-C-02-0016)

(BNL-51047) Avail: NTIS HC A06/MF A01

A survey of the present state-of-the-art of fuel cells and batteries suitable for hybrid fuel cell/battery power plants is presented. Also given are a systems study on phosphoric acid fuel cells for transportation applications and the results of an experimental study of phosphoric acid and alkaline fuel cells under conditions and intermittent operation. A review of fuel options and fuel processing for fuel cells is included. DOE

N80-26628# Argonne National Lab., Ill. Chemistry Div. **REVERSE ABSORPTION MODE OF THE HYCOS CHEMICAL HEAT PUMP WITH LOW GRADE (APPROXIMATELY 30 DEG C) THERMAL ENERGY INPUTS**

D. M. Gruen, M. Mendelsohn, I. Sheft, and G. Lamich 1980 23 p refs Presented at the Workshop on Thermochem. Energy Storage, Stockholm, 7-9 Jan. 1980; sponsored by the Swedish Royal Academy of Engineering Sciences (Contract W-7405-eng-38)

(CONF-800133-1) Avail: NTIS HC A02/MF A01

An efficient and cost competitive chemical heat pump and energy conversion system driven by solar, and by fossil fuels (gas or oil), are discussed. The HYCOS concept uses two different metal hydrides with different free energies of formation enabling hydrogen to flow from one to another of the hydrides under the influence of appropriate thermal gradients. In the chemical heat pump mode, hydrogen flows between two pairs of four vessels which take the place of the generator condenser and evaporator absorber elements of conventional absorption refrigerators. The functions of generator absorber and condenser evaporator are interchanged at the end of each two minute cycle. The chemical heat pump materials are based on the AB5 alloys which combine a remarkable ability to absorb hydrogen rapidly and reversibly at moderate pressures near ambient temperature with a large hydrogen storage capacity. DOE

N80-26671# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

DEVELOPMENT OF HIGH-TEMPERATURE TURBINE SYSTEM TECHNOLOGY TO A TECHNOLOGY READINESS STATUS PHASE 2 Quarterly Report, Oct. - Dec. 1979

1979 129 p ref (Contract EX-76-C-01-1806)

(FE-1806-76) Avail: NTIS HC A07/MF A01

The development of a high temperature gas turbine for use in a combined cycle power plant, with coal-derived fuel, at a firing temperature of 2600 F and with growth capability to 3000 F is discussed. Component design and technology testing and system design and trade-off analyses are described including hot gas path development tests, turbine simulator tests, low temperature-low Btu gas cleanup system, and aerodynamic evaluations. DOE

N80-26769# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Solar Thermal Power Systems Project.

COST AND PRICE ESTIMATE OF BRAYTON AND STIRLING ENGINES IN SELECTED PRODUCTION VOLUMES

H. R. Fortgang and H. F. Mayers 31 May 1980 16 p (Contracts NAS7-100; DE-A101-79ET-20397; JPL Proj. 5105-29)

(NASA-CR-163265; DOE/JPL-1060/35; JPL-Pub-80-42) Avail:

NTIS HC A02/MF A01 CSCL 10B

The methods used to determine the production costs and required selling price of Brayton and Stirling engines modified for use in solar power conversion units are presented. Each engine part, component and assembly was examined and evaluated to determine the costs of its material and the method of manufacture based on specific annual production volumes. Cost estimates are presented for both the Stirling and Brayton engines in annual production volumes of 1,000, 25,000, 100,000 and 400,000. At annual production volumes above 50,000 units; the costs of both engines are similar, although the Stirling engine costs are somewhat lower. It is concluded that modifications to both the Brayton and Stirling engine designs could reduce the estimated costs. R.E.S.

N80-26774# Toledo Univ., Ohio. **NONLINEAR AEROELASTIC EQUATIONS OF MOTION OF TWISTED, NONUNIFORM, FLEXIBLE HORIZONTAL-AXIS WIND TURBINE BLADES Final Report**

Krishna Rao V. Kaza Jul. 1980 70 p refs (Grant NSG-3139; Contract EX-76-1-01-1028)

(NASA-CR-159502; DOE/NASA/3139-1) Avail: NTIS HC A04/MF A01 CSCL 10A

The second-degree nonlinear equations of motion for a flexible, twisted, nonuniform, horizontal axis wind turbine blade were developed using Hamilton's principle. A mathematical ordering scheme which was consistent with the assumption of a slender beam was used to discard some higher-order elastic and inertial terms in the second-degree nonlinear equations. The blade aerodynamic loading which was employed accounted for both wind shear and tower shadow and was obtained from strip theory based on a quasi-steady approximation of two-dimensional, incompressible, unsteady, airfoil theory. The resulting equations had periodic coefficients and were suitable for determining the aeroelastic stability and response of large horizontal-axis wind turbine blades. R.E.S.

N80-26775# Boeing Engineering and Construction, Seattle, Wash.

MOD-2 WIND TURBINE SYSTEM CONCEPT AND PRELIMINARY DESIGN REPORT. VOLUME 2: DETAILED REPORT

Jul. 1979 269 p

(Contracts DEN3-2; DE-A101-793T-20305)

(NASA-CR-159609; DOE/NASA-0002-80/2) Avail: NTIS HC A12/MF A01 CSCL 10A

The configuration development of the MOD-2 wind turbine system (WTS) is documented. The MOD-2 WTS project is a continuation of DOE programs to develop and achieve early commercialization of wind energy. The MOD-2 is design optimized for commercial production rates which, in multiunit installations, will be integrated into a utility power grid and achieve a cost of electricity at less than four cents per kilowatt hour. J.M.S.

N80-26779# General Electric Co., Philadelphia, Pa. Space Sciences Lab.

PARAMETRIC STUDY OF PROSPECTIVE EARLY COMMERCIAL MHD POWER PLANTS (PSPPEC). GENERAL ELECTRIC COMPANY, TASK 1: PARAMETRIC ANALYSIS Final Report

C. H. Marston, F. N. Alyea, D. J. Bender, L. K. Davis, T. C. Dellinger, J. G. Hnat, E. H. Komito, C. A. Peterson, D. A. Rogers, A. J. Roman et al Feb. 1980 358 p refs Prepared in cooperation with Foster Wheeler Corp., Livingston, N.J., Hooker Chemical Co., Niagara Falls, N.Y. and Bechtel National, Inc., San Francisco

(Contract DEN3-52; EF-77-A01-2674)

(NASA-CR-159634; DOE/NASA/0052-79/1) Avail: NTIS HCA16/MFA01 CSCL 10B

The performance and cost of moderate technology coal-fired open cycle MHD/steam power plant designs which can be expected to require a shorter development time and have a lower development cost than previously considered mature OCMHD/steam plants were determined. Three base cases were considered: an indirectly-fired high temperature air heater (HTAH) subsystem delivering air at 2700 F, fired by a state of the art

atmospheric pressure gasifier, and the HTAH subsystem was deleted and oxygen enrichment was used to obtain requisite MHD combustion temperature. Coal pile to bus bar efficiencies in ease case 1 ranged from 41.4% to 42.9%, and cost of electricity (COE) was highest of the three base cases. For base case 2 the efficiency range was 42.0% to 45.6%, and COE was lowest. For base case 3 the efficiency range was 42.9% to 44.4%, and COE was intermediate. The best parametric cases in bases cases 2 and 3 are recommended for conceptual design. Eventual choice between these approaches is dependent on further evaluation of the tradeoffs among HTAH development risk, O2 plant integration, and further refinements of comparative costs. J.M.S.

N80-26794# American Univ., Washington, D. C.
DEFINITION OF CHEMICAL AND ELECTROCHEMICAL PROPERTIES OF A FUEL CELL ELECTROLYTE Interim Technical Report, 24 Jul. 1978 - 24 Dec. 1979

Jalil Ahmad and R. T. Foley Jan. 1980 70 p refs
(Contract DAAK79-77-C-0080; DA Proj. 1K1-61102-AH-51)
(AD-A083608) Avail: NTIS HC A04/MF A01 CSCL 07/4

The present research is oriented toward the task of developing an improved electrolyte for the direct hydrocarbon-air fuel cell. The electrochemical behavior of methanesulfonic acid, ethanesulfonic acid, and sulfoacetic acid as fuel cell electrolytes was studied in a half cell at various temperatures. The rate of electro-oxidation of hydrogen at 115 degrees was very high in methanesulfonic acid and sulfoacetic acids. The rate of the electro-oxidation of propane in methanesulfonic acid at 80 C and 115 C was low. Further, there is evidence for adsorption of these acids on the platinum electrode. Sulfoacetic acid with H2 has supported about two times higher current density than trifluoromethanesulfonic acid monohydrate, but, attempts to purify the compound were unsuccessful. It was concluded that anhydrous sulfonic acids are not good electrolytes; water solutions are required. Sulfonic acids containing unprotected C-H bonds are adsorbed on platinum and probably decompose during electrolysis. A completely substituted sulfonic acid would be the preferred electrolyte. GRA

N80-26800# General Electric Co., Philadelphia, Pa. Valley Forge Space Center.

REQUIREMENT DEFINITION AND PRELIMINARY DESIGN OF A PHOTOVOLTAIC CENTRAL POWER STATION EXPERIMENTAL TEST FACILITY. VOLUME 2: SOLMET SITE INSOLATION AND WEATHER DATA

G. OBrien Dec. 1979 481 p refs
(Contract EY-76-C-04-0789)
(SAND-79-7022-Vol-2) Avail: NTIS HC A21/MF A01

The results of a study of the requirements and preliminary design for a photovoltaic central power station experimental test facility presented. The facility's initial capacity of 2 MW with growth to 10 MW is intended to assess photovoltaic array fields operating as generation sources in utility systems. Requirements, a preliminary design, costs and schedule were established for the facility construction. Utility participation were reviewed with selected utilities, and both a site selection methodology and a summary set of combined continental US insolation and meteorological data was prepared. A set insolation and weather data for 26 SOLMET sites are included. DOE

N80-26853# Aerojet Energy Conservation Co., Sacramento, Calif.
MULTI-MEGAWATT ORGANIC RANKINE ENGINE POWER PLANT (MORE). PHASE 1A: SYSTEM DESIGN OF MORE POWER PLANT FOR INDUSTRIAL ENERGY CONSERVATION EMPHASIZING THE CEMENT INDUSTRY Final Report, 15 Sep. 1978 - 30 Sep. 1979

E. K. Bair, B. Breindel, F. N. Collamore, J. N. Hodgson, and G. K. Olson 31 Jan. 1980 94 p refs
(Contract DE-AC03-78ET-12434)
(DOE/ET-12434/T1) Avail: NTIS HC A05/MF A01

The Multi-Megawatt Organic Rankine Engine (MORE) program is directed towards the development of a large, organic Rankine power plant for energy conservation from moderate temperature industrial heat streams. Organic Rankine power plants are ideally suited for use with heat sources in the temperature range below 1100 F. Cement manufacture was selected as the prototype

industry for the MORE system because of the range of parameters which can be tested in a cement application. This includes process exit temperatures of 650 F to 1110 F for suspension preheater and long dry kilns, severe, dust loading, multi-metawatt power generation potential, and boiler exhaust gas acid dew point variations. The work performed during the Phase 1A System Design contract period is described. The System Design task defines the complete MORE system and its installation to the level necessary to obtain detailed performance maps, equipment specifications, planning of supporting experiments, and credible construction and hardware cost estimates. The MORE power plant design is based upon installation in the Black Mountain Quarry Cement Plant near Victorville, California. DOE

N80-26857# Sandia Labs., Albuquerque, N. Mex. Advanced Energy Projects Div.

AERODYNAMIC PERFORMANCE OF THE 17-M-DIAMETER DARRIEUS WIND TURBINE IN THE THREE-BLADED CONFIGURATION: AN ADDENDUM

Mark H. Worstell Feb. 1980 59 p refs
(Contract EY-76-C-04-0789)
(SAND-79-1753) Avail: NTIS HC A04/MF A01

The US Department of Energy (DOE)/Sandia 17-m wind turbine has been tested in the three bladed configuration at five rotational speeds. These data are presented along with some fundamental comparisons to the earlier two bladed results. Also included is the theoretical output of the three bladed 17-m turbine at two selected rotational speeds. DOE

N80-26859*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INTERNATIONAL PHOTOVOLTAIC PROGRAM. VOLUME 2: APPENDICES

Dennis Costello, Robert Koontz, David Posner, Patricia Heiferling, Paul Carpenter, Sylvia Forman, and Lewis Perelman Dec. 1979 218 p refs Prepared jointly with Midwest Research Inst., Golden, Colo., Massachusetts Inst. of Technol. Cambridge and Illinois Inst. of Technol., Chicago 2 Vol.
(Contract EG-77-C-01-4042)
(NASA-CR-163339) Avail: NTIS HC A10/MF A01

The results of analyses conducted in preparation of an international photovoltaic marketing plan are summarized. Included are compilations of relevant statutes and existing Federal programs; strategies designed to expand the use of photovoltaics abroad; information on the domestic photovoltaic plan and its impact on the proposed international plan; perspectives on foreign competition; industry views on the international photovoltaic market and ideas about the how US government actions could affect this market; international financing issues; and information on issues affecting foreign policy and developing countries. DOE

N80-26864# Franklin Research Center, Philadelphia, Pa.
SYSTEM PLANNING ANALYSIS APPLIED TO OTEC: INITIAL CASES BY FLORIDA POWER CORPORATION, TASK 2

Mar. 1980 111 p ref Prepared for Florida Power Corp., St. Petersburg
(Contract DE-AC02-79ET-29187)
(DOE/ET/29187-2; FC-5237-2) Avail: NTIS HC A06/MF A01

The FPC system planning methodology was used on: (1) Base Case, 10 year generation expansion plan with coal plants providing base load expansion, and (2) same, but 400 MW of OTEC substituting for coal burning units with equal resultant system reliability. The OTEC inputs were based on reasonable economic projections of direct capital cost and O and M costs for first generation large commercial plants. The Base Case conditions for FPC system planning methodology involved base load coal fueled additions during the 1980's and early 1990's. The first trial runs of the PROMOD system planning model substituted OTEC for 400 MW purchases of coal generated power during 1988-1989 and then 400 MW coal capacity thereafter. Result showed higher system reliability than Base Case runs. Production costing computer model runs were used as input to Corporate Model to examine corporate financial impact. Results show present

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value of total revenue requirements unfavorable to OTEC as compared to coal units. DOE

N80-26878# AEG-Telefunken, Wedel (West Germany). Fachbereich Raümfahrt, Neue Technologien.

DESIGN AND FABRICATION OF TERRESTRIAL PHOTO-VOLTAIC SOLAR GENERATORS FOR FIELD TESTING IN REGIONS OF INTENSIVE INSOLATION Final Report

Hans-Dieter Wegmann Bonn Bundesmin. fuer Forsch. u. Technol. Oct. 1979 36 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol. (BMFT-FB-T-79-34) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 7,15

The design and production of photovoltaic solar energy converters is described for three different applications: a transmitter station, a navigation buoy, and a laboratory building. The collectors consisted of interconnected 5 cm x 5 cm silicon solar cells encapsulated in glass or glass fiber reinforced acrylic resin. The largest device delivered 2000 W of electrical power.

Author (ESA)

N80-27192# STD Research Corp., Arcadia, Calif.

OPEN-CYCLE MHD SYSTEMS ANALYSIS Final Report

R. A. Harvey, C. D. Maxwell, J. L. Miller, and S. T. Demetriades Nov. 1979 156 p refs Sponsored by Electric Power Research Inst.

(EPRI-AF-1230) Avail: NTIS HC A08/MF A01

The power plant performance and economic characteristics of six open cycle magnetohydrodynamics (MHD) power plant options are investigated: four with directly fired air preheaters, one with separately fired air preheaters, and one using oxygen enrichment. Using the directly fired options, the effects of high sulfur Eastern coal and low sulfur Western coal, sulfur emissions control by seed regeneration and by wet limestone scrubbers, and slag removal performance in the MHD combustor unit are compared. Critical components requiring further development are identified. DOE

N80-27801*# General Electric Co., Wilmington, Mass. Aircraft Equipment Div.

SOLID POLYMER ELECTROLYTE FUEL CELL TECHNOLOGY PROGRAM Final Report

31 May 1980 53 p refs

(Contract NAS9-15286)

(NASA-CR-160734; TPR-77) Avail: NTIS HC A04/MF A01 CSCL 10A

Work is reported on phase 5 of the Solid Polymer Electrolyte (SPE) Fuel Cell Technology Development program. The SPE fuel cell life and performance was established at temperatures, pressures, and current densities significantly higher than those previously demonstrated in sub-scale hardware. Operation of single-cell Buildup No. 1 to establish life capabilities of the full-scale hardware was continued. A multi-cell full-scale unit (Buildup No. 2) was designed, fabricated, and test evaluated laying the groundwork for the construction of a reactor stack. A reactor stack was then designed, fabricated, and successfully test-evaluated to demonstrate the readiness of SPE fuel cell technology for future space applications. R.E.S.

N80-27817# Battelle Pacific Northwest Labs., Richland, Wash. **WIND CHARACTERISTICS FOR DESIGN OF WIND TURBINES: RESEARCH IN THE USA**

J. R. Connell 1 Dec. 1979 22 p Presented at the IEA Meeting, Stockholm, 12-13 Sep. 1979

(Contract EY-76-C-06-1830)

(PNL-SA-7967; CONF-7909128-1)

Avail: NTIS HC A02/MF A01

The Pacific Northwest Laboratory (PNL) of the United States Department of Energy has the primary responsibility for providing information on wind characteristics for design and for evaluation of performance of wind energy conversion systems (WECS). The objectives of the whole program are, broadly, to develop technical wind information which is relevant to the design of WECS, to determine suitable methods of measuring and analyzing the wind for evaluating WECS performance, and to communicate the information usefully to WECS designers. DOE

N80-27825# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

ENERGY PROGRAMS AT THE JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY Quarterly Report, Oct. - Dec. 1979

Feb. 1980 49 p refs

(Contracts EX-76-A-36-100B; DE-AI01-79ET-27025)

(PB80-163686; JHU/APL/EQR/79-4)

Avail: NTIS HC A03/MF A01 CSCL 10A

Work on various tasks to develop energy resources, utilization concepts, and storage methods is summarized. Reports are presented in the following areas: geothermal prospecting; hydroelectric power generation in southeastern states; neotectonic investigations in Connecticut; ocean thermal energy conversion core unit testing and recovery of landfill methane; and unconventional gas sources--Eastern Devonian shales. R.E.S.

N80-28195# Nagoya Univ. (Japan). Inst. of Plasma Physics. **COMPARATIVE STUDY OF ENERGY ACCOUNTING FOR HEAVY ION FUSION WITH VARIOUS DRIVER ACCELERATORS**

S. Kawasaki (Kanazawa Univ.) and A. Miyahara Apr. 1980 18 p refs

(IPPJ-454) Avail: NTIS HC A02/MF A01

Typical designs of driver heavy ion accelerator systems are compared with regard to their 'energy payback time' versus 'cost of construction'. The detailed analyses show that the energy investment for the construction of the Heavy Ion Fusion power station is somewhat smaller than the energy produced by the station in its lifetime, in spite of the large scale of its hardware. The situation could be more favorable than, or at least comparable with, the case of magnetically confined fusion. L.F.M.

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ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

Includes transport of fuels by pipelines, tubes, etc., microwave power transmission, and superconducting power transmission.

A80-32717 Superconductivity - Will its potential be realized. E. J. Lerner. *High Technology*, Apr. 1980, p. 64-71.

The article surveys possible applications of superconductivity and the question of how rapidly or whether this potential will be realized. Attention is given to applications such as magnetic levitation trains, Josephson junction computers, new means of cancer detection, and water purification. Also discussed are the use of superconducting magnets to produce the high fields needed for nuclear fusion plants and for magnetohydrodynamic generators. Further, experiments under way on superconducting power lines for virtually lossless transmission of electric power are examined. It is concluded that the main obstacle to implementation of such applications is the reluctance of American business and government to invest in further research. M.E.P.

A80-32942 Increasing power input to a single solar power satellite rectenna by using a pair of satellites. R. V. Gelsthorpe (ERA Technology, Ltd., Leatherhead, Surrey, England) and P. Q. Collins (Imperial College of Science and Technology, London, England). *Electronics Letters*, vol. 16, Apr. 24, 1980, p. 311-313.

An outline of the solar power satellite concept is given, and some remarks are made regarding the desirability of increasing the power handling capability of the receiving site. Three arrangements, each based on the use of a pair of satellites, are described by means of which the power handled by a single site may be doubled. (Author)

A80-33161 # Excitation of a superconducting strip resonator by a system of Josephson point contacts (Vozbuzhdenie sverkhprovodiashchego poloskovogo rezonatora sistemoi tochechnykh Dzhozefsonovskikh kontaktov). S. I. Zub (Akademiia Nauk Ukrainskoi SSR, Fiziko-Tekhnicheskii Institut Nizkikh Temperatur, Kharkov, Ukrainian SSR). *Zhurnal Tekhnicheskoi Fiziki*, vol. 50, Apr. 1980, p. 854-857. In Russian.

The amplitudes of oscillations generated by a system of spot contacts in a strip resonator, the shape of the current-voltage curve, and the emitted power are studied as a function of the resonator and contact system parameters. It is shown that the effective excitation of a superconducting strip resonator by a system of Josephson point contacts is possible within a range of well defined relations between the parameters of the resonator and the contact system. The conditions for optimum excitation are formulated. V.L.

A80-33424 Loss factors in the design of thermochemical power plants, CO₂-CH₄ vs. SO₃ chemical transport fluids. T. A. Chubb, D. E. Simmons, and J. J. Nemecek (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 126-129.

A80-33756 Interfacing dispersed solar and wind systems with electric distribution systems. F. S. Ma, M.-L. Chan, and D. H. Curtice (Systems Control, Inc., Palo Alto, Calif.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 3. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 2138-2142. 5 refs.

This paper reports on the results of a research effort in progress.

The objective is to develop a methodology for evaluating the impacts on the planning and operation of the electric distribution systems as a result of increased penetration of dispersed solar and wind (DSW) electric generators. The paper presents a discussion of the major consideration in the planning and operation of the distribution system when DSW devices are introduced. All of these considerations need to be factored into the cost of service determination for rate designs. The paper also describes the methodology being developed for the analysis. (Author)

A80-36963 # New directions for future satellite power system /SPS/ concepts. G. M. Hanley (Rockwell International Corp., Pittsburgh, Pa.). In: Shuttle to the next space age; Proceedings of the Southeast Seminar for Reporters and Teachers, Huntsville, Ala., July 18, 19, 1979. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 49-54. (AIAA 79-3069)

Evolution of SPS concepts since initiation of DOE/NASA system studies is described, and directions these concepts may take are discussed. Early SPS studies considered a large matrix of concepts, including several variations of solar thermal and solar photovoltaic concepts as well as nuclear concepts. These studies narrowed down to two solar photovoltaic satellite concepts that are currently the DOE/NASA reference concepts. Recent technology improvements in solid-state transistors and solar cells appear to have a potentially significant impact on future SPS satellite concepts. These impacts are discussed. (Author)

A80-37828 # High power pulse modeling of coaxial transmission lines. J. P. O'Loughlin (USAF, Weapons Laboratory, Kirtland AFB, N. Mex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979. Digest of Technical Papers. Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 96-99.

When coaxial cable is used for high voltage pulse transmission, a voltage transient appears on the outer sheath conductor. Although the magnitude of the transient is in the order of only a few per cent, this amounts to several kilovolts in many cases and must be carefully considered in terms of its effect on instrumentation, control and safety. To a first approximation, theoretically a coaxial cable should not develop any voltage on the outer sheath. A more refined analysis and model shows that the complete cancellation depends upon the self inductance of the sheath being exactly equal to the mutual inductance between the sheath and the center conductor. This condition is never exactly satisfied due to current distribution effects, even when the distribution is uniform and radially symmetric. The situation becomes worse when proximity effects are accounted for. The predicted sheath voltage agrees with experimental data within reasonable limits. (Author)

A80-39628 Resistance of titanium alloys AT3 and AT6 to gas-abrasive wear. N. G. Boriskina, A. M. Bryksin, and E. M. Kenina. (*Metallovedenie i Termicheskaya Obrabotka Metallov*, Dec. 1979, p. 34-36.) *Metal Science and Heat Treatment*, vol. 21, no. 11-12, May 1980, p. 934-936. 7 refs. Translation.

The effect of temperature, mineralization, pH, and flow rate of the corrosive medium on the gas-abrasive wear of commercial titanium alloys AT3 and AT4 is investigated in order to determine their suitability for drill pipes. It is shown that the gas-abrasive wear of these alloys depends largely on the temperature and pH of the corrosive medium, while mineralization and the corrosive medium flow rate do not affect the alloys. Wear is negligible in alkaline and neutral solutions at room temperature; however, intensive wear of both alloys is observed after treatment in acid solutions (pH less than 4) at 250 C. Alloy AT3 has higher corrosion and gas-abrasive resistance than AT6. Both alloys are recommended for deep well drill pipes. V.L.

A80-40713 Characteristics of CO₂-CH₄ reforming-methanation cycle relevant to the Solchem thermochemical power system. T. A. Chubb (U.S. Navy, Naval Research Laboratory,

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Washington, D.C.), *Solar Energy*, vol. 24, no. 4, 1980, p. 341-345. 21 refs.

The CO₂-CH₄ reforming-methanation chemical cycle provides an attractive means of transporting solar energy to a central station in accord with the Solchem concept. The CO₂-CH₄ working fluid permits use of low temperature pipelines, in contrast to H₂O-CH₄, and has low toxicity, in contrast to SO₃. Thermochemical receivers are expected to operate at or above the carbon removal temperature. Catalyst specificity is required in the methanator to provide high methanation temperature without carbon deposition. Methanator operation at 500 C may be achievable. (Author)

A80-40752 Status of coal gasification processes. K. S. Vorres (Institute of Gas Technology, Chicago, Ill.). *International Journal of Energy Research*, vol. 4, Apr.-June 1980, p. 109-112.

The current status of a number of processes which have been or are being developed to produce high-Btu, medium-Btu, and low-Btu gas from coal is reviewed. It is noted that the commercialization of high- and medium-Btu coal gasification technology on a significant scale will require very large capital expenditures for a single plant. Besides the financial barrier, a number of perhaps more difficult regulatory barriers will have to be overcome. B.J.

A80-41898 * # Satellite Power Systems /SPS/ - Overview of system studies and critical technology. S. V. Manson (NASA, Washington, D.C.). *American Astronautical Society, Goddard Memorial Symposium, 18th, Washington, D.C., Mar. 27, 28, 1980, Paper 80-084*. 20 p. 11 refs.

Systems studies and critical technology issues for the development and evaluation of Satellite Power Systems (SPS) for the photovoltaic generation of electrical energy and its transmission to earth are reviewed. Initial concept studies completed in 1976 and system definition studies initiated in the same year have indicated the technical feasibility of SPS and identified challenging issues to be addressed as part of the SPS Concept Development and Evaluation Program. Systems considered in the study include photovoltaic and solar thermal power conversion configurations employing klystron or solid state microwave generators or lasers for power transmission, and power transmission options, system constructability and in-orbit and ground operations. Technology investigations are being performed in the areas of microwave power transmission, structure/controls interactions and the behavior of key materials in the space/SPS environment. Favorable results have been obtained in the areas of microwave phase distribution and phase control, dc-RF conversion, antenna radiating element, and no insurmountable problems have been discovered in any of the investigations to date. A.L.W.

A80-43830 System-reliability studies for wave-energy generation. J. M. Dawson, S. Din. (Rendel Palmer and Tritton, London, England), M. G. Mytton, N. L. Shore, and H. B. Stansfield (Kennedy and Doukin, Woking, Surrey, England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 5, June 1980, p. 296-300.

A study is reported that is being undertaken in the United Kingdom to determine means of developing the potential of the large wave-energy resource around the coast, in particular, that to the west facing the Atlantic. It is shown that derivation of the mean annual energy to be expected involved knowledge, not only of the wave climates, conversion efficiency characteristics of the proposed devices and of the power transmission system, but also of factors reflecting the availability overall. Attention is given to a simplified approach to the quantifying of reliability for each stage of the process. An appropriate method of analysis is established and a summary of the results obtained is given. M.E.P.

N80-22378* #, LinCom Corp., Pasadena, Calif.
SPS PHASE CONTROL SYSTEM PERFORMANCE VIA ANALYTICAL SIMULATION

W. C. Lindsey, A. V. Kantak, C. M. Chie, and R. W. D. Booth
Mar. 1979 222 p refs
(Contract NAS9-15725)
(NASA-CR-160582; TR-7903-0977) Avail: NTIS
HC A10/MF A01 CSCL 22A

A solar power satellite transmission system which incorporates automatic beam forming, steering, and phase control is discussed. The phase control concept centers around the notation of an active retrodirective phased array as a means of pointing the beam to the appropriate spot on Earth. The transmitting antenna (spacenna) directs the high power beam so that it focuses on the ground-based receiving antenna (rectenna). A combination of analysis and computerized simulation was conducted to determine the far field performance of the reference distribution system, and the beam forming and microwave power generating systems. A.R.H.

N80-22608# Brookhaven National Lab., Upton, N. Y.
LOAD EXCITATION AT THE SUPERCONDUCTING CABLE TEST FACILITY

E. B. Forsyth, A. J. Mc Nerney, and M. Meth Sep. 1979 11 p
Presented at the 7th Symp. on Superconducting Power Transmission, Moscow, Sep. 1979; sponsored by US/USSR Tech. Exchange Comm.
(Contract EY-76-C-02-0016)

(BNL-26641) Avail: NTIS HC A02/MF A01
The superconducting cable test facility was constructed to evaluate and demonstrate flexible superconducting power transmission cables under realistic conditions. Power supplies were installed to excite two superconducting cables either separately or simultaneously. The cables formed a straight run of 100 m with a pair of terminations rated for full current and voltage located at the east and west ends of the cable enclosure. The design and operation of the test facilities are discussed. DOE

N80-22609# Brookhaven National Lab., Upton, N. Y.
CALORIMETRIC MEASUREMENT OF ac LOSSES IN SUPERCONDUCTING CABLES OF SHORT LENGTHS

J. E. Jensen 1979 13 p ref Presented at the 7th Symp. on Superconducting Power Transmission, Moscow, Sep. 1979; sponsored by US/USSR Tech. Exchange Comm.
(Contract EY-76-C-02-0016)

(BNL-26712) Avail: NTIS HC A02/MF A01
The measurement of ac losses in superconducting cables by calorimetric means is necessary as a verification of electronic measurements on short high-current models and because the present method of electronic measurement is not applicable to longer cables with simultaneously applied high current and voltage. Consequently, after the first tests of Cable no. 101 showed higher losses than anticipated using the electronic wattmeter measurements, it was decided to attempt to verify these measurements calorimetrically. The results of test completed to date are reported. DOE

N80-22770# TRW, Inc., McLean, Va. Energy Systems Group.

OIL SHALE DATA BOOK
Jun. 1979 410 p
(Contract DE-AC01-78RA-32012)
(PB80-125636) Avail: NTIS HC A18/MF A01 CSCL 08I

A ready reference for evaluation of appropriate shale oil recovery technologies and associated processes is presented. Technologies addressed are: mining and crushing; ore haulage; beneficiation of lean ore; surface and in situ retorting; upgrading of shale oil and gas clean-up; shale disposal and waste water treatment; pipeline transportation. GRA

N80-22793* # General Electric Co., Santa Barbara, Calif. Center for Advanced Studies.

THERMAL ENERGY STORAGE AND TRANSPORT
Walter Hausz In NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 57-77

06 ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

(EPRI Proj. 1199-3)

Avail: NTIS HC A99/MF A01 CSCL 10B

The extraction of thermal energy from large LWR and coal fired plants for long distance transport to industrial and residential/commercial users is analyzed. Transport of thermal energy as high temperature water is shown to be considerably cheaper than transport as steam, hot oil, or molten salt over a wide temperature range. The delivered heat is competitive with user-generated heat from oil, coal, or electrode boilers at distances well over 50 km when the pipeline operates at high capacity factor. Results indicate that thermal energy storage makes meeting of even very low capacity factor heat demands economic and feasible and gives the utility flexibility to meet coincident electricity and heat demands effectively. J.M.S.

N80-22861*# New Mexico Univ., Albuquerque. Technology Application Center.

SOLAR POWER SATELLITES. CITATIONS FROM THE INTERNATIONAL AEROSPACE ABSTRACTS DATA BASE.

Progress Report, 1973 - Nov. 1979

Gerald F. Zollars Dec. 1979 88 p Sponsored by NASA and NTIS

(NASA-CR-162931; PB80-802697) Avail: NTIS HC A05/MF A01 CSCL 10B

This bibliography of 320 citations to the international literature concerns the development of solar power satellites. The design and construction of the satellite solar arrays and the technology of satellite solar energy conversion and transmission to Earth are the major topics covered. Feasibility analyses of the solar power satellite concept are also included. GRA

N80-22863# Mitre Corp., McLean, Va. METREK Div.

NEW ENGLAND ENERGY DEVELOPMENT SYSTEMS CENTER (NEEDS). AN EXPERIMENT IN UNIVERSITY-INDUSTRY COOPERATIVE RESEARCH. VOLUME 2: CASE HISTORIES Final Report

Zwi Kohorn Jul. 1979 140 p refs 2 Vol.

(Grant NSF CG-00007)

(PB80-112980; MTR-79W00188-Vol-2; NSF/RA-790261)

Avail: NTIS HC A07/MF A01 CSCL 10A

Case histories of 25 projects involving the New England Energy Development Systems Center as a broker sponsor, and/or research and development (R and D) performer are reported. Projects are grouped into the energy areas of electricity generation, electrical distribution, and reported energy planning. Each case is a self-contained narrative, uniformly structured and sequenced under the following standard headings: project description, problem identification, recruitment, R and D funding, project management, R and D program, information dissemination, evaluation, and references. GRA

N80-23825# Sandia Labs., Livermore, Calif. Solar Components Div.

THERMOCHEMICAL ENERGY STORAGE AND TRANSPORT PROGRAM Progress Report, Oct. 1977 - Dec. 1978

T. T. Bramlette Sep. 1979 109 p refs

(Contract EY-76-C-04-0789)

(SAND-79-8208) Avail: NTIS HC A06/MF A01

To exploit the potential advantages and quantify the disadvantages of thermochemical reactions for energy storage and transport applications, the program was structured initially to explore a wide range of chemical reactions and applications. In general, the development procedure consists of: (1) identification and evaluation of preferred current and future users of reversible chemical reactions for energy storage and transport; (2) identification of specification requirements and evaluation of available technology and technology needs for selected storage and transport systems; (3) formulation and evaluation of energy storage and transport concepts which meet the requirements established above; (4) definition and development of the required technology; (5) comparison of thermochemical storage and transport concept with competing technologies, and assessment of their conservation potential; and (6) development of the most promising concepts and systems to the point of demonstration on a scale commensurate with commercial

applications. Progress made during the reporting period is summarized. DOE

N80-24507# National Bureau of Standards, Washington, D.C. Electrosystems Div.

MEASUREMENTS ON INSULATING MATERIALS AT CRYOGENIC TEMPERATURES Final Report

William E. Anderson and Richard S. Davis Jan. 1980 165 p refs Prepared for Brookhaven National Lab., Upton, N.Y.

(Contract EA-77-A-01-6010)

(PB80-134598; NBSIR-79-1950)

Avail: NTIS

HC A08/MF A01 CSCL 09A

Results of a four-year effort to study the high voltage dielectric behavior of various materials at cryogenic temperatures are described. Dissipation factors at 60 Hz were measured for polymer tapes and epoxy samples at 4.2 K, atmospheric pressure. Multi-layer polymer samples in coaxial geometries at temperatures from 7 K to 10 K and helium pressures up to 1.5 megapascals were also studied. The measurements were performed at stresses up to 40 MV/m. Since partial discharges were major source of losses at the higher stresses and their presence was possibly detrimental to the integrity of the insulation, instrumentation was developed and implemented to study these discharges under conditions found in proposed ac superconducting power-transmission lines. GRA

N80-25195# National Bureau of Standards, Washington, D.C.

DIMENSIONS/NBS, VOLUME 63, NO. 11 Monthly Report Nov. 1979 41 p refs

(PB80-141542; NBS/DIM-63/11)

Avail: NTIS

HC A03/MF A02 CSCL 14B

Short summaries of major technical developments, highlights of work in progress, major speeches and statements by Bureau management, and a listing of NBS publications are presented. Topics covered include: fire safety tips for wood burning appliances; computer interface standards; new photometric calibrator performs direct measurement; girth weld standards for Alaskan natural gas pipeline; and 'ultra-black' coating for high absorbance of solar energy. GRA

N80-25360*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

THE SOLAR POWER SATELLITE CONCEPTS: THE PAST DECADE AND THE NEXT DECADE

Christopher C. Kraft, Jr. Jul. 1979 22 p Presented at the 15th AIAA Ann. Meeting and Tech. Display, Washington, D.C., 6-8 Feb. 1979 Original contains color illustrations

(NASA-TM-81000; JSC-14898)

Avail: NTIS

HC A02/MF A01 CSCL 22B

Results of studies on the solar power satellite concept are summarized. The basic advantages are near continuous access to sunlight and freedom from atmospheric effects and cloud cover. The systems definition studies consider photovoltaic and thermal energy conversion systems and find both to be technically feasible, with the photovoltaic approach preferred. A microwave test program is under way which will provide quantitative data on critical parameters, including beam forming and steering accuracy. Ballistic and winged launch vehicles are defined for the transportation of construction materials, with the shuttle expected to provide low cost transportation to and from space. A reference system is outlined for evaluating the concept in terms of environmental and other considerations. Preliminary estimates of natural resource requirements and energy payback intervals are encouraging. E.D.K.

N80-25383# Argonne National Lab., Ill.

PROCEEDINGS OF THE WORKSHOP ON STRATOSPHERIC AND MESOSPHERIC IMPACTS OF SATELLITE POWER SYSTEMS (SPS)

Dec. 1979 120 p refs Workshop held at Rosemont, Ill., 6-8 Sep. 1978

(Contract W-31-109-eng-38)

(CONF-7809197) Avail: NTIS HC A06/MF A01

Composition perturbations due to rocket exhaust emissions and reentry effects are considered. Climatic effects due to

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increased noctilucent cloud formation and composition perturbations are also discussed, as well as the effects of localized energy injection, including rocket exhaust thermal energy and microwave absorption. DOE

N80-25364# Battelle Columbus Labs., Ohio.
PRELIMINARY MATERIALS ASSESSMENT FOR THE SATELLITE POWER SYSTEM (SPS)

R. R. Teeter and W. M. Jamieson Jan. 1980 131 p refs
(Contract W-7405-eng-92)

(DOE/ER-0038) Avail: NTIS HC A07/MF A01

Presently, there are two SPS reference design concepts (one using silicon solar cells, the other using gallium arsenide solar cells). A materials assessment of both systems was performed based on the materials lists set forth in the DOE/NASA SPS Reference System Report: Concept Development and Evaluation Program. This listing identified 22 materials used in the SPS. Tracing the production processes for these 22 materials, a total demand for over 20 different bulk materials and nearly 30 raw materials was revealed. Assessment of these SPS material requirements produced a number of potential material supply problems. The more serious problems are those associated with the solar cell materials, and the graphite fiber required for the satellite structure and space construction facilities. In general, the gallium arsenide SPS option exhibits more serious problems than the silicon option, possibly because gallium arsenide technology is not as well developed as that for silicon. DOE

N80-25808# Department of Energy, Washington, D. C.
SYSTEMS ENGINEERING FOR POWER: ORGANIZATIONAL FORMS FOR LARGE SCALE SYSTEMS, VOLUME 1

L. H. Fink, ed. and T. A. Trygar, ed. Oct. 1979 376 p refs
Conf. held at Davos, Switzerland, 30 Sep. - 5 Oct. 1979

(CONF-790904-P2) Avail: NTIS HC A17/MF A01

Several articles addressing electrical energy system engineering problems are presented. The development of decentralized organizational forms for large scale interconnected power systems is discussed. A number of strategies are investigated for obtaining the desired control structures including the approximation of centralized control laws; the development of controllers using multiple, approximate models of the overall system; the use of decomposition methods; and a direct formulation of decentralized optimal stochastic control problems. A particular emphasis is given to the numerical modeling methods for large scale systems. Descriptor system approaches are explored along with other deterministic and probabilistic modeling methods. Perturbation methods in the construction of model decompositions are analyzed and evaluated. M.G.

N80-26004# Argonne National Lab., Ill.
PROCEEDINGS OF THE WORKSHOP ON METEOROLOGICAL EFFECTS OF SATELLITE POWER SYSTEM RECTENNA OPERATION AND RELATED MICROWAVE TRANSMISSION PROBLEMS

Dec. 1979 58 p refs Workshop held at Rosemont, Ill., 23 Aug. 1978 Sponsored by DOE

(CONF-7808114) Avail: NTIS HC A04/MF A01

From Workshop on Meteorological Effects of Satellite Power Systems Rectenna Operation and Related Microwave Transmission Problems; Rosemont, IL, USA (23 Aug. 1978). Discussion at the workshop concentrated on the effects of the Satellite Power System (SPS) on the atmosphere and the effects of the atmosphere on the SPS microwave beam propagation. The three main concerns were the effects on the atmosphere of the estimated 750 MW excess heat released at the SPS rectenna site, the microwave interactions with the atmosphere, possibly causing loss of beam control and scattering of beam energy, and the possible effects of the beam on atmospheric electrification processes. Construction of a rectenna will modify the thermal and radiative properties of the ground, and operations will introduce a heat source at the surface. It was generally agreed that the direct effects of any single causes due to an SPS in the lower atmosphere will be small but detectable in some instances, and that their combined effects need better definition. Variations in the refractive index of the atmosphere and the presence of hydrometeors in the

atmosphere cause refraction, scattering, and adsorption of electromagnetic waves. Refractive-index anomalies in the atmosphere may impact on power beam control. The effect of the rectenna waste heat may be studied on two scales: the mesoscale (regional and city sizes, 10 to 100 km) and the cloud scale (10 km and less). At 2.45 GHz the refractive index of air at fixed pressure depends mostly on water vapor and temperature. In the presence of convective or turbulent air motions a spectrum of atmospheric refractivity develops. These variations can lead to beam wandering and spreading. Direct interactions with the atmospheric electricity fields are not thought to be crucial at the 2.45 GHz frequency. However, the mere physical presence of the rectenna might have some modifying influence on the occurrence and electrical behavior of thunderstorms over and around the rectenna. DOE

N80-26487# Argonne National Lab., Ill.
COAL/OIL MIXTURE PIPELINE: A VIABLE ALTERNATIVE COAL TRANSPORTATION SYSTEM?

J. Harkness, B. L. and L. J. Petrovic (Resource Engineering, Inc.)
In Pittsburgh Energy Technol. Center The 2nd Intern. Symp. on Coal-Oil Mixture Combust., Vol. 2 1979 22 p refs

Avail: NTIS HC A99/MF A01

A coal transportation system which utilizes coal/oil mixture technology is compared to the coal/water system and to another alternative, coal/methanol system. Major emphasis is placed on the system design considerations and trade-offs, the resource requirements (including capital), and the cost of delivered energy. The system environmental impacts, the status of the technologies, oil quality and supply, and the potential system flexibilities are discussed qualitatively. R.C.T.

N80-26785# Raytheon Co., Waltham, Mass. Microwave and Power Tube Div.

MICROWAVE BEAMED POWER TECHNOLOGY IMPROVEMENT Final Report

W. C. Brown 15 May 1980 48 p

(Contracts NAS7-100)

(NASA-CR-163043; JPL-9950-373; PT-5613) Avail: NTIS HC A03/MF A01

The magnetron directional amplifier was tested for (1) phase shift and power output as a function of gain, anode current, and anode voltage, (2) background noise and harmonics in the output, (3) long life potential of the magnetron cathode, and (4) high operational efficiency. Examples of results were an adequate range of current and voltage over which 20 dB of amplification could be obtained, spectral noise density 155 dB below the carrier, 81.7% overall efficiency, and potential cathode life of 50 years in a design for solar power satellite use. A fabrication method was used to fabricate a 64 slot, 30 in square slotted waveguide array module from 0.020 in thick aluminum sheet. The test results on the array are discussed. J.M.S.

N80-27404# Department of Energy, Washington, D. C. Office of Energy Research.

SATELLITE POWER SYSTEMS (SPS): CONCEPT DEVELOPMENT AND EVALUATION PROGRAM, PRELIMINARY ASSESSMENT

Sep. 1979 21 p refs

(DOE/ER-0041) Avail: NTIS HC A02/MF A01

Preliminary results of a DOE-NASA 3-year study of satellite solar energy conversion and microwave transmission to Earth are presented. The assessment includes technical and economic feasibility; the effects of the microwave power transmission beam on biological, ecological, and electromagnetic systems; the impact of SPS construction, deployment and operations on the biosphere and on society; and the merits of SPS compared to other future energy alternatives. DOE

N80-27809# Boeing Aerospace Co., Seattle, Wash.
SOLAR POWER SATELLITE SYSTEM DEFINITION STUDY, VOLUME 1: EXECUTIVE SUMMARY, PHASE 3 Final Report,

Dec. 1979 - May 1980

Jun. 1980 69 p refs 5 Vol.

(Contract NAS9-15636)

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(NASA-CR-160742; D180-25969-1-Vol-1) Avail: NTIS
HC A04/MF A01 CSCL 10A

Results of a three phase study of the Solar Power Satellite System are summarized. Various options and alternate systems were considered and the following conclusions were reached: antenna mounted solid state transmitters are potentially as cost effective as the klystron approach, although limited to 2500 megawatts net output; the free electron laser and optical diode laser appear most promising for laser power transmission; ground antenna siting need not be restricted to below 35 degrees of latitude; and nonrecurring cost reductions attainable by using a smaller Heavy Lift Launch Vehicle are highly attractive. L.F.M.

N80-27810*# Boeing Aerospace Co., Seattle, Wash.
SOLAR POWER SATELLITE SYSTEM DEFINITION STUDY.
VOLUME 2, PART 3: FINAL BRIEFING, 16 MAY 1980,
PHASE 3

Jun. 1980 410 p 5 Vol.

(Contract NAS9-15636)

(NASA-CR-160743; D180-25969-2-Vol-2) Avail: NTIS
HC A18/MF A01 CSCL 10A

Alternatives to the microwave transmission system previously defined Solar Power Satellite Systems were investigated. These were the laser power transmission, transportation systems, and an analysis of solid state power transmission. The advantages of each system are presented. F.O.S.

N80-27811*# Boeing Aerospace Co., Seattle, Wash.
SOLAR POWER SATELLITE SYSTEM DEFINITION STUDY.
VOLUME 3: LASER SPS ANALYSIS, PHASE 3 Final Report,
Dec. 1979 - May 1980

Jun. 1980 99 p refs 5 Vol.

(Contract NAS9-15636)

(NASA-CR-160744; D180-25969-3-Vol-3) Avail: NTIS
HC A05/MF A01 CSCL 10A

The potential use of lasers for transmitting power to Earth from Solar Power Satellites was examined. Free electron lasers appear most promising and would have some benefits over microwave power transmission. Further research in laser technology is needed. L.F.M.

N80-27812*# Boeing Aerospace Co., Seattle, Wash.
SOLAR POWER SATELLITE SYSTEM DEFINITION STUDY.
VOLUME 4: SOLID STATE SPS ANALYSIS, PHASE 3
Final Report, Dec. 1979 - May 1980

Jun. 1980 79 p 5 Vol.

(Contract NAS9-15636)

(NASA-CR-160745; D180-25969-4-Vol-4) Avail: NTIS
HC A05/MF A01 CSCL 10A

A 2500 megawatt solid ground output Solar Power Satellite (SPS) of conventional configuration was designed and analyzed. Because the power per receiving antenna is halved, as compared with the klystron reference, twice the number of receiving antennas are needed to deliver the same total power. The solid state approach appears feasible with a slightly greater specific mass and slightly higher cost than the klystron SPS design. L.F.M.

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ENERGY STORAGE

Includes flywheels, heat storage, underground air storage, compressed air, storage batteries, and electric hybrid vehicles.

A80-33419 Energy storage and electron transfer by carbanion photolysis. M. A. Fox, Mr. Kabir-ud-Din, and N. J. Singletary (Texas, University, Austin, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 102-106. 17 refs. Research supported by the U.S. Department of Energy.

Photo-induced carbanion reactions are studied as a possible means of efficiently storing solar energy in the form of covalent bonds. Five representative photoprocesses observed in the laboratory involving highly basic carbanions, namely a ring-opening, an isomerization, anion radical formation, reductive alkylation and electron transfer accompanied by anodic current generation, are presented which indicate that carbanions can undergo photo-induced chemical reaction. The anion reactions are shown to proceed by pathways consistent with orbital topological predictions. It is also pointed out that although current generation in the carbanionic photogalvanic cell is much less efficient than in solid-state or liquid photovoltaic cells, the optimization of cell parameters may lead to improved photoconversion. A.L.W.

A80-33420 Photochemical storage of solar energy. C. Kutal, R. R. Hautala, and R. B. King (Georgia, University, Athens, Ga.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 108-111. 11 refs. Research supported by the U.S. Department of Energy and NSF.

A solar energy storage system based upon the interconversion of norbornadiene and quadricyclene possesses several attractive features, including high specific energy storage capacity, long-term kinetic stability of the energy-rich photoproduct at ambient temperatures, and relatively inexpensive reactants. An energy storage system based on these principles could result in the use of solar energy for low grade (about 100 C) heat applications such as space conditioning and hot water production in buildings. (Author)

A80-33510 Effect of vertical wall conductance on temperature relaxation in thermally stratified liquid thermal storage tanks. C. Sherman, B. D. Wood, and J. Mason (Arizona State University, Tempe, Ariz.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 591-595.

The efficiency of solar systems using liquid sensible heat thermal storage systems is enhanced by temperature stratification in the storage tank. This paper presents the results of an empirical study to evaluate the effects of vertical wall conductance on the temperature relaxation time of a quiescent liquid thermal storage tank which is initially uniformly stratified. Five sets of data are analyzed for a fiberglass tank with a height to diameter ratio of 2 with no liner and with copper, aluminum, steel, and stainless steel liners. Plots of temperature distribution versus time for each case are included. It is shown that vertical conduction down the tank walls can reduce thermal stratification to a significant extent. (Author)

A80-33511 Dynamic model of a mixed /sensible plus latent/ low-temperature thermal storage system. J.-P. Maye and M. Gauchotte (Poitiers, Université, Poitiers, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 596-598.

A80-33512 Thermal storage in rock beds. L. Boisdet and J.-L. Peube (CNRS, Laboratoire d'Energétique Solaire, Font-Romeu, Pyrénées-Orientales, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 599-602. 12 refs.

The feasibility of thermal stratification in rock bed thermal storage is examined. A one-dimensional numerical model is developed for a stratified thermal storage system and it is shown that a good thermal stratification is impossible within a small thermal storage with solid materials. An experiment is performed to test the mathematical model. The agreement between the model and the experiment is better than 10 percent. It is suggested that a three-dimensional model would be needed to study the complex phenomena associated with free convection in the storage system. V.L.

A80-33513 Experimental results from the solar ground coupling research facility at Brookhaven National Laboratory. P. D. Metz (Brookhaven National Laboratory, Upton, N.Y.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 604-608. Research sponsored by the U.S. Department of Energy.

The results of the first half year of operation of the solar ground coupling research facility at Brookhaven National Laboratory are presented. The data are analyzed from the eight original experiments which are first generation ground coupled heat transfer and storage devices for a solar source heat pump system. A computer model of the heat transfer between these devices and the earth is discussed. (Author)

A80-33514 Energy storage in ground-water aquifers. W. J. Schaeztle, C. E. Brett (Alabama, University, Huntsville, Ala.), and D. M. Grubbs. In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 614-618. 12 refs. U.S. Department of Energy Contract No. 31-109-38-4550.

One of the major economic costs in solar energy systems is the thermal energy storage system. The present paper deals with a thermal storage concept provided by nature. The system consists of two wells drilled into an underground water aquifer. Warm water is deposited into one well as the same amount of water is drawn from the other well. When the energy is withdrawn, the water flow is reversed. V.P.

A80-33515 Development of a thermal storage system based on the heat of adsorption of water in hygroscopic materials. A. J. T. M. Wijsman, R. Oosterhaven, and C. den Ouden (Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, Technisch Fysische Dienst TNO, Delft, Netherlands). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 619-623.

A80-33516 The 'soil therm' system for interseasonal earth storage of solar heat for individual housing. G. Vachaud and J.-Y. Ausseur (Grenoble, Institut de Mécanique, Grenoble, France). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 625-628. 7 refs. Research supported by the Centre National de la Recherche Scientifique.

A80-33517 The effect of system size on the practicality of aquifer storage. L. Ebeling, D. L. Reddell, S. Tostengard, W. B. Harris, and R. R. Davison (Texas A & M University, College Station, Tex.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 629-633. 6 refs.

The results of computer simulations and well cost estimates indicate that aquifer storage has considerable potential for relatively

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small systems such as those having an annual energy consumption for heating or cooling of a few billion Btu's. Aquifer thicknesses above fifty feet are very attractive, but in some applications even a zone as thin as 15 feet might be used. Preliminary results of the Texas A & M cold water storage experiment are given. (Author)

A80-33518 A design method to determine the optimal distribution and amount of insulation for in-ground heat storage tanks. G. T. Williams, C. R. Attwater, and F. C. Hooper (Toronto, University, Toronto, Canada). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 634-638. Contracts No. EY-76-C-02-2939-A001; No. EY-76-C-02-2939-M002.

A80-33519 Latent heat energy storage using direct contact heat transfer. D. D. Edie, S. S. Melsheimer, J. C. Mullins, and J. F. Marra (Clemson University, Clemson, S.C.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 640-644. 12 refs. Contract No. EY-76-5-05-5190.

The use of direct contact heat transfer in latent heat energy storage systems has been proposed as a means of combating phase segregation problems and enhancing heat and mass transfer performance. Studies have shown that several salt hydrates perform satisfactorily, and that acceptable heat transfer fluids are available. Studies of system geometry and heat transfer performance, as well as of crystal growth velocity, have also been completed. Data are now being collected on a 200 liter prototype unit which will provide long term performance information under realistic operating conditions. (Author)

A80-33520 The sizing and economics of phase change energy storage units in air-based solar heating systems. J. J. Jurinak and S. I. Abdel-Khalik (Wisconsin, University, Madison, Wis.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 645-649. 8 refs. Contract No. E(11-1)-2588.

A80-33521 Experimental study of coolness storage using sodium sulfate decahydrate. W. J. Rice (Delaware, University, Wilmington, Del.; Villanova University, Villanova, Pa.) and J. J. Sliwowski (Delaware, University, Wilmington, Del.). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 650-654. Research supported by the Delmarva Power and Light Co. and Baltimore Gas and Electric Co.

An amount of 3434 pounds of sodium-sulfate based thermal storage material has been deployed in the Solar One House of the University of Delaware in a test of its efficacy as a coolness storage material for air conditioning using off-peak electricity. The test showed the material could store over 200,000 Btu's of coolness and that there was no significant change in its storage capability after 26 cycles carried out over a period of about four months. (Author)

A80-33522 Development of a storage system based on encapsulated p.c.-materials. E. van Galen and C. den Ouden (Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek Technisch Fysische Dienst TNO, Delft, Netherlands). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 655-658.

A short-term thermal storage system is presented which is based on a phase change material encapsulated in a polymer construction. The storage material belongs to the family of fused salt eutectics and contains two special additives: a polymer matrix and a nucleating agent to prevent severe supercooling. Results of the performance test of this storage system are given. In comparison with a water storage system, the same useful output can be reached with the present

system for a two times smaller volume. This is due to a higher collector efficiency, lower heat losses of the tank and a higher energy density. V.L.

A80-33523 Investigation of latent heat of fusion storage for solar heating systems. B. Ziegenbein (Brown, Boveri et Cie. AG, Heidelberg, West Germany). In: Sun II; Proceedings of the Silver Jubilee Congress, Atlanta, Ga., May 28-June 1, 1979. Volume 1. Elmsford, N.Y., Pergamon Press, Inc., 1979, p. 660-664.

The paper presents a summary of experimental and simulated results for the solar space heating system of the BBC-Solar House in Heidelberg, West Germany. The main objectives of this project are the development of latent heat of fusion storage subsystems and the investigation of the long term performance in comparison with an equivalent water storage unit. This has been accomplished by running the solar heating system of the BBC-Solar House alternatively with different thermal storage subsystems for three subsequent heating seasons. The analytical model used for computer simulations of various types of heating systems was shown to be reliable and accurate within 5%. (Author)

A80-33870 Comparison of measured and predicted rock bed storage performance. R. W. Persons, J. A. Duffie, and J. W. Mitchell (Wisconsin, University, Madison, Wis.). *Solar Energy*, vol. 24, no. 2, 1980, p. 199-201. 5 refs. Research supported by the U.S. Department of Energy.

A80-34081 # An analysis of off-guideway energy storage/propulsion systems for dual mode transit systems. I. J. Sacks (California, University, Livermore, Calif.). In: Advanced transit and urban revitalization - An international dialogue; Proceedings of the International Conference, Indianapolis, Ind., April 25-28, 1978. Volume 2. Washington, D.C., Advanced Transit Association, 1978. 24 p. 25 refs. Contract No. W-7405-eng-48.

Some evaluation criteria and a method for combining these criteria for the selection of an energy storage/propulsion system for off-guideway operation of a dual mode transit system are presented. In addition, technical options for these energy storage/propulsion systems are discussed. These options are drawn from mechanical, chemical, and electrical energy storage systems. The selection criteria discussed are used to select 'attractive' near term system option. (Author)

A80-34777 * Manufacturing methods of a composite cell case for a Ni-Cd battery. J. L. Bauer, R. S. Bogner (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), E. P. Lowe, and E. Orlowski (Programmed Composites Co., Fullerton, Calif.). In: New horizons - Materials and processes for the eighties; Proceedings of the Eleventh National Conference, Boston, Mass., November 13-15, 1979. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 364-387. 5 refs. Contract No. NAS7-100.

Graphite epoxy material for a nickel cadmium battery cell case has been evaluated and determined to perform in the simulated environment of the battery. The basic manufacturing method requires refinement to demonstrate production feasibility. The various facets of production scale-up, i.e., process and tooling development together with material and process control, have been integrated into a comprehensive manufacturing process that assures production reproducibility and product uniformity. Test results substantiate that a battery cell case produced from graphite epoxy pre-impregnated material utilizing internal pressure bag fabrication method is feasible. (Author)

A80-35382 A mixed integer scheduling model for combined thermal and hydroelectric-pumped storage generator systems. A. H. A. El-Sawy (Mitre Corp., McLean, Va.) and J. Byrd, Jr. (West Virginia University, Morgantown, W. Va.). *Energy Systems and Policy*, vol. 3, no. 4, 1980, p. 337-351. 5 refs.

A mixed integer programming model is developed and optimized to generate the optimal daily schedule for a combined thermal and hydroelectric-pumped storage power generating system. Various model modifications, generalizations and problems of implementation are discussed. Also included are the results of postoptimality analysis showing the sensitivity of the optimal schedule cost and configuration. Further computational experience with the mixed integer power-scheduling model, using various heuristic priority ordering and cutoff rules to cut down the computer solution time and the number of iterations involved, led to the following conclusions: (1) the average cost priority rule led to the lowest solution time, (2) the cutoff rule is effective in cutting both the solution time and the number of iterations of search while yielding a solution that is as close to the optimal as one desires. Recommendations for further research are included. (Author)

A80-35402 Putting baseload to work on the night shift. *EPRI Journal*, vol. 5, Apr. 1980, p. 6-13.

The use of energy storage systems to make use of baseload electric generating capacity during times of peak demand and thus conserve the more expensive fossil fuels generally employed for peak power generation is discussed. Means for storing baseload electricity generated from coal or nuclear plants are examined, with attention given to pumped water storage both above and below ground, compressed air storage and advanced-technology batteries. Systems of end-use storage, where electricity generated by the utility at night and available at lower rates is stored at the place of utilization to provide daytime space heating, hot water and even air conditioning and vehicle power, are considered, and the storage of solar energy is presented as an illustration of ways in which utility and customer energy storage can complement one another. It is concluded that the range of applications, potential benefits and technological potential of energy storage at the utility and consumer levels will ensure an important future role for this technology. A.L.W.

A80-37003 On the design of silver-hydrogen electrochemical cells. P. O. Offenhardt and G. L. Holleck (EIC Corp., Newton, Mass.). *Electrochemical Society, Journal*, vol. 127, June 1980, p. 1213-1219. 8 refs. Contract No. F33615-76-C-2093.

With a projected energy density of 70-110 Wh/kg and an estimated lifetime in excess of 1000 cycles, silver-hydrogen cells represent a promising electrochemical energy storage device for specialized applications. A cell design using a rolled stack configuration is especially attractive. A comprehensive computer simulation has been used to optimize the energy density of such a cell. The parameters considered include: cell geometry, electrode and lead dimensions, water generation and consumption, electrolyte movement, heat generation and dissipation, and active material utilization. The results show that balancing of electrolyte transport processes is essential for stable long term operation. Energy density is a strong function of rate, with incomplete silver electrode utilization the main factor. At higher rates no more than three or four layers can be used if the maximum temperature increase on discharge is to be kept below 5-10 C to avoid electrolyte loss via evaporation/condensation processes. Conversely, use of only one or two layers leads to an unacceptably high penalty in the energy density. (Author)

A80-37005 Electrical data of sodium/sulfur cells operating with dissolved catholyte. G. Weddigen (Brown, Boveri et Cie. AG, Heidelberg, West Germany). (*Electrochemical Society, Meeting, Pittsburgh, Pa., Oct. 15-20, 1978.*) *Electrochemical Society, Journal*, vol. 127, June 1980, p. 1225-1227. Bundesministerium für Forschung und Technologie Contract No. NT-4471.

Usual sodium/sulfur cells have an operating temperature of 300 C or higher. Thus the precipitation of solid polysulfides can be avoided during discharge until a stoichiometry of Na₂S₃ has been obtained in the sulfur compartment. Using organic solvents it becomes possible to discharge sodium/sulfur cells even up to the catholyte composition of Na₂S. Besides this the operating tempera-

ture can be lowered to 150 C. It is shown how rechargeability and internal resistance depend on temperature, solvent, and additives.

(Author)

A80-37009 Some aspects on the self-discharge of LiAl/FeS experimental cells with molten salt electrolyte. R. Knödler, G. Böhme (Battelle-Institut, Frankfurt am Main, West Germany), and W. Borger (Varta Batterie AG, Kelkheim, West Germany). *Electrochemical Society, Journal*, vol. 127, June 1980, p. 1311-1313. 7 refs. Research supported by the Varta Batterie AG; Bundesministerium für Forschung und Technologie Contract No. ET-5138-A.

Results are presented of an investigation into the self-discharge behavior of LiAl/FeS with molten salt electrolyte. The experimental setup was such that it was possible to determine the smallest possible self-discharge rate of this battery system. The experimental results suggest the following conclusions: (1) the self-discharge rate of LiAl/FeS cells is less than 1% per day; (2) the electronic conductivity of the molten electrolyte is drastically increased by the addition of Li₂O₂; in a complete cell, Li₂O is oxidized to Li₂O₂, thereby causing self-discharge due to electronic conductivity; and (3) the presence of air or oxygen in the cell atmosphere causes an increase in the self-discharge rate, whereas nitrogen has no effect. The consequence of the presence of air or oxygen is the formation of Li₂O₂ in the electrolyte. Therefore, increased conductivity of the melt may be one of the reasons for enhanced self-discharge. S.D.

A80-37455 Conceptual design of integrated energy storage and attitude control system. N. H. Nguyen and F. Mariau (Matra, S.A., Vélizy-Villacoublay, Yvelines, France). In: *Automatic control in space; Proceedings of the Eighth Symposium, Oxford, England, July 2-6, 1979.* Oxford, Pergamon Press, Ltd., 1980, p. 237-245. European Space Agency Contract No. 3261.

The concept of energy storage wheels (ESW) is reviewed with reference to their applications in future space missions. The key design features of ESW include the use of frictionless magnetically suspended bearings and emergency ball bearings, the use of dc motors for high efficiency, and the use of a drag free rotor made of composite materials. Major interface problems associated with the introduction of ESW into the power storage and attitude control systems are discussed, including uncertainties of wheel alignment and ESW inertia, as well as gain dispersions of ESW control electronics. The discussion also includes the proposed space missions, attitude control system designs for these missions, and the architecture of a power storage system using ESW. V.L.

A80-37591 Rechargeable batteries: Advances since 1977. Edited by R. W. Graham. Park Ridge, N. J., Noyes Data Corp. (*Energy Technology Review*, No. 55; *Chemical Technology Review*, No. 160), 1980. 464 p. \$54.

The book is a data-based publication, providing information retrieved and made available from the U.S. patent literature. It thus serves a double purpose in that it supplies detailed technical information and can be used as a guide to the patent literature in the field of rechargeable batteries. The topics covered include lead-acid batteries, lithium batteries, sodium-sulfur batteries, alkaline zinc and iron electrode batteries, zinc-halogen batteries, nickel-cadmium and nickel-hydrogen batteries, and other battery systems. Also included are company index, inventor index, and U.S. patent number index. S.D.

A80-37811 International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers. Conference sponsored by IEEE, U.S. Air Force, U.S. Army, U.S. Navy, and U.S. Department of Energy. Edited by A. H. Guenther (USAF, Weapons Laboratory, Kirtland AFB, N. Mex.) and M. Kristjansen (Texas Tech University, Lubbock, Tex.). Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979. 521 p. \$60.

The Conference concentrated on electron and ion diodes,

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magnetic components, power conditioning, breakdown mechanisms, switching, accelerators, and inductive and capacitive energy storage systems. Papers were given on hydrogen thyratrons for high power switching, electromagnetic guns and reaction engines, contacts for pulsed high current, exploding aluminum foil fuses, a Marx module for Antares, an electron-beam triggered spark gap, flashlamps, magnetic insulation in short coaxial vacuum structures and a low inductance 2 MV tube. A.T.

A80-37857 # TRIDENT - A megavolt pulse generator using inductive energy storage. D. Conte, R. D. Ford, W. H. Lupton, and I. M. Vitkovitsky (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers.

Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 276-283. 7 refs. Research sponsored by the U.S. Defense Nuclear Agency.

A megavolt level pulse generator, TRIDENT, has been constructed utilizing an inductive store as the primary pulse forming device. The 2.5 micro H coaxial storage inductor can be energized with up to 500 kA obtained from a 500 kJ, 60 kV capacitor bank. Current interruption is accomplished using a three stage opening switch comprised of an explosively actuated switch in parallel with foil and wire fuses. The generator has been operated at the 410 kA charge level (70% energy) to produce 700 kV pulses with risetimes of 150 nsec. Energy has been deposited into a 7.5 ohms resistive load at a rate of 5×10 to the 10th W. Operation with optimized fuse dimensions and at full charge is anticipated to approach megavolt outputs at powers of 10 to the 11th W. Future experiments include utilizing a homopolar generator as the current source. (Author)

A80-37873 # The mechanical design of a compensated pulsed alternator prototype. M. Brennan, W. L. Bird, J. H. Gully, M. L. Spann, K. M. Tolk, W. F. Weldon, H. G. Rylander, and H. H. Woodson (Texas, University, Austin, Tex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers.

Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 392-397. Research supported by the U.S. Department of Energy and Texas Atomic Energy Research Foundation.

A prototype of a compensated pulsed alternator (compulsator) with 150-kA peak output current is described. The rotor is made of 2913 laminations shrink fitted on a vertical shaft. Since the rotor has an L/D of 3.2 and a maximum speed of 5400 rpm, these insulated laminations are clamped on the ends with large Belleville washers to increase the effective stiffness. The stator is mounted on a torque frame which allows it to rotate during discharge to reduce the forces transmitted to ground. The mechanical considerations and design of this machine are presented. (Author)

A80-37875 # A compressed magnetic field generator systems model. J. E. Gover (Sandia Laboratories, Albuquerque, N. Mex.). In: International Pulsed Power Conference, 2nd, Lubbock, Tex., June 12-14, 1979, Digest of Technical Papers.

Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1979, p. 402-405. 6 refs.

A model relating the volume of a compressed magnetic field generator pulsed power system to its electrical energy output is developed. This systems model includes energy density and/or power density models of the electronic components and a CMF generator model which has been confirmed experimentally for system output energies up to 5000 joules. For a given output energy there exists an optimum selection of the pulsed power components to give an overall minimum system volume. Under optimum conditions the volume of the CMF generator is equal to one-half of the overall system volume and the overall system volume increases with the one-half power of the systems output energy. In an all electronic system there is a linear relationship between system volume and output energy. (Author)

A80-37966 Seasonal regeneration through underground strata. T. Yokoyama, H. Umemiya, T. Teraoka, H. Watanabe

(Yamagata, University, Yonezawa, Japan), K. Katsuragi (Nippon Chikassui-Kaihatsu Co., Ltd., Japan), and K. Kasahara (Mayekawa Manufacturing Co., Ltd., Tokyo, Japan). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.

New York, Pergamon Press, Inc., 1980, p. 623-653. 14 refs.

A seasonal regeneration system based on artificial ground water recharge is examined; summer heat and winter 'cold' are stored in underground strata and utilized when necessary. A recovery coefficient of nearly 40% indicates that seasonal regeneration through underground strata is feasible and suitable for many applications. B.J.

A80-37967 Some aspects of energy storage systems using Glauber salt mixtures. D. Y. S. Lou and A. J. Harrison (Delaware, University, Newark, Del.). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.

New York, Pergamon Press, Inc., 1980, p. 666-679. 5 refs. Contract No. E(11-1)-4042.

An investigation on the phase-transformation process of the Glauber salt mixture has been performed. Results on the visual observations of the crystallization process, measurement of the crystallization rate and its dependence upon the degree of undercooling are reported in this paper. Based on experimental investigation, it is concluded that the crystallization process is limited by the rate of thermal diffusions from the growing interface. (Author)

A80-37968 A direct contact thermal energy storage system. A. S. Elasfour (Cairo, University, Giza, Egypt). In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.

New York, Pergamon Press, Inc., 1980, p. 680-696. 6 refs.

A direct contact thermal energy storage system is suggested. In this system, the heat storing material would be divided into small droplets. During the energy extraction process, the droplets while being in their liquid state, would be allowed to fall freely in the heat carrying fluid, and meanwhile to solidify. Hereafter, the solidification of these droplets during the energy extraction process is studied under certain assumptions. Considering low Archimedes number combinations, solutions are given corresponding to different ranges of Reynolds number. The factors affecting the performance of the system during the energy extraction process are presented, and the possibilities of obtaining compact heat exchanger are investigated and discussed. (Author)

A80-37988 Hybrid chemical concepts for storage of solar thermal energy. A. C. Vialaron (CNRS, Toulouse, France). (*Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 38-41.) In: Solar energy: International progress; Proceedings of the International Symposium-Workshop, Cairo, Egypt, June 16-22, 1978. Volume 2.

New York, Pergamon Press, Inc., 1980, p. 1109-1118. 5 refs. Translation.

Solar energy storage procedures that merely involve storage of heat are compared with hybrid storage procedures that involve a chemical reaction as well as thermal storage. A sulfur dioxide and magnesium oxide system that utilizes the dissociation of water (hydrogen production) is described, and two scenarios for application of this system are considered. The system capabilities and requirements are examined. M.L.

A80-39086 Can this car electrify America. C. G. Burck. *Fortune*, vol. 102, July 14, 1980, p. 77, 78, 80.

A brief description of the Gulf and Western electric car propulsion system is presented. Attention is given to the firm's goals in developing the system, which include creating a new market for zinc. In addition, a comparison is made with General Motor's

nickel-zinc battery system, on the basis of operating cost and performance. M.E.P.

A80-40068 # The efficiency of ballast in composite flywheels (Effektivnost' ballasta v makhovikakh iz kompozitov). V. L. Kulakov and G. G. Portnov (Akademii Nauk Latvskoi SSR, Institut Mekhaniki Polimerov, Riga, Latvian SSR). *Mekhanika Kompozitnykh Materialov*, Mar.-Apr. 1980, p. 291-299. 8 refs. In Russian.

The feasibility of using ballast to increase the energy efficiency of composite flywheels was assessed; attention was given to flywheels made of glass/plastic, carbon/plastic, boron/plastic, and synthetic/plastic materials. It is shown that the use of ballast ensures a significant increase of the specific bulk energy capacity of the flywheel only in the case of a synthetic/plastic flywheel (about 50%); flywheels made from the other three composites tested experience only a slight increase of energy capacity (7-14%). B.J.

A80-40601 The lithium-sulfur dioxide primary battery - Its characteristics, performance and applications. D. Linden and B. McDonald (Duracell International, Inc., Lithium Systems Div., Elmsford, N.Y.). *Journal of Power Sources*, vol. 5, Mar. 1980, p. 35-55. 10 refs.

The lithium-sulfur dioxide battery is a new primary battery system with many advantages over conventional batteries. It has an energy density up to 330 W h/kg (150 W h/lb), two to four times greater than zinc batteries, and can perform to temperatures as low as -54 C (-65 F). The battery can withstand high temperature storage at 71 C (160 F) for long periods of time and its shelf life is projected to be 5-10 years at 21 C (70 F). The chemistry, construction and detailed performance characteristics of the battery are presented. The Li/SO₂ system provides an all-purpose, all-climate primary battery that is capable of filling a wide variety of military, industrial and consumer applications. A number of these applications are discussed. With increasing production and cost reduction, the Li/SO₂ battery will be cost-competitive and will receive wide acceptability and use. (Author)

A80-40602 Primary Li/SOCl₂ cells. X - Optimization of D cells with respect to energy density, storability and safety. A. N. Dey (P. R. Mallory Laboratory for Physical Science, Burlington, Mass.). *Journal of Power Sources*, vol. 5, Mar. 1980, p. 57-72. 20 refs. Grant No. DAAB07-74-C-0109.

Hermetically-constructed Li/SOCl₂ D cells were used for the studies reported in this publication. Optimization with respect to energy density resulted in a capacity recovery of 18-19 A h at 3.5 volt at 25 C, at 0.01 A corresponding to 20 W h/cu in. (1.24 W h/cu cm) and 300 W h/lb (661 W h/kg). The optimization with respect to storability resulted in cells having no voltage-delays after three months of storage at 72 C and test at -30 C at 3.0 A. The optimization with respect to safety resulted in cells which are resistant to abuses such as shorting and force-discharge. Approaches have also been developed to stabilize the partially-discharged cells and thus prevent spontaneous explosions on storage. (Author)

A80-40603 Abusive testing of large Li/SOCl₂ cells. N. Marincic and F. Goebel (GTE Sylvania, Inc., Waltham, Mass.). *Journal of Power Sources*, vol. 5, Mar. 1980, p. 73-82. 10 refs. USAF-supported research.

Results are reported of various abuse tests conducted with lithium-thionyl chloride primary batteries of 2,000 A h and 10,000 A h capacity. The mechanical abuse tests, such as shock and vibration, showed that the large prismatic cells can now be built to satisfy typical military requirements. The thermal abuse tests showed that the cells can withstand a considerable overheating or a thermal shock treatment, as long as provisions were made for the thermal expansion of the electrolyte. The electrochemical abuse tests showed that the cells could be overdischarged (driven in reverse beyond discharge) to an equivalent of up to 50% of the discharge capacity with no adverse effects. The short circuit test, as a combination of the electrochemical and thermal abuse, was performed with no

rupture, explosions or any other adverse effects on the surroundings. (Author)

A80-40604 Lithium batteries with voltage compatibility with conventional systems. M. Broussely, Y. Jumel, and J. P. Gabano (Société des Accumulateurs Fixes et de Traction, Poitiers, France). *Journal of Power Sources*, vol. 5, Mar. 1980, p. 83-87. 6 refs.

The possibility of using lead or lead-bismuth mixed oxides as positive materials in organic electrolyte lithium cells with a working voltage similar to those of conventional systems (1.5 V) has been considered. Performances and main characteristics of this new class of lithium batteries are described. (Author)

A80-40605 Preparation of iron sulfides and the study of their electrochemical characteristics for use in a nonaqueous-lithium battery. Y. Uetani, K. Yokoyama, and O. Okamoto (Hitachi Maxell, Ltd., Ibaraki, Osaka, Japan). *Journal of Power Sources*, vol. 5, Mar. 1980, p. 89-98. 10 refs.

A80-40606 Evaluation of cathode materials for the lithium-carbonmonofluoride battery. A. Morita, T. Iijima, T. Fujii, and H. Ogawa (Matsushita Electric Industrial Co., Ltd., Central Research Laboratories, Moriguchi, Japan). *Journal of Power Sources*, vol. 5, Mar. 1980, p. 111-125. 9 refs.

The lithium-carbonmonofluoride (CF)_n system, one of the most promising systems for high energy density primary batteries, is described in this paper. In this system, discharge performance mainly depends on the cathode material, (CF)_n, prepared by fluorinating various carbon materials at moderate temperatures. Two kinds of active carbons, graphite and coke, were chosen and tested in cells to determine the best carbon material for the carbonmonofluoride cathode. The (CF)_n cathode made of coke has been shown to have excellent discharge performance, good storage behavior, and an energy density of 140 W h/kg in small button cell sizes. (Author)

A80-40715 Solar energy with chemical storage for cogeneration of electric power and heat. H. W. Prengle, Jr., J. C. Hunt, C. E. Mauk, and E. C.-H. Sun (Houston, University, Houston, Tex.). *Solar Energy*, vol. 24, no. 4, 1980, p. 373-384. 12 refs. Research supported by the University of Houston; Contract No. EG-77-C-01-3974.

U.S.A. energy use by the year 2000 is estimated to be 116-130 quads, compared to 82 quads for 1978. Solar energy, utilized both at the individual residence-building level plus power plant level, along with all other conventional and new energy sources, will be needed to meet future energy demand. In order to make maximum utilization of energy sources to meet national energy-conservation and energy-economic policy, a power plant of the future must cogenerate electrical energy and heat medium, whether it burns fossil fuel or uses solar energy. A solar energy Central Receiver-AHS Chemical Storage cogeneration power plant can be configured to give complete flexibility for day-night and seasonal load combinations, with work efficiencies up to 46 per cent. Such a plant, as a stand-alone or network station, is a real possibility in the not too distant future. Electrical energy and heat medium produced therefrom will be competitive with fossil fuel powered generating plants. A 100 MWe Central Receiver-AHS Cycle cogeneration power plant is discussed in detail; cycle analysis, preliminary cost estimates, and unit energy costs are discussed. (Author)

A80-41473 # Application of heat pipes to thermal energy storage systems. A. Abhat (Stuttgart, Universität, Stuttgart, West Germany). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1509*. 9 p. 7 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4060-A.

The application of heat pipes as heat transport elements in a latent heat thermal energy store for solar residential heating systems is proposed. The paper describes the development of a 20 mm diameter, 3070 mm long, axially-grooved, copper-water heat pipe selected for this purpose. The heat pipe was operated with slight

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gravity assistance and tested in various operational modes that simulated charging, discharging and by-pass of the heat store. Entrainment effects resulted in adverse performance, forcing modifications in the capillary structure. Results from experiments performed during three tests series, characterized by the type of capillary structure used, are discussed. (Author)

A80-41649 Whirl and critical speeds of flywheel-container systems aboard vehicles. G. Genta and M. Gola (Torino, Politecnico, Turin, Italy). *Meccanica*, vol. 14, Mar. 1979, p. 55-61. 9 refs.

Container-flywheel systems for road vehicles can be mounted in a variety of ways on the vehicle's body, thus allowing large or small displacements. In the case of steady precession kinematic conditions are here obtained for both large and small displacements. Dynamic analysis in the small displacement case is then tested against a complete non-linear simulation model, previously used for studies on flywheel bus dynamics. Whirling and critical speeds are obtained and discussed. (Author)

A80-41852 Performance analysis of zinc-bromine batteries in vehicle and utility applications. F. G. Will and H. S. Spacil (General Electric Co., Schenectady, N.Y.). *Journal of Power Sources*, vol. 5, June 1980, p. 173-188. 11 refs.

Rechargeable zinc-bromine batteries exhibit a number of inherent advantages that let them appear as possible candidates for applications in electric vehicles and utility load levelling. Based upon known single cell data, the performance characteristics of zinc-bromine batteries in vehicles and utility applications are predicted. The attainable specific energy and energy efficiency are computed as a function of specific power. The effects of specific cell resistance, self-discharge rate, and charge and discharge time on specific energy and efficiency are examined. (Author)

A80-42270 # Preliminary evaluation of coal-fired fluid bed combustion-augmented compressed air energy storage power plants. R. D. Lessard, A. J. Giramonti (United Technologies Research Center, East Hartford, Conn.), and D. Merrick (Coal Processing Consultants, Ltd., Harrow, Middx., England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar. 10-13, 1980, Paper 80-GT-160*. 8 p. 9 refs. Members, \$1.50; nonmembers, \$3.00.

This paper presents highlights of an ongoing study program to assess the technical and economic feasibility of advanced concepts for generating peak-load electric power from a compressed air energy storage (CAES) power plant incorporating a coal-fired fluid bed combustor (FBC). It reviews the analyses performed to select an FBC/CAES power plant system configuration for the subsequent conceptual design phase of the study. Included in this review are: the design and operating considerations involved with integrating either an atmospheric or a pressurized fluid bed combustor with a CAES system to yield practical system configurations; the integration of system configurations; the parametric performance of these system configurations; and the preliminary screening which considered performance, cost, and technical risk and led to the identification of an open-bed PFBC/CAES system as having the greatest near-term commercialization potential. (Author)

A80-42297 Properties of alternate electrolytes for secondary zinc batteries. R. F. Thornton (General Electric Co., Schenectady, N.Y.) and E. J. Carlson (General Electric Co., Lamp Business Div., Cleveland, Ohio). *Electrochemical Society, Journal*, vol. 127, July 1980, p. 1448-1452. 14 refs.

Several mixed aqueous electrolytes have been characterized for zinc oxide solubility, ionic conductivity, density, and nickel hydroxide utilization. These electrolytes were made by reducing the usual potassium hydroxide concentration and by adding the salts such as potassium fluoride or potassium phosphate to partially compensate for the lower ionic conductivity. These mixed electrolytes may be

useful in prolonging the cycle life of the zinc electrode in secondary batteries. (Author)

A80-42299 A preliminary investigation for an Al/AlCl₃-NaCl/FeS₂ secondary cell. N. Koura (Tokyo Science University, Noda, Chiba, Japan). *Electrochemical Society, Journal*, vol. 127, July 1980, p. 1529-1531. 17 refs.

The development of an Al/AlCl₃-NaCl/FeS₂ cell as a potential candidate for advanced secondary cells is investigated, considering that aluminum has a negative potential and a high theoretical capacity, and the system has a low melting point and is stable as molten salt not in the presence of air or moisture. Discharge curves at various temperatures showed a high plateau at about 0.9 V and a low plateau at about 0.6 V; it was also shown that the more the current density increased, the greater was the high plateau capacity. In addition, FeS was detected from the FeS₂ electrode discharged up to 0.65 V, and Al₂S₃ was detected up to 0.20 V by X-ray analysis. J.P.B.

A80-43480 A convolution model of rock bed thermal storage units. E. F. Sowell and R. L. Curry (California State University, Fullerton, Calif.). *Solar Energy*, vol. 24, no. 5, 1980, p. 441-449. 15 refs. Research supported by the U.S. Department of Energy.

A method is presented whereby a packed-bed thermal storage unit is dynamically modeled for bi-directional flow and arbitrary input flow stream temperature variations. The method is based on the principle of calculating the output temperature as the sum of earlier input temperatures, each multiplied by a predetermined 'response factor', i.e., discrete convolution. A computer implementation of the scheme, in the form of a subroutine for a widely used solar simulation program (TRNSYS) is described and numerical results compared with other models. Also, a method for efficient computation of the required response factors is described; this solution is for a triangular input pulse, previously unreported, although the solution method is also applicable for other input functions. This solution requires a single integration of a known function which is easily carried out numerically to the required precision. (Author)

N80-22641# Dayton Univ., Ohio. School of Engineering. ANALYSIS OF SOLIDIFICATION IN A CYLINDRICAL ANNULUS WITH INTERNAL FINS Final Report, Oct. 1977 Oct. 1978

Howard E. Bandow and John N. Crip Wright-Patterson AFB, Ohio AFAPL Jul. 1979 83 p refs (Contract F33615-77-C-2004; AF Proj. 3145) (AD-A080131; UDR-TR-78-69; UDSE-TR-78-07; AFAPL-TR-79-2088) Avail: NTIS HC A05/MF A01 CSCL 10/3

Solutions are presented for the one dimensional and two dimensional inward solidification of a material contained in a cylindrical annulus. The outer boundary is insulated and the inner boundary is subject to a constant efflux via a heat pipe. Results are presented for the axisymmetric case and for the cases of three and six longitudinal fins of rectangular cross section. The fins extend radially from inner to outer radius and were symmetrically spaced in the circumferential direction. The phase change material was LiF-MgF₂-KF and was assumed to be initially at the fusion temperature. GRA

N80-22702*# Kumm (Emerson L.), Tempe, Ariz. DESIGN STUDY OF FLAT BELT CVT FOR ELECTRIC VEHICLES

Emerson L. Kumm Mar. 1980 159 p refs (Contract DEN3-114; Contract EC-77-A-31-1044) (NASA-CR-159822; P-1006) Avail: NTIS HC A08/MF A01 CSCL 131

A continuously variable transmission (CVT) was studied, using a novel flat belt pulley arrangement which couples the high speed output shaft of an energy storage flywheel to the drive train of an electric vehicle. A specific CVT arrangement was

recommended and its components were selected and sized, based on the design requirements of a 1700 KG vehicle. A design layout was prepared and engineering calculations made of component efficiencies and operating life. The transmission efficiency was calculated to be significantly over 90% with the expected vehicle operation. A design consistent with automotive practice for low future production costs was considered, together with maintainability. The technology advancements required to develop the flat belt CVT were identified and an estimate was made of how the size of the flat belt CVT scales to larger and smaller design output torques. The suitability of the flat belt CVT for alternate application to an electric vehicle powered by an electric motor without flywheel and to a hybrid electric vehicle powered by an electric motor with an internal combustion engine was studied. E.D.K.

N80-22777*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

ADVANCED SCREENING OF ELECTRODE COUPLES

J. Giner and K. Cahill Feb. 1980 56 p refs
(Contract NAS3-20794; EC-77-A-31-1002)
(NASA-CR-159738; DOE/NASA/0794-80/1) Avail: NTIS HC A04/MF A01 CSCL 10B

The chromium (Cr(3+)/Cr(2+)) redox couple (electrolyte and electrode) was investigated to determine its suitability as negative electrode for the iron (Fe(3+)/Fe(2+))-chromium (Cr(3+)/Cr(2+)) redox flow battery. Literature search and laboratory investigation established that the solubility and stability of aqueous acidic solutions of chromium(3) chloride and chromium(2) chloride are sufficient for redox battery application. Four categories of electrode materials were tested; namely, metals and metalloid materials (elements and compounds), alloys, plated materials, and Teflon-bonded materials. In all, the relative performance of 26 candidate electrode materials was evaluated on the basis of slow scan rate linear sweep voltammetry in stirred solution. No single material tested gave both acceptable anodic and acceptable cathodic performance. However, the identification of lead as a good cathodic electrocatalyst and gold as a good anodic electrocatalyst led to the invention of the lead/gold combination electrocatalyst. This type of catalyst can be fabricated in several ways and appears to offer the advantages of each metal without the disadvantages associated with their use as single materials. This lead/gold electrocatalyst was tested by NASA-Lewis Research Center in complete, flowing, redox batteries comprising a stack of several cells. A large improvement in the battery's coulombic and energy efficiency was observed. F.O.S.

N80-22788*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THERMAL ENERGY STORAGE: FOURTH ANNUAL REVIEW MEETING

Mar. 1980 650 p refs Meeting held at Tysons Corner, Va., 3-4 Dec. 1979; sponsored by DOE
(NASA-CP-2125; E-428; CONF-791232) Avail: NTIS HC A99/MF A01 CSCL 10C

The development of low cost thermal energy storage technologies is discussed in terms of near term oil savings, solar energy applications, and dispersed energy systems for energy conservation policies. Program definition and assessment and research and technology development are considered along with industrial storage, solar thermal power storage, building heating and cooling, and seasonal thermal storage. A bibliography on seasonal thermal energy storage emphasizing aquifer thermal energy is included.

N80-22789*# Pacific Northwest Lab., Richland, Wash.

SEASONAL THERMAL ENERGY STORAGE PROGRAM

James E. Minor *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 25-31

Avail: NTIS HC A99/MF A01 CSCL 10B

The Seasonal Thermal Energy Storage (STES) Program designed to demonstrate the storage and retrieval of energy on a seasonal basis using heat or cold available from waste or other sources during a surplus period is described. Factors

considered include reduction of peak period demand and electric utility load problems and establishment of favorable economics for district heating and cooling systems for commercialization of the technology. The initial thrust of the STES Program toward utilization of ground water systems (aquifers) for thermal energy storage is emphasized. J.M.S.

N80-22790*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PROGRAM DEFINITION AND ASSESSMENT OVERVIEW

Larry H. Gordon *In* its Thermal Energy Storage Mar. 1980 p 38-41 refs

Avail: NTIS HC A99/MF A01 CSCL 10B

The implementation of a program level assessment of thermal energy storage technology thrusts for the near and far term to assure overall coherent energy storage program is considered. The identification and definition of potential thermal energy storage applications, definition of technology requirements, and appropriate market sectors are discussed along with the necessary coordination, planning, and preparation associated with program reviews, workshops, multi-year plans and annual operating plans for the major laboratory tasks. J.M.S.

N80-22792*# Midwest Research Inst., Kansas City, Mo.

THERMAL ENERGY STORAGE SYSTEMS USING FLUIDIZED BED HEAT EXCHANGERS

V. Ramanathan, T. E. Weast, and K. P. Ananth *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 47-55

(Contract DEN3-96)

Avail: NTIS HC A99/MF A01 CSCL 10B

The viability of using fluidized bed heat exchangers (FBHX) for thermal energy storage (TES) in applications with potential for waste heat recovery was investigated. Of the candidate applications screened, cement plant rotary kilns and steel plant electric arc furnaces were identified, via the chosen selection criteria, as having the best potential for successful use of FBHX/TES system. A computer model of the FBHX/TES systems was developed and the technical feasibility of the two selected applications was verified. Economic and tradeoff evaluations in progress for final optimization of the systems and selection of the most promising system for further concept validation are described. J.M.S.

N80-22794*# General Electric Co., Schenectady, N. Y.

CONCEPTUAL DESIGN OF THERMAL ENERGY STORAGE SYSTEMS FOR NEAR-TERM ELECTRIC UTILITY APPLICATIONS

Eldon W. Hall *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 79-84

(Contract DEN3-12; EPRI Proj. 1082-1)

Avail: NTIS HC A99/MF A01 CSCL 10B

Promising thermal energy storage systems for midterm applications in conventional electric utilities for peaking power generation are evaluated. Conceptual designs of selected thermal energy storage systems integrated with conventional utilities are considered including characteristics of alternate systems for peaking power generation, viz gas turbines and coal fired cycling plants. Competitive benefit analysis of thermal energy storage systems with alternate systems for peaking power generation and recommendations for development and field test of thermal energy storage with a conventional utility are included. Results indicate that thermal energy storage is only marginally competitive with coal fired cycling power plants and gas turbines for peaking power generation. J.M.S.

N80-22795*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

INDUSTRIAL STORAGE APPLICATIONS OVERVIEW

Rudolph A. Duscha *In* its Thermal Energy Storage Mar. 1980 p 85-94 refs

Avail: NTIS HC A99/MF A01 CSCL 10B

The implementation of a technology demonstration for the food processing industry, development and technology demonstrations for selected near-term, in-plant applications and advanced

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industrial applications of thermal energy storage are overviewed.
R.E.S.

N80-22796*# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.
APPLICATIONS OF THERMAL ENERGY STORAGE TO WASTE HEAT RECOVERY IN THE FOOD PROCESSING INDUSTRY

F. Wojnar (Heinz (H. J.) Co.) and Wayne L. Lunberg /*n* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 95-104

(Contract EC-77-C-01-5002)

Avail: NTIS HC A99/MF A01 CSCL 10B

A study to assess the potential for waste heat recovery in the food industry and to evaluate prospective waste heat recovery system concepts employing thermal energy storage was conducted. The study found that the recovery of waste heat in canning facilities can be performed in significant quantities using systems involving thermal energy storage that are both practical and economical. A demonstration project is proposed to determine actual waste heat recovery costs and benefits and to encourage system implementation by the food industry. R.E.S.

N80-22797*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COLLECTION AND DISSEMINATION OF TES SYSTEM INFORMATION FOR THE PAPER AND PULP INDUSTRY
M. W. Dietrich and Howard Edde (Edde (Howard), Inc., Bellevue, Wash.) /*n* its Thermal Energy Storage Mar. 1980 p 105-111

(Contract DEN3-190)

Avail: NTIS HC A99/MF A01 CSCL 10B

A survey of U.S. and international paper and pulp mills using thermal energy storage (TES) systems as a part of their production processes was conducted to obtain sufficient operating data to conduct a benefits analysis encompassing: (1) an energy conservation assessment, (2) an economic benefits analysis, and (3) an environmental impact assessment. An information dissemination plan was then proposed to effectively present the benefits of TES to the U.S. paper and pulp industry. R.E.S.

N80-22798*# Sandia Labs., Livermore, Calif.

SOLAR THERMAL POWER STORAGE APPLICATIONS LEAD LABORATORY OVERVIEW

Lee G. Radosevich /*n* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 113-124

Avail: NTIS HC A99/MF A01 CSCL 10B

The implementation of the applications elements of the thermal energy storage for Solar Thermal Applications program is described. The program includes the accelerated development of thermal storage technologies matched to solar thermal power system requirements and scheduled milestones. The program concentrates on storage development in the FY80 to 85 time period with emphasis on the more near-term solar thermal power system application. R.E.S.

N80-22799*# Sandia Labs., Albuquerque, N. Mex.
THERMAL STORAGE EXPERIENCE AT THE MSSTF AND PLANS FOR THE FUTURE

Thomas D. Harrison and Robert A. Randall /*n* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 125-130 ref

(Contract DE-AC04-76DP-00789)

Avail: NTIS HC A99/MF A01 CSCL 10C

The background of thermal storage development at the Midtemperature Solar Systems Test Facility is reviewed. The problems which were encountered are discussed and a course of action for resolving the problems is outlined. Scaling effects of going from laboratory models to full-size applications were determined and applied to thermal storage needs in near-term solar projects. R.E.S.

N80-22800*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THERMAL ENERGY STORAGE EFFORT AT JPL

Donald L. Young /*n* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 131-140

Avail: NTIS HC A99/MF A01 CSCL 10C

The technical, operational, and economic readiness of parabolic dish systems for electric and thermal applications was investigated. A parabolic dish system was then developed to the point at which subsequent commercialization activities can lead to successful market penetration. The immediate possible applications of the dish system to thermal energy storage are discussed. R.E.S.

N80-22801*# Martin Marietta Corp., Baltimore, Md.
INTERNALLY INSULATED THERMAL STORAGE SYSTEM DEVELOPMENT PROGRAM

Owen L. Scott /*n* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 141-155

Avail: NTIS HC A99/MF A01 CSCL 10C

A cost effective thermal storage system for a solar central receiver power system using molten salt stored in internally insulated carbon steel tanks is described. Factors discussed include: testing of internal insulation materials in molten salt; preliminary design of storage tanks, including insulation and liner installation; optimization of the storage configuration; and definition of a subsystem research experiment to demonstrate the system. A thermal analytical model and analysis of a thermocline tank was performed. Data from a present thermocline test tank was compared to gain confidence in the analytical approach. A computer analysis of the various storage system parameters (insulation thickness, number of tanks, tank geometry, etc.) showed that (1) the most cost-effective configuration was a small number of large cylindrical tanks, and (2) the optimum is set by the mechanical constraints of the system, such as soil bearing strength and tank hoop stress, not by the economics. M.G.

N80-22803*# Texas Univ. at Austin. Energy Foundation of Texas.

HIGH TEMPERATURE UNDERGROUND THERMAL ENERGY STORAGE SYSTEM FOR SOLAR ENERGY

R. Eugene Collins /*n* NASA. Lewis Res. Center Thermal Energy Storage Aug. 1980 p 163-171

Avail: NTIS HC A99/MF A01 CSCL 10C

The activities feasibility of high temperature underground thermal storage of energy was investigated. Results indicate that salt cavern storage of hot oil is both technically and economically feasible as a method of storing huge quantities of heat at relatively low cost. One particular system identified utilizes a gravel filled cavern leached within a salt dome. Thermal losses are shown to be less than one percent of cyclically transferred heat. A system like this having a 40 MW sub t transfer rate capability and over eight hours of storage capacity is shown to cost about \$13.50 per KWh sub t. M.G.

N80-22805*# Institute of Gas Technology, Chicago, Ill.
HIGH-TEMPERATURE MOLTEN SALT THERMAL ENERGY STORAGE SYSTEMS FOR SOLAR APPLICATIONS

Randy J. Petri and T. D. Claar /*n* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 183-190 refs

Avail: NTIS HC A99/MF A01 CSCL 10C

Alkali and alkaline earth carbonate latent-heat storage salts, metallic containment materials, and thermal conductivity enhancement materials were investigated to satisfy the high temperature (704 to 871 C) thermal energy storage requirements of advanced solar-thermal power generation concepts are described. Properties of the following six salts selected for compatibility studies are given: three pure carbonates, K₂CO₃, Li₂CO₃ and Na₂CO₃; two eutectic mixtures, BaCO₃/Na₂CO₃ and K₂CO₃/NaCO₃, and one off-eutectic mixture of Na₂CO₃/K₂CO₃. M.G.

N80-22806*# Oak Ridge National Lab., Tenn.
BUILDING HEATING AND COOLING APPLICATIONS

THERMAL ENERGY STORAGE PROGRAM OVERVIEW

D. M. Eissenberg *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 191-201

Avail: NTIS HC A99/MF A01 CSCL 10B

Thermal energy storage technology and development of building heating and cooling applications in the residential and commercial sectors is outlined. Three elements are identified to undergo an applications assessment, technology development, and demonstration. Emphasis is given to utility load management thermal energy system application where the stress is on the 'customer side of the meter'. Thermal storage subsystems for space conditioning and conservation means of increased thermal mass within the building envelope and by means of low-grade waste heat recovery are covered. M.G.

N80-22807*# Oak Ridge National Lab., Tenn.
SUBCONTRACTED ACTIVITIES RELATED TO TES FOR BUILDING HEATING AND COOLING

Jim Martin *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 203-211

Avail: NTIS HC A99/MF A01 CSCL 10B

The subcontract program elements related to thermal energy storage for building heating and cooling systems are outlined. The following factors are included: subcontracts in the utility load management application area; life and stability testing of packaged low cost energy storage materials; and development of thermal energy storage systems for residential space cooling. Resistance storage heater component development, demonstration of storage heater systems for residential applications, and simulation and evaluation of latent heat thermal energy storage (heat pump systems) are also discussed. Application of thermal energy storage for solar application and twin cities district heating are covered including an application analysis and technology assessment of thermal energy storage. R.C.T.

N80-22808*# Purdue Univ., Lafayette, Ind.
THERMAL ENERGY STORAGE TESTING FACILITY

R. J. Schoenhals, H. F. Kuehler, and C. P. Lin *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 223-231

Avail: NTIS HC A99/MF A01 CSCL 10C

The thermal performance of resistance storage heaters in respect to current standards is determined. The design and construction of a storage heater test facility with capability for measuring the performance of electric resistance heated storage units is described. The performance of commercial units are compared based on existing standards. Additional performance standards are proposed. R.C.T.

N80-22809*# Rocket Research Corp., Redmond, Wash.
APPLICATION OF THERMAL ENERGY STORAGE TO PROCESS HEAT RECOVERY IN THE ALUMINUM INDUSTRY

John McCabe *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 233-237

Avail: NTIS HC A99/MF A01 CSCL 10B

The economic viability and the institutional compatibility of a district heating system in the city of Bellingham, Washington are assessed and the technical and economic advantages of using thermal energy storage methods are determined. R.C.T.

N80-22810*# General Electric Co., Schenectady, N. Y. Corporate Research and Development.
HEAT STORAGE CAPABILITY OF A ROLLING CYLINDER USING GLAUBER'S SALT

C. S. Herrick and K. P. Zarnoch *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 239-259 refs

(Contract EM-78-C-05-5759)

Avail: NTIS HC A99/MF A01 CSCL 10C

The rolling cylinder phase change heat storage concept was developed to the point where a prototype design is completed and a cost analysis is prepared. A series of experimental and

analytical tasks are defined to establish the thermal, mechanical, and materials behavior of rolling cylinder devices. These tasks include: analyses of internal and external heat transfer; performance and lifetime testing of the phase change materials; corrosion evaluation; development of a mathematical model; and design of a prototype and associated test equipment. R.C.T.

N80-22811*# Oak Ridge National Lab., Tenn.
THERMAL ENERGY STORAGE TEST FACILITY

Mark P. Ternes *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 261-264

(Contract W-7405-eng-26)

Avail: NTIS HC A99/MF A01 CSCL 10C

The thermal behavior of prototype thermal energy storage units (TES) in both heating and cooling modes is determined. Improved and advanced storage systems are developed and performance standards are proposed. The design and construction of a thermal cycling facility for determining the thermal behavior of full scale TES units is described. The facility has the capability for testing with both liquid and air heat transport, at variable heat input/extraction rates, over a temperature range of 0 to 280 F. R.C.T.

N80-22814*# Delaware Univ., Wilmington. Inst. of Energy Conversion.

LIFE AND STABILITY TESTING OF PACKAGED LOW-COST ENERGY STORAGE MATERIALS

Galen R. Frysinger. *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 277-281

Avail: NTIS HC A99/MF A01 CSCL 10C

Thermal cycling and performance tests, performed to verify the package integrity, life, and stability of the chub packaged materials system for storage coolness with application to residential air conditioning, are described. The moisture vapor retention characteristics of the laminate film for long term chub performance was determined. The stability, mechanical integrity, and thermal performance of chubs following mechanical shock, vibration, and temperature extremes is reported. A.W.H.

N80-22815*# General Electric Co., Santa Barbara, Calif.
EVALUATION OF THERMAL ENERGY STORAGE FOR THE PROPOSED TWIN CITIES DISTRICT HEATING SYSTEM

Charles F. Meyer *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 283-295 refs

Avail: NTIS HC A99/MF A01 CSCL 10C

The technical and economic feasibility of incorporating thermal energy storage components into the proposed Twin Cities District heating project was evaluated. The technical status of the project is reviewed and conceptual designs of district heating systems with and without thermal energy storage were compared in terms of estimated capital requirements, fuel consumption, delivered energy cost, and environmental aspects. The thermal energy storage system is based on cogeneration and the storage of heat in aquifers. A.W.H.

N80-22817*# Argonne National Lab., Ill.
EXPERIMENTAL EVALUATION OF THERMAL ENERGY STORAGE

J. G. Asbury and H. N. Hersh *In* NASA. Lewis Res. Center Thermal Energy Storage Mar. 1980 p 307-314 refs

Avail: NTIS HC A99/MF A01 CSCL 10C

The technical performance of commercially available thermal energy storage (TES) residential heating units under severe weather conditions is discussed. The benefits and costs of TES to the user and utility companies were assessed. The TES issues, research and development needs, and barriers to commercialization were identified. The field tests which determined the performance characteristics for the TES are described and the TES systems, which included both ceramic and hydronic systems, are compared. A.W.H.

N80-22819*# Honeywell, Inc., Minneapolis, Minn.
ACTIVE HEAT EXCHANGE SYSTEM DEVELOPMENT FOR

07 ENERGY STORAGE

LATENT HEAT THERMAL ENERGY STORAGE

Richard T. LeFrois *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 337-352

(Contract DEN3-38)

Avail: NTIS HC A99/MF A01 CSCL 10C

Alternative mechanizations of active heat exchange concepts were analyzed for use with heat of fusion Phase Change Materials (PCM's) in the temperature range of 250 C to 350 C for solar and conventional power plant applications. Over 24 heat exchange concepts were reviewed, and eight were selected for detailed assessment. Two candidates were chosen for small-scale experimentation: a coated tube and shell heat exchanger, and a direct contact reflux boiler. A dilute eutectic mixture of sodium nitrate and sodium hydroxide was selected as the PCM from over fifty inorganic salt mixtures investigated. Preliminary experiments with various tube coatings indicated that a nickel or chrome plating of Teflon or Ryton coating had promise of being successful. An electroless nickel plating was selected for further testing. A series of tests with nickel-plated heat transfer tubes showed that the solidifying sodium nitrate adhered to the tubes and the experiment failed to meet the required discharge heat transfer rate of 10 kW(t). Testing of the reflux boiler is under way. A.R.H.

N80-22820*# Naval Research Lab., Washington, D. C.

ENERGY STORAGE-BOILER TANK Progress Report, 1979
Talbot A. Chubb, J. J. Nemecek, and D. E. Simmons *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 353-359

(Contract EC-77-A-31-1024; NRL Proj. M003)

Avail: NTIS HC A99/MF A01 CSCL 10B

Activities performed in an effort to demonstrate heat of fusion energy storage in containerized salts are reported. The properties and cycle life characteristics of a eutectic salt having a boiling point of about 385 C (NaCl, KCl, Mg Cl₂) were determined. M-terphenyl was chosen as the heat transfer fluid. Compatibility studies were conducted and mild steel containers were selected. The design and fabrication of a 2MWh storage boiler tank are discussed. A.R.H.

N80-22822*# Grumman Aerospace Corp., Bethpage, N.Y.

ACTIVE HEAT EXCHANGE SYSTEM DEVELOPMENT FOR LATENT HEAT THERMAL ENERGY STORAGE

Joseph Alario and Robert Haslett *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 375-383

(Contract DEN3-39)

Avail: NTIS HC A99/MF A01 CSCL 10C

Various active heat exchange concepts were identified from among three generic categories: scrapers, agitators/vibrators and slurries. The more practical ones were given a more detailed technical evaluation and an economic comparison with a passive tube-shell design for a reference application. Two concepts selected for hardware development are a direct contact heat exchanger in which molten salt droplets are injected into a cooler counterflowing stream of liquid metal carrier fluid, and a rotating drum scraper in which molten salt is sprayed onto the circumference of a rotating drum, which contains the fluid heat sink in an internal annulus near the surface. A fixed scraper blade removes the solidified salt from the surface which has been nickel plated to decrease adhesion forces. Suitable phase change material (PCM) storage media with melting points in the temperature range of interest (250 C to 400 C) were investigated. The specific salt recommended for laboratory tests was a chloride eutectic (20.5KCl-24/5 NaCl-55.0MgCl 2% by wt.), with a nominal melting point of 385 C. A.R.H.

N80-22825*# Pacific Northwest Lab., Richland, Wash.

AQUIFER THERMAL ENERGY STORAGE PROGRAM
Kenneth Fox *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 401-411

(Contract EY-76-C-06-1830)

Avail: NTIS HC A99/MF A01 CSCL 10C

The purpose of the Aquifer Thermal Energy Storage Demon-

stration Program is to stimulate the interest of industry by demonstrating the feasibility of using a geological formation for seasonal thermal energy storage, thereby, reducing crude oil consumption, minimizing thermal pollution, and significantly reducing utility capital investments required to account for peak power requirements. This purpose will be served if several diverse projects can be operated which will demonstrate the technical, economic, environmental, and institutional feasibility of aquifer thermal energy storage systems. Author

N80-22827*# Texas A&M Research Foundation, College Station.
COLD WATER AQUIFER STORAGE

Donald L. Reddell, Richard R. Davison, and William B. Harris *In* NASA, Lewis Res. Center Thermal Energy Storage Mar. 1980 p 591-599

Avail: NTIS HC A99/MF A01 CSCL 10C

A working prototype system is described in which water is pumped from an aquifer at 70 F in the winter time, chilled to a temperature of less than 50 F, injected into a ground-water aquifer, stored for a period of several months, pumped back to the surface in the summer time. A total of 8.1 million gallons of chilled water at an average temperature of 48 F were injected. This was followed by a storage period of 100 days. The recovery cycle was completed a year later with a total of 8.1 million gallons recovered. Approximately 20 percent of the chill energy was recovered. A.R.H.

N80-22838# Los Alamos Scientific Lab., N. Mex.

SUPERCONDUCTING MAGNETIC ENERGY STORAGE FOR ELECTRIC UTILITIES AND FUSION SYSTEMS

J. D. Rogers 1978 45 p refs. Presented at the Instr. Soc. of Am. Meeting, Philadelphia, 16 Oct. 1978

(Contract W-7405-eng-36)

(LA-UR-78-1213; CONF-781025-1)

Avail: NTIS

HC A03/MF A01

Energy storage inductors, under development for load leveling and transmission line stabilization in electric utility systems and for driving magnetic confinement and plasma heating coils in fusion energy system are described. Superconducting magnetic energy storage (SMES) systems, which will store and deliver electrical energy for load leveling, peak shaving, and the stabilization of electric utility network are discussed. In the fusion area, inductive energy transfer and storage is being developed. Both 1-ms fast discharge theta pinch systems and 1 to 2-s slow energy transfer Tokamak systems have been demonstrated. The major components and the method of operation of a SMES unit are described, and potential applications of different size SMES systems in electric power grids are assessed. Results are given of a reference design for a 10-Gwh unit for load leveling, of a 30-MJ coil proposed for system stabilization, and of tests with a small-scale, 100-kj magnetic energy storage system. Fusion energy storage and transfer are results included. The common technology base for the various storage systems is examined. A.R.H.

N80-22841# Argonne National Lab., Ill. Systems Engineering and Technology Group.

UNDERGROUND PUMPED HYDROELECTRIC STORAGE (UPHS)

C. A. Blomquist, A. A. Frigo, and S. W. Tam Apr. 1979 42 p refs

(Contract W-31-109-eng-38)

(ANL/EES-TM-60) Avail: NTIS HC A03/MF A01

The operating characteristics of single- and double-stage, reversible, Francis-type pump turbines are discussed. System studies are discussed in terms of machinery costs, plant sizes, and pump-turbine efficiencies, and results and conclusions are presented. In general, the utilization of advanced turbomachinery seems to be justified for underground pumped hydroelectric storage plants. DOE

N80-22842# Oak Ridge National Lab., Tenn. Energy and Environmental Systems Div.

LOW TEMPERATURE THERMAL ENERGY STORAGE

C. S. Seagaser and J. E. Christian, Mar. 1979 86 p refs

(Contract W-31-109-eng-38)

(ANL/CES/TE-79-3) Avail: NTIS HC A05/MF A01

Techniques and estimated costs of low temperature thermal energy storage (TES) devices applicable to integrated community energy systems (ICES) installations serving communities ranging in size from approximately 3000 to about 100,000 population are evaluated. The storage of thermal energy in the form of either hotness or coldness by virtue of a change in temperature of the material, or as latent heat of fusion in which the material changes from the liquid phase to the solid phase at essentially a constant temperature is described. Both types of material are considered for TES in ICES applications. DOE

N80-22845# EIC, Inc., Newton, Mass.

METHANOL-BASED HEAT PUMPS FOR STORAGE OF SOLAR THERMAL ENERGY, PHASE 1 Final Report, 25 Apr. 1977 - 30 Jun. 1978

P. O. D. Offenhardt, M. J. Turner, F. C. Brown, R. B. Warren, J. P. Pemsler, and S. B. Brummer Jan. 1979 109 p refs Prepared for Sandia Labs., Livermore, Calif.

(Contract EY-76-C-04-0789)

(SAND-79-8188) Avail: NTIS HC A06/MF A01

Reaction of CH₃OH vapor with a solid state inorganic salt substrate to produce a solid methanolated salt can be used as the basis of a combined solar heat pump/thermal energy storage system. Experiments carried out indicate that the reaction of CaCl₂ with CH₃OH vapor to produce CaCl₂·2CH₃OH is well suited to heating and cooling applications. The heat of reaction is about 20 kcal per mole of CH₃OH, and kinetics and thermodynamics of the reaction appear adequate down to a CH₃OH pool temperature around -10 C. Analytical and experimental work on the design of the heat exchanger for the reacting salt bed indicate that high rates of heat transfer can be accomplished in a reasonably compact system; the indicated energy density for the solid-phase reactant is in excess of 13,000 Btu/cu ft, assuming that the void fraction for anhydrous CaCl₂ is 85% or less. DOE

N80-23216# Honeywell, Inc., St. Paul, Minn. Technology Strategy Center.

ASSESSMENT AND PRELIMINARY DESIGN OF AN ENERGY BUFFER FOR REGENERATIVE BRAKING IN ELECTRIC VEHICLES Final Report

R. Buchholz and Anoop K. Mathur Dec. 1979 138 p

(Contracts DEN3-48; EC-77-C-31-1044)

(NASA-CR-159756; DOE/NASA/0048-79/1; TSCIO082-FR)

Avail: NTIS HC A07/MF A01 CSCL 13F

Energy buffer systems, capable of storing the vehicle energy during braking and reusing this stored energy during acceleration, were examined. Some of these buffer systems when incorporated in an electric vehicle would result in an improvement in the performance and range under stop and go driving conditions. Buffer systems considered included flywheels, hydropneumatic, pneumatic, spring, and regenerative braking. Buffer ranking and rating criteria were established. Buffer systems were rated based on predicted range improvements, consumer acceptance, driveability, safety, reliability and durability, and initial and life cycle costs. A hydropneumatic buffer system was selected.

Author

N80-23661# Mechanical Technology, Inc., Latham, N. Y.
MAGNETIC BEARING SUPPORT STUDY FOR A 10 kW-hr ENERGY STORAGE FLYWHEEL

M. W. Eusepi and D. F. Wilcock Nov. 1979 180 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7025; MTI-75TR59)

Avail: NTIS HC A09/MF A01

The design of a magnetic suspension system which fully supports a 10 kW-hr energy storage flywheel is presented. Discussions leading to the selection of the design to other storage levels ranging from a 1 kW-hr vehicular size to a large 100 kW-hr stationary system are included. DOE

N80-23788# Lincoln Lab., Mass. Inst. of Tech., Lexington.

APPLICATION AND DESIGN STUDIES OF COMPRESSED-AIR ENERGY STORAGE FOR SOLAR APPLICATIONS Final Report

G. T. Flynn and J. L. Nash-Webber 28 Sep. 1979 118 p refs

(Contract EX-76-A-01-2295-029)

(CAES-7) Avail: NTIS HC A06/MF A01

Adiabatic compressed air energy storage (CAES), in which both the heat of compression and the compressed air stored separately, was studied. The applicability of this technology to solar power systems was examined. The basic thermodynamics of ideal single and two stage adiabatic CAES is reviewed. Generic single stage and two stage types are discussed, and the efficiency and mass flow rate as a function of storage pressure and stage pressure ratios were investigated. The performance and cost of available turbomachinery for the single and two stage adiabatic systems are examined. DOE

N80-23789# Argonne National Lab., Ill.

OPTIMAL DESIGN OF COMPRESSED AIR ENERGY STORAGE SYSTEMS

F. W. Ahrens, A. Sharma, and K. M. Ragsdell 1979 13 p

refs Presented at the 6th Annual Conf. on Energy, Rolla, Mo., Oct. 1979 Prepared in cooperation with Illinois Univ., Chicago and Purdue Univ., Lafayette, Ind.

(Contract W-31-109-eng-38)

(CONF-791069-3) Avail: NTIS HC A02/MF A01

Compressed air energy storage (CAES) power systems considered by various electric utilities for load leveling applications are discussed. Models of CAES systems which employ natural underground aquifer formations, and present an optimal design methodology which demonstrates their economic viability are developed. The approach is based upon a decomposition of the CAES plant and utility grid system into three partially-decoupled subsystems. Numerical results are given for a plant employing the Media, Illinois Galesville aquifer formation. DOE

N80-23793# Battelle Pacific Northwest Labs., Richland, Wash.
THERMAL ENERGY STORAGE IN AQUIFIERS: PRELIMINARY INFORMATION

R.-D. Allen Dec. 1979 86 p refs

(Contract EY-76-C-06-1830)

(PNL-3062) Avail: NTIS HC A05/MF A01

Topics discussed include conceptual design; numerical modelling; field experiments; relevant technical information, feasibility studies; preliminary aquifer selection considerations; and preliminary design and operating considerations. DOE

N80-23786# United Technologies Research Center, East Hartford, Conn.

PARAMETRIC PERFORMANCE EVALUATION AND TECHNICAL ASSESSMENT OF ADIABATIC COMPRESSED AIR ENERGY STORAGE SYSTEMS Final Report

R. D. Lessard and W. A. Blecher Oct. 1979 157 p refs

Sponsored by Elec. Power Res. Inst.

(EPRI Proj. 1199-1)

(EPRI-EM-1188) Avail: NTIS HC A08/MF A01

An adiabatic compressed air energy storage (ACAES) system, an advanced compressed air energy storage system concept which features thermal energy storage (TES) is discussed. The intermediate pressure hybrid ACAES system (an ACAES system wherein the heat of compression is transferred to the TES at a pressure level substantially below the cavern air storage pressure and which utilizes combustion of some fossil fuel prior to expansion to raise the turbine inlet temperature) was examined for near term commercialization. The level of performance and the level of turbomachinery technology required of an intermediate-pressure hybrid ACAES system are evaluated. DOE

N80-23801# Los Alamos Scientific Lab., N. Mex.

ENERGY STORAGE TECHNOLOGY-ENVIRONMENTAL IMPLICATIONS OF LARGE SCALE UTILIZATION

M. C. Krupka, J. E. Moore, W. E. Keller, G. A. Baca (Los Alamos Tech. Assoc., Inc., N. Mex.), R. I. Brasier (Los Alamos Tech. Assoc., Inc., N. Mex.), and W. S. Benneth (Los Alamos Tech. Assoc., Inc., N. Mex.) 1979 20 p refs Presented at the 2d Intern. Alternative Energy Sources Conf., Miami Beach, Fla.,

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10-13 Dec. 1979

(Contract W-7405-eng-36)

(LA-UR-79-3098; CONF-791204-4)

Avail: NTIS

HC A02/MF A01

Environmental impacts for several energy storage technologies have been identified. State-of-the-art control technology options were similarly identified. Recommendations for research and development on new control technology were made where present controls were either deemed inadequate or non-existent. Specifically, the energy storage technologies under study included: advanced lead-acid battery, compressed air, underground pumped hydroelectric, flywheel, superconducting magnet and various thermal systems (sensible, latent heat and reversible chemical reaction). In addition, a preliminary study was conducted on fuel cell technology. Although not strictly classified as an energy storage system, fuel cells in conjunction with product recycling units can serve an energy storage function. A very large number of potential environmental impacts can be identified for all of these technologies. However, not all are of primary importance. Detailed discussions of a number of environmental impacts from the latest LASL study as they relate to primarily operational situations are emphasized. In addition, a brief discussion on new application for energy storage technologies and the additional costs of controls to be used for mitigation of specific impacts are also presented. DOE

N80-23823# Battelle Pacific Northwest Labs., Richland, Wash. **NUMERICAL ANALYSIS OF TEMPERATURE AND FLOW EFFECTS IN A DRY, TWO-DIMENSIONAL POROUS-MEDIA RESERVOIR USED FOR COMPRESSED AIR ENERGY STORAGE**

L. E. Wiles Oct. 1979 87 p refs

(Contract EY-76-C-06-1830)

(PNL-3047) Avail: NTIS HC A05/MF A01

The hydrodynamics and thermodynamic responses of a compressed air energy storage dry porous media reservoir subjected to simulated air mass cycling were investigated to develop design guidelines for the efficient and stable operation of the air storage reservoir. The analysis and results obtained by two dimensional modeling of dry reservoirs are presented. While the fluid/thermal response of the underground system is dependent on many parameters, the two-dimensional model was applied only to those parameters that entered the analysis by virtue of inclusion of the vertical dimension. In particular, the parameters or responses that were quantified or characterized include well bore heat transfer, heat losses to the vertical boundaries of the porous zone, gravitationally induced flows, producing length of the wellbore, and the effects of nonuniform permeability. The analysis of the wellbore heat transfer included consideration of insulation, preheating (bubble development with heated air), and air mass flow rate. DOE

N80-23824# Mechanical Technology, Inc., Latham, N. Y. **APPLICATION OF MAGNETIC SUSPENSIONS AND FLUID FILM BEARINGS TO ENERGY STORAGE FLYWHEELS**

M. Eusepi, L. Martin, and A. Ray Mar. 1979 168 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7007) Avail: NTIS HC A08/MF A01

The design of a suspension system for the support of a 10 kWh energy storage flywheel, with scaling equations and curves suitable for extending the 10 kWh design to other flywheel sizes up to 100 kWh is presented. The design of a test vehicle suitable for evaluating the final suspension design is included. The first phase of this effort was a concept study in which fluid film bearings for both radial and axial load support and magnet suspensions were examined in several combinations to determine suitability. The concept study is described and includes discussions on flywheel sizing, journal and thrust bearing sizing, magnetic suspension sizing and geometric arrangements. DOE

N80-23832# Oak Ridge Y-12 Plant, Tenn. Fabrication Systems Dept.

OAK RIDGE FLYWHEEL EVALUATION LABORATORY Annual Report, 1 Apr. - 30 Sep. 1979

R. S. Steele, Jr., J. M. Casstevens, and B. J. Sutton Dec. 1979 29 p refs

(Contracts W-7405-eng-48; W-7405-eng-26)

(Y-2210) Avail: NTIS HC A03/MF A01

The Oak Ridge Flywheel Evaluation Laboratory (ORFEL) was assembled, and the initial stages of proof testing were completed. The significant accomplishments for the past year included the establishment of adequate full-time personnel; facility modification to reflect the emphasis on flywheel evaluation over simple testing; and the facility proof test involving two aluminum disk flywheels and one composite flywheel. DOE

N80-23851# BDM Corp., Albuquerque, N. Mex. **INVESTIGATION OF THE TECHNICAL AND ECONOMIC FEASIBILITY OF USING PUMPED WELL-WATER ENERGY STORAGE SYSTEMS Final Report**

Dec. 1979 92 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7096; BDM/TAC-79-518-TR-R1) Avail: NTIS HC A05/MF A01

Work completed on the three technical tasks of the project is summarized. The first task included a conceptual/preliminary system design, a selection of potential geographic locations in New Mexico for this system, and a study of relating institutional issues. The second task included a design of the baseline energy storage system with the identification of major components (off the shelf) and their associated performance estimates and a proposed site location within New Mexico. The third task area included an estimate of the capital cost for the storage system (e.g., cost of major components and processes, O and M costs) and an estimate of the potential annual fossil fuel savings. DOE

N80-23861# Yardney Electric Corp., Pawcatuck, Conn. **RESEARCH, DEVELOPMENT AND DEMONSTRATION OF NICKEL-ZINC BATTERIES FOR ELECTRIC VEHICLE PROPULSION Annual Report, 1978**

Oct. 1979 64 p

(Contract W-31-109-eng-38)

(ANL/OEPM-78-12) Avail: NTIS HC A04/MF A01

The work carried on nickel zinc batteries over the past year was directed in three major areas: (1) elucidating the failure modes of the nickel-zinc battery system; (2) improving performance of the system; and (3) effecting a cost reduction program. Progress on the three areas is reported. DOE

N80-24215# Energy Research Corp., Danbury, Conn. **RESEARCH, DEVELOPMENT, AND DEMONSTRATION OF NICKEL-ZINC BATTERIES FOR ELECTRIC VEHICLE PROPULSION Annual Report**

Oct. 1979 139 p

(Contract W-31-109-eng-38)

(ANL/OEPM-78-10) Avail: NTIS HC A07/MF A01

Progress in the nickel electrode development program directed at the optimization of the electrical performance, specifically, in terms of increased cycle life is reported. Pilot plant facilities to produce nickel hydroxide, manufacturing processes to produce nickel hydroxide and the effect of additives upon shape change, cycle performance and on the mechanistic processes involved in the shape change are covered along with a low cost separator which exhibits stability in the electrolyte, has uniform pores which are of a sufficiently small size to impede the growth of zinc dendrites, and exhibits low electrical resistance and good flexibility. The feasibility of sealed cell operation is also examined. Results of accelerated testing are presented. DOE

N80-24216# Department of Energy, Washington, D. C. Office of Transportation Programs.

ELECTRIC AND HYBRID VEHICLE PROGRAM Quarterly Report, Jul. - Sep. 1979

Nov. 1979 27 p

(Contract EC-77-A-31-1044)

(DOE/CS-0026) Avail: NTIS HC A03/MF A01

Progress in U.S. programs on the design, development, production, performance testing, and commercializing of electric and hybrid electric powered vehicles is briefly summarized. DOE

N80-24828# Argonne National Lab., Ill.
ASSESSMENT OF HIGH-HEAD TURBOMACHINERY FOR UNDERGROUND PUMPED HYDROELECTRIC STORAGE PLANTS

S. W. Tam, A. A. Frigo, and C. A. Blomquist 1979 18 p refs Presented at the 2nd Miami Intern. Conf. on Alternative Energy Sources, Coral Gables, Fla., 10-13 Dec. 1979

(Contract W-31-109-eng-38)

(CONF-791204-11) Avail: NTIS HC A02/MF A01

The costs for underground pumped hydroelectric storage (UPHS) plants equipped with advanced single and two stage reversible pumped turbines for operating heads from 500 to 1500 m are considered. The effects of machinery costs, operating heads, plant configurations and sizes are included. The results indicate that the use of advanced machinery seems to push the minimum UPHS plant cost to heads greater than 1500 m. The employment of advanced reversible pump turbines seems to be economically attractive. It is shown that pump-turbine efficiencies and the so-called charge/discharge ratio are very important design parameters for UPHS applications and the interactive effects of these parameters have been analyzed. Under certain conditions a pump-turbine option with a higher charge/discharge ratio at the expense of somewhat lower operating efficiency can be desirable.

DOE

N80-24837# Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

ASSESSMENT OF CRUDE OIL AND REFINED PETROLEUM PRODUCT QUALITY DURING LONG-TERM STORAGE Final Interim Report, Jun. 1978 - Dec. 1979

L. L. Stavinoha, J. N. Bowden, S. R. Westbrook, and H. N. Giles (DOE, Washington, D.C.) Dec. 1979 70 p refs

(Contracts DAAK70-78-C-0001; DAAK70-80-C-0001;

EL-78-A-01-2815)

(AD-A082365; AFLRL-121) Avail: NTIS HC A04/MF A01 CSDL 15/3

It is national policy to develop a strategic petroleum reserve of up to one billion barrels of crude oil and refined petroleum products to lessen U.S. vulnerability to the effects of a severe petroleum supply interruption. A four task program was undertaken to assist in ensuring that products being considered for long term storage would remain of a quality immediately usable and to identify likely quality assurance procedures. This report summarizes the results of this work. The first task reviewed and assessed the state-of-the-art in crude and petroleum product storage. The second task investigated the effect of storage on the quality of finished products. The third task developed a DOE/SPRO computer based search capability for crude oil characterization data. The fourth and final program task consisted of an overall assessment of long term fuel storage, including recommendations for product specifications intended for storage, and test methodology for monitoring selecting product quality.

GRA

N80-24766# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

AN ELECTRIC VEHICLE PROPULSION SYSTEM'S IMPACT ON BATTERY PERFORMANCE: AN OVERVIEW

John M. Bozek, John J. Smithrick, Robert C. Cataldo, and John G. Ewashinka 1980 10 p refs Presented at the 3d Intern. Elec. Vehicle Exposition and Conf., St. Louis, 20-22 May 1980 (Contract EC-77-A-31-1044)

(NASA-TM-81515; DOE/NASA/1044-7; E-459) Avail: NTIS HC A02/MF A01 CSDL 10B

The performance of two types of batteries, lead-acid and nickel-zinc, was measured as a function of the charging and discharging demands anticipated from electric vehicle propulsion systems. The benefits of rapid high current charging were mixed: although it allowed quick charges, the energy efficiency was reduced. For low power (overnight) charging the current wave shapes delivered by the charger to the battery tended to have no effect on the battery cycle life. The use of chopper speed controllers with series traction motors resulted in a significant reduction in the energy available from a battery whenever the motor operates at part load. The demand placed on a battery by an electric vehicle propulsion system containing electrical

regenerative braking confirmed significant improvement in short term performance of the battery. R.E.S.

N80-24803# Sandia Labs., Albuquerque, N. Mex.
BATTERIES FOR SPECIFIC SOLAR APPLICATIONS: PROJECT DESCRIPTION

1979 47 p Presented at the Photovoltaic/Battery Storage Meeting, Albuquerque, N. Mex., 26-27 Jul. 1979

(Contract EY-76-C-04-0789)

(SAND-79-1782C; CONF-790768-1)

Avail: NTIS

HC A03/MF A01

The Sandia Laboratories electrochemical power sources program is outlined. The project is divided into five tasks: (1) battery requirements analysis; (2) laboratory evaluation; (3) photovoltaic advanced systems tests; (4) photovoltaic application experiments; and (5) battery research and development. The status of each task is reviewed. DOE

N80-24810# Battelle Pacific Northwest Labs., Richland, Wash.
COMPRESSED AIR ENERGY STORAGE TECHNOLOGY PROGRAM IN THE UNITED STATES

W. V. Loscutoff 1979 8 p Presented at the Intern. Assembly on Energy Storage, Dubrovnik, Yugoslavia, 26 May - 1 Jun. 1979

(Contract EY-76-C-06-1830)

(PNL-SA-7669; CONF-790515-6)

Avail: NTIS

HC A02/MF A01

The development of compressed air energy storage (CAES) technology is a recognized objective of the United States Department of Energy. The specific objectives are to develop the technology to a level that will permit early commercialization of the concept and to develop advanced CAES systems that will not require any petroleum fuels for operation. The CAES technology research and development program is summarized and a brief set of recommendations on the developments required for the commercialization of the concept is provided. DOE

N80-24886# General Electric Co., Schenectady, N. Y. Chemical Systems and Technology Lab.

THERMAL ENERGY STORAGE SUBSYSTEMS FOR SOLAR HEATING AND COOLING APPLICATIONS: ROLLING CYLINDER THERMAL STORAGE Interim Report

R. F. Thornton and C. S. Herrick Jun. 1979 119 p refs

(Contract EM-78-C-05-5759)

(ORO-5759-T1) Avail: NTIS HC A06/MF A01

The rolling cylinder provides a means for utilizing the latent heat of fusion of salt hydrates for thermal energy storage. Calorimetric tests of laboratory scale rolling cylinders using Glauber's salt have confirmed the technical feasibility of the concept. Several concepts for large scale, one million Btu units were evaluated for heat rate capability, blower and rolling power requirements, and relative cost and manufacturability. Large scale units seem technically and economically viable. The recommended size of the prototype is a two foot diameter, nine foot long cylinder of about 250,000 Btu theoretical capacity.

DOE

N80-25769# Department of Energy, Washington, D. C.

STRATEGIC PETROLEUM RESERVE Annual Report

18 Feb. 1980 86 p

(DOE/RA-0047) Avail: NTIS HC A05/MF A01

Progress on implementing the Strategic Petroleum Reserve (SPR) program is reported. The volume of crude oil in storage through 1979 is 91.7 million barrels, the average cost of which was \$14.00 per barrel. Phase 1 facilities development is described. The total reserve storage capacity is 228 million barrels and will be increased to 248 million barrels by the time Phase 1 is complete. Phase 2 construction goods are described. Changes in the world crude market has forced changes in realistic goals for 1979. Development of improved geotechnical capability for the SPR by interagency, laboratory and contractor support is discussed. The cost control and program management was improved and management disciplines were emphasized in 1979. The Distribution Plan for the SPR utilizing methods of allocation or competitive sale are described. DOE seeks to minimize the effects of SPR purchases on world oil prices and on the availability of supplies for domestic consumption. DOE

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N80-25779* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THERMAL ENERGY STORAGE

Jun. 1980 77 p refs

(Contract EC-77-A-31-1034)

(NASA-TM-81514; E-457; DOE/NASA/1034-8) Avail: NTIS HC A05/MF A01 CSCL 10C

The planning and implementation of activities associated with lead center management role and the technical accomplishments pertaining to high temperature thermal energy storage subsystems are described. Major elements reported are: (1) program definition and assessment; (2) research and technology development; (3) industrial storage applications; (4) solar thermal power storage applications; and (5) building heating and cooling applications.

R.E.S.

N80-25780* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PULSE CHARGING OF LEAD-ACID TRACTION CELLS

John J. Smithrick May 1980 22 p refs

(Contract EC-77-A-31-1044)

(NASA-TM-81513; DOE/NASA/1044-6; E-454) Avail: NTIS HC A02/MF A01 CSCL 10C

Pulse charging, as a method of rapidly and efficiently charging 300 amp-hour lead-acid traction cells for an electric vehicle application was investigated. A wide range of charge pulse current square waveforms were investigated and the results were compared to constant current charging at the time averaged pulse current values. Representative pulse current waveforms were: (1) positive waveform-peak charge pulse current of 300 amperes (amps), discharge pulse-current of zero amps, and a duty cycle of about 50%; (2) Romanov waveform-peak charge pulse current of 300 amps, peak discharge pulse current of 15 amps, and a duty of 50%; and (3) McCulloch waveform peak charge pulse current of 193 amps, peak discharge pulse current of about 575 amps, and a duty cycle of 94%. Experimental results indicate that on the basis of amp-hour efficiency, pulse charging offered no significant advantage as a method of rapidly charging 300 amp-hour lead-acid traction cells when compared to constant current charging at the time average pulse current value. There were, however, some disadvantages of pulse charging in particular a decrease in charge amp-hour and energy efficiencies and an increase in cell electrolyte temperature. The constant current charge method resulted in the best energy efficiency with no significant sacrifice of charge time or amp-hour output. Whether or not pulse charging offers an advantage over constant current charging with regard to the cell charge/discharge cycle life is unknown at this time.

R.E.S.

N80-25801* Electric Storage Battery Co., Yardley, Pa.
RESEARCH, DEVELOPMENT AND DEMONSTRATION OF LEAD-ACID BATTERIES FOR ELECTRIC VEHICLE PROPULSION Annual Report, 1978

Oct. 1979 106 p refs

(Contract W-31-109-eng-38)

(ANL/OEPM-78-8) Avail: NTIS HC A06/MF A01

The development of two levels of electric vehicle batteries, improved state-of-the-art (ISOA) and advanced is discussed. Two approaches, for the ISOA battery are being considered: one utilizing the flat pasted type plate in common use for present electric vehicle and automotive type batteries and the second utilizing the tubular type positive plate concept presently used in heavy duty industrial applications. Two battery design concepts appear to have the potential of meeting the advancing battery goals. One is tubular positive plate battery and the other is the bipolar type battery.

R.E.S.

N80-25802* Gould, Inc., Rolling Meadows, Ill.
RESEARCH, DEVELOPMENT AND DEMONSTRATION OF NICKEL-ZINC BATTERIES FOR ELECTRIC VEHICLE PROPULSION Annual Report, 1978

Oct. 1979 143 p

(Contract W-31-109-eng-38)

(ANL/OEPM-78-11) Avail: NTIS HC A07/MF A01

The progress towards the demonstration of technical and economic feasibility of the nickel-zinc battery for electric vehicle

propulsion is described. Six major tasks are discussed: separator development; zinc electrode development; product design and analysis; cell/module/battery testing; process development; and pilot plant.

R.E.S.

N80-25803* Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

CONCEPTUAL DESIGN OF ADVANCED CENTRAL RECEIVER POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 4: COMMERCIAL AND PILOT PLANT COST DATA Final Report

Mar. 1979 200 p refs

(Contract EG-77-C-03-1483)

(SAN-1483-1/5; ESG-79-2-Vol-4)

Avail: NTIS

HC A09/MF A01

Cost summaries are presented for the 100 MWe and 281 MWe commercial plants, and a summary for the cost summary data include Nth plant data for the 100 MWe and 281 MWe commercial plants, and a summary for the alternative concept air-rock storage system. The plant costing technique is described in the section discussing the 100 MWe baseline concept.

DOE

N80-25805* Los Alamos Scientific Lab., N. Mex.
SUPERCONDUCTING MAGNETIC ENERGY STORAGE (SMES) PROGRAM Progress Report, 1 Jan. - 31 Dec. 1979

J. D. Rogers, comp. Jan. 1980 30 p refs

(Contract W-7405-eng-36)

(LA-8199-PR) Avail: NTIS HC A03/MF A01

Work on the development of two superconducting magnetic energy storage units is described. One is a 30-MJ unit for use by the Bonneville Power Administration to stabilize power oscillations on their Pacific ac Intertie, and the second is a 1 to 1 GWh unit for use as a diurnal load-leveling device. A contract was placed for the fabrication design of the 30 MJ coil design. Orders were placed for the stabilizing system converter and protective energy dump system, converter transformer, automation of the 4.5 K refrigerator and its installation into a trailer and a trailer mounted heat-rejection system. A third compressor was added to the refrigeration system, and the refrigerator was tested and accepted. The superconductor for the 30 MJ coil was received, tested, and found to be satisfactory. The reference design for the 1 to 10 GWh diurnal load-leveling unit was completed. The summary and recommendations of the study are included.

DOE

N80-25861* Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

HYBRID THERMAL STORAGE WITH WATER Final Report, 1 Sep. 1977 - 10 Nov. 1978

30 Sep. 1979 328 p refs

(Contract EG-77-C-02-4480)

(ESG-DOE-13259) Avail: NTIS HC A15/MF A01

After completion of a state-of-the-art survey, four distinct hybrid system concepts were developed. Two computer codes were developed to model the behavior of hybrid storage devices. A systems model code was also developed to compute the performance of solar heating systems. The systems model yielded results in excellent agreement with TRNSYS code, but required only 5% of the computer time to complete a 1 year simulation. Designs for a unique water tank in a bed of gravel system, using an annular tank, were developed. Three sizes of this design were estimated to be applicable to the majority of residential applications in the United States. It was estimated that the use of these designs could result in a reduction in total cost of a solar heating system of up to 21%. It must be noted that the large uncertainties in the experimental data on which the analysis used in this study was based, and the uncertainties involved in the heat transfer modeling of hybrid systems, are significantly larger than the performance benefits indicated.

DOE

N80-25869* Georgia Univ., Athens. Dept. of Chemistry.
DEVELOPMENT OF A PRACTICAL PHOTOCHEMICAL ENERGY STORAGE SYSTEM. THE NORBORNADIENE-

QUADRICYCLENE ENERGY STORAGE SYSTEM Final Report

Richard R. Hautala, Charles R. Kutaf, and R. Bruce King 15 Aug. 1979 41 p refs

(Contracts EY-76-S-09-0893; DE-AS09-76EV-00893) (SRO-0893-17) Avail: NTIS HC A03/MF A01

The photosensitized conversion of norbornadiene to quadricyclene has been examined as a promising method for storing energy from sunlight. A device based on this reaction requires two steps: (1) energy storage through the sensitized photolysis of norbornadiene to quadricyclene in an endothermic reaction; and (2) energy release through the catalyzed reconversion of quadricyclene to norbornadiene in an exothermic reaction. Both sensitizers and catalysts have been successfully incorporated onto heterogeneous supports, and in several instances these immobilized components perform as well as or better than their homogeneous counterparts. An overview of the scientific progress achieved in each of the areas noted is reported. In addition, the energy capacity of the norbornadiene-quadricyclene system (relative to some typical applications) is assessed and the potential costs associated with this type of photochemical energy storage are analyzed. DOE

N80-26879# Sandia Labs., Albuquerque, N. Mex. PRELIMINARY DEVELOPMENT OF THE BAND TYPE VARIABLE INERTIA FLYWHEEL (BVIF) Final Report

D. G. Ullman Nov. 1979 163 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7089) Avail: NTIS HC A08/MF A01

An energy storage flywheel with variable moment of inertia, combining the functions of energy storage and power control is introduced and discussed. The specific configuration addressed is the band type variable flywheel (BVIF). This hollow shell flywheel is packed with long thin bands of flexible material mounted like the main spring in a watch. The performance equations of this configuration are derived and studied. A proof-of-concept model is described and conclusions are drawn on the BVIF's operational potential. DOE

N80-26900# Midwest Research Inst., Golden, Colo. ANALYSIS OF COMMUNITY SOLAR SYSTEMS FOR COMBINED SPACE AND DOMESTIC HOT WATER HEATING USING ANNUAL CYCLE THERMAL ENERGY STORAGE

F. C. Hooper, J. D. McClenahan, J. D. Cook, F. Baylin, R. Monte, and S. Sillman Jan. 1980 9 p refs Presented at the 2nd Ann. Systems Simulation and Econ. Anal. Conf., San Diego, Calif., 23-25 Jan. 1980 Prepared in cooperation with Toronto Univ., Ontario

(Contract EG-77-C-01-4042)

(SERI/TP-355-570; CONF-800101-20) Avail: NTIS HC A02/MF A01

A simplified design procedure was examined for estimating the storage capacity and collector area for annual-cycle-storage, community solar heating systems in which 100% of the annual space heating energy demand is provided from the solar source for the typical meteorological year. Hourly computer simulations of the performance of these systems were carried out for 10 cities in the United States for 3 different building types and 4 community sizes. These permitted the use of design values for evaluation of a more simplified system sizing method. Results of this study show a strong correlation between annual collector efficiency and two major, location-specific, annual weather parameters: the mean air temperature during daylight hours and the total global insolation on the collector surface. Storage capacity correlates well with the net winter load, which is a measure of the seasonal variation in the total load, a correlation which appears to be independent of collector type. DOE

N80-26201# Minicars, Inc., Goleta, Calif.**NEAR HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM, PHASE 1. APPENDICES A AND B. MISSION ANALYSIS AND PERFORMANCE SPECIFICATION STUDIES REPORT, VOLUME 1**

Oct. 1979 468 p Revised Sponsored in part by DOE

(Contract NAS7-100)

(NASA-CR-163330; JPL-9950-37) HC A20/MF A01 CSCL 13F

Avail: NTIS

The three most promising vehicle use patterns (missions) for the near term electric hybrid vehicle were found to be all-purpose city driving, commuting, and family and civic business. The mission selection process was based principally on an analysis of the travel patterns found in the Nationwide Transportation Survey and on the Los Angeles and Washington, D.C. origin-destination studies data. Travel patterns in turn were converted to fuel requirements for 1985 conventional and hybrid cars. By this means, the potential fuel savings for each mission were estimated, and preliminary design requirements for hybrid vehicles were derived. A.R.H.

N80-26202# Minicars, Inc., Goleta, Calif. NEAR HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM, PHASE 1. APPENDICES C AND D. VOLUME 2 Final Report

Oct. 1979 352 p Sponsored in part by DOE

(Contract NAS7-100)

(NASA-CR-163331; JPL-9950-337; FR-4500-09-79-11) Avail: NTIS HC A16/MF A01 CSCL 13F

Results of tradeoff studies are presented in summary form. Various aspects of the overall vehicle design discussed include selection of the base vehicle, the battery-pack configuration, structural modifications, occupant protection, vehicle dynamics, and aerodynamics. The drivetrain design and integration, power conditioning unit, battery subsystem, control system, environmental system are described. Specifications, weight breakdown, and energy consumption measures, and advanced technology components are included. A.R.H.

N80-26203# General Electric Co., Schenectady, N. Y. NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1. APPENDIX B: DESIGN TRADE-OFF STUDIES Final Report

8 Oct. 1979 204 p refs Prepared for JPL

(Contract JPL-955190)

(NASA-CR-163227; SRD-79-134/3-App-B-Vol-1;

JPL-9950-334-App-B-Vol-1) Avail: NTIS HC A10/MF A01 CSCL 13F

The relative attractiveness of various hybrid/electric power train configurations and electrical and mechanical drive-line components was studied. The initial screening was concerned primarily with total vehicle weight and economic factors and identified the hybrid power train combinations which warranted detailed evaluation over various driving cycles. This was done using a second-by-second vehicle simulation program which permitted the calculations of fuel economy, electricity usage, and emissions as a function of distance traveled in urban and highway driving. Power train arrangement possibilities were examined in terms of their effect on vehicle handling, safety, serviceability, and passenger comfort. A dc electric drive system utilizing a separately excited motor with field control and battery switching was selected for the near term hybrid vehicle. Hybrid vehicle simulations showed that for the first 30 mi (the electric range of the vehicle) in urban driving, the fuel economy was 80 mpg using a gasoline engine and 100 mpg using a diesel engine. In urban driving the hybrid would save about 75% of the fuel used by the conventional vehicle and in combined urban/highway driving the fuel saving is about 50%. J.M.S.

N80-26204# General Electric Co., Schenectady, N. Y. NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1. APPENDIX B: DESIGN TRADE-OFF STUDIES REPORT. VOLUME 2: SUPPLEMENT TO DESIGN TRADE-OFF STUDIES Final Report

8 Oct. 1979 319 p refs Prepared for JPL

(Contract JPL-955190)

(NASA-CR-163228; SRD-79-134/4-App-B-Vol-2;

JPL-9950-334-App-B-Vol-2) Avail: NTIS HC A14/MF A01 CSCL 13F

Results of studies leading to the preliminary design of a hybrid passenger vehicle which is projected to have the maximum potential for reducing petroleum consumption in the near term are presented. Heat engine/electric hybrid vehicle tradeoffs,

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assessment of battery power source, and weight and cost analysis of key components are among the topics covered. Performance of auxiliary equipment, such as power steering, power brakes, air conditioning, lighting and electrical accessories, heating and ventilation is discussed along with the selection of preferred passenger compartment heating procedure for the hybrid vehicle. Waste heat from the engine, thermal energy storage, and an auxiliary burner are among the approaches considered. J.M.S.

N80-26205* General Electric Co., Schenectady, N. Y.
NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1. APPENDIX B: DESIGN TRADE-OFF STUDIES REPORT. VOLUME 3: COMPUTER PROGRAM LISTINGS Final Report

8 Oct. 1979 115 p Prepared for JPL
(Contract JPL-955190)
(NASA-CR-163229: SRD-79-134/5-App-B-Vol-3;
JPL-9950-334-App-B-Vol-3) Avail: NTIS HC A06/MF A01
CSCL 13F

A description and listing is presented of two computer programs: Hybrid Vehicle Design Program (HYVELD) and Hybrid Vehicle Simulation Program (HYVEC). Both of the programs are modifications and extensions of similar programs developed as part of the Electric and Hybrid Vehicle System Research and Development Project. J.M.S.

N80-26206* General Electric Co., Schenectady, N. Y.
NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1 Final Report

8 Oct. 1979 146 p refs. Prepared for JPL
(Contract JPL-955190)
(NASA-CR-163230: SRD-79-134/1: JPL-9950-334) Avail:
NTIS HC A07/MF A01 CSCL 13F

The preliminary design of a hybrid vehicle which fully meets or exceeds the requirements set forth in the Near Term Hybrid Vehicle Program is documented. Topics addressed include the general layout and styling, the power train specifications with discussion of each major component, vehicle weight and weight breakdown, vehicle performance, measures of energy consumption, and initial cost and ownership cost. Alternative design options considered and their relationship to the design adopted, computer simulation used, and maintenance and reliability considerations are also discussed. J.M.S.

N80-26207* General Electric Co., Schenectady, N. Y.
NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1. APPENDIX A: MISSION ANALYSIS AND PERFORMANCE SPECIFICATION STUDIES REPORT Final Report

8 Oct. 1979 136 p refs Prepared for JPL Original contains color illustrations
(Contract JPL-955190)
(NASA-CR-163231: SRD-79-134/2-App-A;
JPL-9950-334-App-A) Avail: NTIS HC A07/MF A01 CSCL
13F

Results of a study leading to the preliminary design of a five passenger hybrid vehicle utilizing two energy sources (electricity and gasoline/diesel fuel) to minimize petroleum usage on a fleet basis are presented. The study methodology is described. Vehicle characterizations, the mission description, characterization, and impact on potential sales, and the rationale for the selection of the reference internal combustion engine vehicle are presented. Conclusions and recommendations of the mission analysis and performance specification report are included. J.M.S.

N80-26208* General Electric Co., Schenectady, N. Y.
NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1. APPENDIX C: PRELIMINARY DESIGN DATA PACKAGE Final Report

8 Oct. 1979 208 p Prepared for JPL
(Contract JPL-955190)
(NASA-CR-163232: SRD-79-134/6-App-C;
JPL-9950-334-App-C) Avail: NTIS HC A10/MF A01 CSCL
13F

The design methodology, the design decision rationale, the vehicle preliminary design summary, and the advanced technology

developments are presented. The detailed vehicle design, the vehicle ride and handling and front structural crashworthiness analysis, the microcomputer control of the propulsion system, the design study of the battery switching circuit, the field chopper, and the battery charger, and the recent program refinements and computer results are presented. J.M.S.

N80-26209* General Electric Co., Schenectady, N. Y.
NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1. APPENDIX D: SENSITIVITY ANALYSIS REPORT Final Report

8 Oct. 1979 55 p refs Prepared for JPL
(Contract JPL-955190)
(NASA-CR-163233: SRD-79-134/7-App-D;
JPL-9950-334-App-D) Avail: NTIS HC A04/MF A01 CSCL
13F

Parametric analyses, using a hybrid vehicle synthesis and economics program (HYVELD) are described investigating the sensitivity of hybrid vehicle cost, fuel usage, utility, and marketability to changes in travel statistics, energy costs, vehicle lifetime and maintenance, owner use patterns, internal combustion engine (ICE) reference vehicle fuel economy, and drive-line component costs and type. The lowest initial cost of the hybrid vehicle would be \$1200 to \$1500 higher than that of the conventional vehicle. For nominal energy costs (\$1.00/gal for gasoline and 4.2 cents/kWh for electricity), the ownership cost of the hybrid vehicle is projected to be 0.5 to 1.0 cents/mi less than the conventional ICE vehicle. To attain this ownership cost differential, the lifetime of the hybrid vehicle must be extended to 12 years and its maintenance cost reduced by 25 percent compared with the conventional vehicle. The ownership cost advantage of the hybrid vehicle increases rapidly as the price of fuel increases from \$1 to \$2/gal. M.G.

N80-26210* Minicars, Inc., Goleta, Calif.
NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM, PHASE 1 Final Report

Jan. 1980 144 p refs Sponsored in part by DOE Prepared for JPL
(Contracts NAS7-100: JPL-955188)
(NASA-CR-163235: JPL-9950-337: FR-4500-01-80) Avail:
NTIS HC A07/MF A01 CSCL 13F

Missions for hybrid vehicles that promise to yield high petroleum impact were identified and a preliminary design, was developed that satisfies the mission requirements and performance specifications. Technologies that are critical to successful vehicle design, development and fabrication were determined. Trade-off studies to maximize fuel savings were used to develop initial design specifications of the near term hybrid vehicle. Various designs were 'driven' through detailed computer simulations which calculate the petroleum consumption in standard driving cycles, the petroleum and electricity consumptions over the specified missions, and the vehicle's life cycle costs over a 10 year vehicle lifetime. Particular attention was given to the selection of the electric motor, heat engine, drivetrain, battery pack and control system. The preliminary design reflects a modified current compact car powered by a currently available turbocharged diesel engine and a 24 kW (peak) compound dc electric motor. A.R.H.

N80-26211* Fiat Research Center, Turin, Italy.
ELECTROCHEMICAL ENERGY STORAGE ON BOARD OF ROAD ELECTRIC VEHICLES

P. Montalenti, G. Brusaglino, M. Marchetto (Fabbrica Italiana Magneti, Marelli), and M. Maja (Inst. di Elettrochimica del Politecnico di Torino) 1979 11 p refs Presented at Intern. Assembly on Energy Storage, Dubrovnik, Yugoslavia, 27 May - 1 Jun. 1979
Avail: NTIS HC A02/MF A01

The use of batteries to power electric vehicles is evaluated in terms of accelerations and maximum speed. A kaline, lead/acid, and high energy density batteries are analyzed for lifetime cycles, weight range, and power density. It is concluded that the lead/acid and Ni/Cd batteries are suitable for immediate application, but improvement in lifetime and reliability for economy is recommended. Future configurations of the Ni/Fe and Ni/Zn batteries

will open the market to urban, suburban and commercial transportation. F.O.S.

N80-26212* # AiResearch Mfg. Co., Torrance, Calif.
ADVANCED PROPULSION SYSTEM FOR HYBRID VEHICLES Final Report
 L. V. Norrup and A. T. Lintz Jan. 1980 213 p refs
 (Contracts DEN3-91; EC-77-A-31-1044)
 (NASA-CR-159771; DOE/NASA/0091-80/1;
 AiResearch-79-16430) Avail: NTIS HC A10/MF A01 CSDL 13F

A number of hybrid propulsion systems were evaluated for application in several different vehicle sizes. A conceptual design was prepared for the most promising configuration. Various system configurations were parametrically evaluated and compared, design tradeoffs performed, and a conceptual design produced. Fifteen vehicle/propulsion systems concepts were parametrically evaluated to select two systems and one vehicle for detailed design tradeoff studies. A single hybrid propulsion system concept and vehicle (five passenger family sedan) were selected for optimization based on the results of the tradeoff studies. The final propulsion system consists of a 65 kW spark-ignition heat engine, a mechanical continuously variable traction transmission, a 20 kW permanent magnet axial-gap traction motor, a variable frequency inverter, a 386 kg lead-acid improved state-of-the-art battery, and a transaxle. The system was configured with a parallel power path between the heat engine and battery. It has two automatic operational modes: electric mode and heat engine mode. Power is always shared between the heat engine and battery during acceleration periods. In both modes, regenerative braking energy is absorbed by the battery. Author

N80-26213# California Univ., Livermore. Lawrence Livermore Lab.

ENERGY-STORAGE SYSTEMS FOR AUTOMOBILE PROPULSION, 1979 STUDY. VOLUME 3: BATTERY/FLYWHEEL ELECTRIC VEHICLES USING ADVANCED BATTERIES
 M. Schwartz 15 Dec. 1979 58 p refs
 (Contract W-7405-eng-48)
 (UCRL-52841-Vol-3) Avail: NTIS HC A04/MF A01

The effect of applying flywheels to electric vehicles using advanced batteries is determined. The specific energy of the batteries is maximized at the expense of peak power capability to optimize performance when used with flywheels. The characteristics of battery flywheel vehicles are determined and compared to all-battery vehicles subjected to the same range and peak power specifications. Three combinations of vehicle power and range are considered for an SAE J2279aD cycle: 0.026 kW/kg and 120 km; 0.033 kW/kg and 210 km; and 0.049 kW/kg and 400 km. The combination of 0.016 kW/kg and 80 km is used with an SAE J227aC cycle. The batteries considered are lead/acid, Ni/Fe, Ni/Zn, ZnCl₂, LiAl/FeS₂, Na/S(cer), and Na/S(glass). Projected improvements in batteries and flywheels are considered over the next 20 y, based on probable and optimistic performance. The results show that flywheels do not necessarily yield a saving in vehicle mass (or range increase for constant vehicle mass). DOE

N80-26539# Brookhaven National Lab., Upton, N. Y.
HEAT TRANSFER ENHANCEMENT IN METAL HYDRIDE SYSTEMS

M. J. Rosso, Jr. and G. Strickland Dec. 1979 8 p refs
 Presented at the 2nd Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10 Dec. 1979
 (Contract EY-76-C-02-0016)
 (BNL-27347; CONF-791204-27) Avail: NTIS HC A02/MF A01

The Brookhaven National Laboratory, Department of Energy and Environment has been engaged in finding solutions to the engineering problems associated with the storage of hydrogen as metal hydrides - principally iron-titanium hydride. The thermal conductivity in beds of fine particles, whatever their composition, is inherently poor. Attempts to enhance the heat transfer by the addition of small fractions of high conductivity materials in various configurations are described. The results indicate that the form

of the enhancement material rather than its composition is the more critical factor. DOE

N80-26796# Rocketdyne, Canoga Park, Calif.
HIGH ENERGY STORAGE FLYWHEEL TEST PROGRAM Final Report

D. R. Hodson 28 Jan. 1980 148 p refs
 (Contract DAAG53-75-C-0278)
 (AD-A083302; RI/RD78-207-1) Avail: NTIS HC A07/MF A01 CSDL 10/3

The RS-31 Flywheel System is an energy storage device which is accelerated by an AVCO LYCOMING T55-L-7C 2930 SHP drive engine to 14,506 RPM. The two contra-rotating double disk rotors of the flywheel module have an inertia of 320,176 sq. in.-lbs storing 30 KW-HRS of energy at design speed. This was a Research Development test activity designed to explore and verify design predictions of system performance. GRA

N80-26803# AiResearch Mfg. Co., Torrance, Calif.
HIGH-ENERGY-DENSITY COMPOSITE FLYWHEEL
 David L. Satchwell and Dennis A. Towgood Feb. 1980 113 p refs
 (Contracts EY-76-C-04-0789; AT(29-1)-789)
 (SAND-79-7019) Avail: NTIS HC A06/MF A01

A flywheel was designed and fabricated to demonstrate a high energy density of 80 w-h/kg in the rotor. The rotor design consists of a multiring, subcircular rim made of S-glass/epoxy composite and Kevlar/epoxy composite materials and mounted on a spoked hub made of graphite/epoxy composite materials. DOE

N80-26804# Battelle Pacific Northwest Labs., Richland, Wash.
POTENTIAL PETROPHYSICAL AND CHEMICAL PROPERTY ALTERATIONS IN A COMPRESSED AIR ENERGY STORAGE POROUS ROCK RESERVOIR

J. A. Stottlemire, R. L. Erikson, and R. P. Smith Oct. 1979 88 p refs
 (Contract EY-76-C-06-1830)
 (PNL-2974) Avail: NTIS HC A05/MF A01

Successful commercialization of compressed air energy storage (CAES) systems depends on long term stability of the underground reservoirs subjected to somewhat unique operating conditions. A discussion on relative importance to CAES of several potential porous media damage mechanisms is presented. In this context, damage is defined as a reduction in intrinsic permeability (measure of air transport capability), a decrease in effective porosity (measure of storage capability), or an increase on elastic and/or inelastic deformation of the porous material. The potential damage mechanisms presented include: (1) disaggregation, (2) particulate plugging, (3) boundary layer viscosity anomalies, (4) inelastic microstructural consolidation, (5) clay swelling and dispersion (6) hydrothermal mineral alteration, (7) oxidation reactions, and (8) well casing corrosion. DOE

N80-26805# Brobeck (William M.) and Associates, Berkeley, Calif.

CONCEPTUAL DESIGN OF A FLYWHEEL ENERGY STORAGE SYSTEM Final Report

Nov. 1979 103 p refs
 (Contract EY-76-C-04-0789)
 (SAND-79-7088; REPT-4500-92-9-R1) Avail: NTIS HC A06/MF A01

A conceptual design of a flywheel energy storage system suitable for on-site interfacing with residential photovoltaic (PV) energy sources was developed. The basic design concept and the general approach to the conceptual design of the energy storage system are described. Cost of the system was determined for production models to be produced in annual quantities up to one hundred thousand for both 10-kWh and 50-kWh capacities, and also for a 10 kWh one-of-a-kind demonstration model. DOE

N80-26840# Argonne National Lab., Ill. Solar Applications Group.
DESIGN AND INSTALLATION MANUAL FOR THERMAL

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ENERGY STORAGE

Roger L. Cole, Kenneth J. Nield, Raymond R. Rohde, and Ronald M. Wolosewicz Jan. 1980 381 p refs
(Contract W-31-109-eng-38)
(ANL-79-15-Ed-2) Avail: NTIS HC A17/MF A01

The design and installation of thermal energy storage in active solar systems is discussed. Both air based and liquid based systems are covered with topics on designing rock beds, tank types, pump and fan selection, installation, costs, and operation and maintenance. Topics relevant to latent heat storage include properties of phase change materials, sizing the storage unit, insulating the storage unit, available systems, and cost. Topics relevant to heating domestic water include safety, single-, and dual-tank systems, domestic water heating with air and liquid based space heating systems, and stand alone domestics hot water systems. Also examined are common problems with storage systems and their solutions, heat transfer fluid properties, economic insulation thickness, heat exchanger sizing, and sample specifications for heat exchangers, wooden rock bins, steel tanks, concrete tanks, and fiberglass reinforced plastic tanks. DOE

N80-26856# Sandia Labs., Livermore, Calif. Materials Science Div.

SIGMA PHASE FORMATION IN ALLOYS FOR SO₂/SO₃ THERMAL ENERGY STORAGE SYSTEMS

D. A. Hughes Feb. 1980 39 p refs
(Contract EY-76-C-04-0789)

(SAND-80-8205) Avail: NTIS HC A03/MF A01

A screening test was completed which identifies the tendency for sigma phase formation in alloys for SO₂/SO₃ thermal energy storage systems. The candidate alloys include austenitic and ferritic stainless steels, Fe-Ni Base, and Ni base alloys. Test specimens were aged for 4,000 hours at ambient temperature, 700, 800, 900, and 1000 C. Aged specimens were tested for Charpy V-notch toughness. Decreases in toughness upon aging correlated well with the observed changes in microstructure. DOE

N80-26862# Department of Energy, Washington, D. C. Div. of Energy Storage Systems.

THERMAL AND MECHANICAL ENERGY-STORAGE PROGRAM, PROJECT SUMMARY DATA FY 1980

1980 196 p Sponsored by DOE

(DOE/CS-0150) Avail: NTIS HC A09/MF A01

The Department of Energy's Division of Energy Storage Systems (STOR) is supporting a broad range of projects to conserve energy and to make possible shifting away from oil and natural gas by developing new and/or improved energy storage systems applicable to central power generation dispersed power generation, solar and waste heat utilization, and vehicle propulsion. These programs include: Thermal Energy Storage; Chemical/Hydrogen Energy Storage; Mechanical and Magnetic Energy Storage; and Underground Energy Storage. Technical and Economic Analysis is supported concurrently to evaluate, competitive energy storage options. This summary report addresses the above categories except for Technical and Economic Analysis. Thermal and Chemical/Hydrogen Energy Storage technologies offer the greatest potential for near term impact of all the storage technologies under development. During FY 80, STOR will commit nearly \$32 million to the Thermal and Mechanical Energy Storage Program. The breakdown of budget authorized funding for FY 1979 and FY 1980 is shown. This publication consists principally of summary sheets for each active project in the Thermal, Chemical/Hydrogen, and Mechanical Energy Storage Program for FY 1979. DOE

N80-26865# Oregon State Univ., Corvallis. School of Oceanography.

EXPOSURE: A NEWSLETTER FOR OCEAN TECHNOLOGISTS, VOLUME 8, NO. 1

Rod Mesecar Mar. 1980 8 p

(AD-A083941) Avail: NTIS HC A02/MF A01 CSCL 10/3

Dramatic progress has been made in the development of high performance batteries in recent years. Much of this development effort has concentrated on lithium-based batteries. The reason for the interest in lithium is that it has the highest

potential of the metals in the electromotive series. Consequently, the theoretical energy density of lithium-based electrochemical couples is higher than other couples. As a result of research and development efforts carried out in industry and in government laboratories, the potential benefits of lithium-based batteries are now being realized in practical hardware. Lithium-sulfur and lithium-halogen couples are being developed for secondary (rechargeable) battery applications and lithium-thionyl chloride, lithium-sulfur dioxide, and lithium-vanadium pentoxide are the better known couples being developed for primary (nonrechargeable) battery applications. Comparisons of two representative examples of lithium battery electrochemistry, namely lithium sulfur dioxide (LiSO₂) and lithium thionyl chloride (LiSOCl₂) are made with other primary battery power sources. GRA

N80-26880# Open Univ., Milton (England). Energy Research Group.

A CHEMICAL HEAT-PUMP/ENERGY STORAGE DEVICE AND ITS APPLICATIONS

Sep. 1978 78 p refs Prepared jointly with Rutherford High Energy Lab., Chilton, England
(Grant SRC-G/RA/5360.4)

(ERG-030) Avail: NTIS HC A05/MF A01; Sec. Energy Res. Group, Milton Keynes, England

A prototype heat-pump was constructed and operated, using sulfuric acid and water as the chemical pair. It achieved a power output of 3.5 kW (this with malfunctioning heat exchangers). The heat-pump chemicals can be reconcentrated either using heat (greater than 120 C) or electricity; in the latter case the chemicals store heat-pumping capacity (with a COP of about 1.5). Thus the chemical heat-pump may find application in conjunction with either waste-heat or off-peak electricity (from nuclear, wind or wave devices at any time other than peak demand time). On the basis of present cost-assumptions, the chemical heat-pump may be immediately cost-effective: using waste heat to provide industrial process heat, using waste heat to provide space-heating and cooling, and as an off-peak heat-pump (reconcentration by electricity). Industrial heat demand in the dairy, bottle washing and brewing industries was analyzed. Author (ESA)

N80-27222*# South Coast Technology, Inc., Santa Barbara, Calif.

THE NEAR-TERM HYBRID VEHICLE PROGRAM, PHASE 1 Final Report

10 Sep. 1979 153 p refs Sponsored by NASA Prepared for JPL

(Contract JPL-955189)

(NASA-CR-163034; JPL-9950-355)

Avail: NTIS

HC A08/MF A01 CSCL 13F

Performance specifications were determined for a hybrid vehicle designed to achieve the greatest reduction in fuel consumption. Based on the results of systems level studies, a baseline vehicle was constructed with the following basic parameters: a heat engine power peak of 53 kW (VW gasoline engine); a traction motor power peak of 30 kW (Siemens 1GV1, separately excited); a heat engine fraction of 0.64; a vehicle curb weight of 2080 kg; a lead acid battery (35 kg weight); and a battery weight fraction of 0.17. The heat engine and the traction motor are coupled together with their combined output driving a 3 speed automatic transmission with lockup torque converter. The heat engine is equipped with a clutch which allows it to be decoupled from the system. A.R.H.

N80-27223*# South Coast Technology, Inc., Santa Barbara, Calif.

MISSION ANALYSIS AND PERFORMANCE SPECIFICATION STUDIES REPORT, APPENDIX A

25 Jan. 1979 177 p refs Sponsored by NASA Prepared for JPL Prepared in cooperation with Gen. Res. Corp., Santa Barbara, Calif.

(Contract JPL-955189)

(NASA-CR-163035; JPL-9950-355)

Avail: NTIS

HC A09/MF A01 CSCL 13F

The Near Term Hybrid Passenger Vehicle Development Program tasks included defining missions, developing distributions

of daily travel and composite driving cycles for these missions, providing information necessary to estimate the potential replacement of the existing fleet by hybrids, and estimating acceleration/gradeability performance requirements for safe operation. The data was then utilized to develop mission specifications, define reference vehicles, develop hybrid vehicle performance specifications, and make fuel consumption estimates for the vehicles. The major assumptions which underlie the approach taken to the mission analysis and development of performance specifications are the following: the daily operating range of a hybrid vehicle should not be limited by the stored energy capacity and the performance of such a vehicle should not be strongly dependent on the battery state of charge. E.D.K.

N80-27224*# South Coast Technology, Inc., Santa Barbara, Calif.

DESIGN TRADEOFF STUDIES AND SENSITIVITY ANALYSIS, APPENDIX B

25 May 1979 251 p refs Sponsored by NASA Prepared for JPL

(Contract JPL-955189)

(NASA-CR-163036; JPL-9950-355-App-B) Avail: NTIS HC A12/MF A01 CSCL 13F

Further work was performed on the Near Term Hybrid Passenger Vehicle Development Program. Fuel economy on the order of 2 to 3 times that of a conventional vehicle, with a comparable life cycle cost, is possible. The two most significant factors in keeping the life cycle cost down are the retail price increment and the ratio of battery replacement cost to battery life. Both factors can be reduced by reducing the power rating of the electric drive portion of the system relative to the system power requirements. The type of battery most suitable for the hybrid, from the point of view of minimizing life cycle cost, is nickel-iron. The hybrid is much less sensitive than a conventional vehicle is, in terms of the reduction in total fuel consumption and resultant decreases in operating expense, to reductions in vehicle weight, tire rolling resistance, etc., and to propulsion system and drivetrain improvements designed to improve the brake specific fuel consumption of the engine under low road load conditions. It is concluded that modifications to package the propulsion system and battery pack can be easily accommodated within the confines of a modified carryover body such as the Ford Ltd. E.D.K.

N80-27225*# South Coast Technology, Inc., Santa Barbara, Calif.

DESIGN TRADEOFF STUDIES AND SENSITIVITY ANALYSIS, APPENDICES B1 - B4

25 May 1979 190 p Sponsored by NASA Prepared for JPL (Contract JPL-955189)

(NASA-CR-163037; JPL-9950-355-App-B1-B4) Avail: NTIS HC A09/MF A01 CSCL 13F

Documentation is presented for a program which separately computes fuel and energy consumption for the two modes of operation of a hybrid electric vehicle. The distribution of daily travel is specified as input data as well as the weights which the component driving cycles are given in each of the composite cycles. The possibility of weight reduction through the substitution of various materials is considered as well as the market potential for hybrid vehicles. Data relating to battery compartment weight distribution and vehicle handling analysis is tabulated. A.R.H.

N80-27226*# South Coast Technology, Inc., Santa Barbara, Calif.

PRELIMINARY DESIGN DATA PACKAGE, APPENDIX C

25 Jul. 1979 239 p refs Sponsored by NASA Prepared for JPL

(Contract JPL-955189)

(NASA-CR-163038; JPL-9950-355-App-C) Avail: NTIS HC A11/MF A01 CSCL 13F

The data and documentation required to define the preliminary design of a near term hybrid vehicle and to quantify its operational characteristics are presented together with the assumptions and rationale behind the design decisions. Aspects discussed include development requirements for the propulsion system, the chassis

system, the body, and the vehicle systems. Particular emphasis is given to the controls, the heat engine, and the batteries. A.R.H.

N80-27227*# South Coast Technology, Inc., Santa Barbara, Calif.

PRELIMINARY DESIGN DATA PACKAGE, APPENDICES C1 AND C2

25 Jul. 1980 202 p refs Sponsored by NASA Prepared for JPL

(Contract JPL-955189)

(NASA-CR-163039; JPL-9950-355-App-C1;

JPL-9950-355-APP-C3) Avail: NTIS HC A10/MF A01 CSCL 13F

The HYBRID2 program which computes the fuel and energy consumption of a hybrid vehicle with a bi-modal control strategy over specified component driving cycles is described. Fuel and energy consumption are computed separately for the two modes of operation. The program also computes yearly average fuel and energy consumption using a composite driving cycle which varies as a function of daily travel. The modelling techniques are described, and subroutines and their functions are given. The composition of modern automobiles is discussed along with the energy required to manufacture an American automobile. The energy required to scrap and recycle automobiles is also discussed. F.O.S.

N80-27230# Army Mobility Equipment Research and Development Center, Fort Belvoir, Va. Electrical Power Lab.

EVA METRO SEDAN ELECTRIC-PROPULSION SYSTEM: TEST AND EVALUATION

E. Eberhart Reimers Sep. 1979 290 p refs

(Contract EC-77-A-31-1042)

(DOE/CS-1042/1) Avail: NTIS HC A13/MF A01

The procedure and results of the performance evaluation of the EVA Metro Sedan (car no.1) variable speed dc chopper motor drive and its three speed automatic transmission are presented. The propulsion systems for a battery powered vehicle manufactured by Electric Vehicle Associates, Valley View, Ohio, was removed from the vehicle, mounted on the programmable electric dynamometer test facility and evaluated with the aid of a HP 3052A Data Acquisition System. Performance data for the automatic transmission, the solid state dc motor speed controller, and the dc motor in the continuous and pulsating dc power mode, as derived on the dynamometer test facility, as well as the entire propulsion system are given. This concept and the system's components were evaluated in terms of commercial applicability, maintainability, and energy utility to establish a design base for the further development of this system or similar propulsion drives. DOE

N80-27231*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HYBRID VEHICLE POTENTIAL ASSESSMENT. VOLUME 7: HYBRID VEHICLE REVIEW

K. O. Leschly 30 Sep. 1979 44 p refs Sponsored by NASA 10 Vol.

(Contract EM-78-I-01-4209)

(NASA-CR-163298; CONS-4209-T1-Vol-7) Avail: NTIS HC A03/MF A01 CSCL 13F

Review of hybrid vehicles built during the past ten years or planned to be built in the near future is presented. An attempt is made to classify and analyze these vehicles to get an overall picture of their key characteristics. The review includes onroad hybrid passenger cars, trucks, vans, and buses. DOE

N80-27232# California Univ., Livermore. Lawrence Livermore Lab.

ENERGY STORAGE SYSTEMS FOR AUTOMOBILE PROPULSION, 1979 STUDY. VOLUME 2: DETAILED REPORT

H. C. Forsberg, C. J. Anderson, E. Behrin, W. Cliff (Battelle Pacific Northwest Lab.), R. Crisp (Arkansas Univ.), C. L. Hudson (Interplan Corp.), L. G. O'Connell, J. S. Payne, R. Renner, and M. D. Schrot 15 Dec. 1979 288 p refs

(Contract W-7405-eng-48)

(UCRL-52841-Vol-2) Avail: NTIS HC A13/MF A01

07 ENERGY STORAGE

The findings of a national multilaboratory study of energy-storage propulsion systems for automobiles are presented, including a technical and cost update for the energy-storage devices and resultant vehicles. In addition, an evaluation methodology is described for national energy and market impact, a manufacturing and service infrastructure study is introduced, and an examination is made of certain specialty markets. The energy-storage device characteristics are projected and the resulting vehicles are evaluated. The systems analyzed included several that were not considered in the 1978 work, and three that had not been previously evaluated: the short-range but high-performance all-electric vehicle; the hydrogen-fuel-cell-powered electric; and the advanced-battery eV, power boosted with an advanced-design, fiber-composite flywheel. DOE

N80-27233# California Univ., Livermore. Lawrence Livermore Lab.

DYNAMIC TESTING OF THE ROADWAY POWERED ELECTRIC VEHICLE (RPEV) SYSTEM

D. D. Davis, C. W. Dease, Ronald I. Wallace, and Carl E. Walter
27 Feb. 1980 17 p refs Presented at the 3d Intern. Elec. Vehicle Exposition and Conf., St. Louis, 20-22 May 1980
(Contract W-7405-eng-48)

(UCRL-83662; CONF-800523-2) Avail: NTIS
HC A02/MF A01

Practicality of the roadway powered electric vehicle (RPEV) system under dynamic operating conditions is being examined. In the RPEV system, energy is electromagnetically coupled without mechanical contact from a powered roadway to electric vehicles. Energy from the roadway can be used for high speed, long range travel, and for replenishing energy stored onboard the vehicles. The stored energy is available for shorter range travel on nonpowered surface streets. The dynamic test system includes a 50 m lane of powered roadway, an ac power source, and an electrically propelled test vehicle equipped with a roadway power pickup, onboard batteries, and instrumentation. The dynamic power coupling system allows up to 16 W of coupled power. Its design is based on results obtained from static prototype tests. Dynamic tests will examine power coupling capacity, system characteristics, vehicle performance, roadway compatibility, and safety. DOE

N80-27523# Argonne National Lab., Ill. Systems Engineering and Technology Group.

HYCSOS: HYDRIDE CONVERSION AND STORAGE SYSTEM SENSITIVITY ANALYSIS

Jeffrey S. Horowitz Sep. 1979 19 p refs
(Contract W-31-109-eng-38)

(ANL/EES-TM-63) Avail: NTIS HC A02/MF A01

The hydride conversion of solar energy system (HYCSOS) chemical heat pump was developed. A computer program was also developed to design a HYCSOS system. Although it is recognized that the program used is not entirely correct, it is felt that studies of this kind are valuable for determining the important parameters of the system design. Results of test studies are discussed. DOE

N80-27814# Defence Research Establishment, Ottawa, (Ontario).
EVALUATION OF THE VERTICAL AXIS WIND TURBINE AT DREO

Howard R. Braun, David J. Bristow, and Sylvia J. Wake Jan. 1980 100 p refs
(AD-A083961; DREO-R-822) Avail: NTIS HC A05/MF A01
CSCL 10/2

A Vertical Axis Wind Turbine-Battery Storage System was installed at the Defence Research Establishment Ottawa (DREO) in December 1975 and was operated for three years. The system was instrumented to control and monitor its operation and performance. This report deals with an evaluation study of a Vertical Axis Wind Turbine-Battery Storage System for a low-power unattended power source. The System's wind turbine, energy-generating and battery-storage system, mechanical drive system, installation, control-circuitry and data-acquisition system are described. Also, a performance-history outlining the problem areas encountered and a data-summary of two years of performance-data acquired during this study are presented. The objective of this study was to assess the System's ability to

provide sixty watts of continuous power. The frequency of mechanical failures, especially in the turbine electrical drive system, made this particular system unsuitable as an unattended power source. It was also concluded that the average annual wind speed in the test location was of insufficient magnitude to provide the specified power output. GRA

N80-27818# Technical Univ. of Denmark, Lyngby. Thermal Insulation Lab.

INVESTIGATION OF HEAT STORAGES WITH SALT HYDRATE AS STORAGE MEDIUM BASED ON THE EXTRA WATER PRINCIPLE

S. Furbo 1980 83 p refs
(EUR-6646-Pt-2) Avail: NTIS (US Sales Only)
HC A05/MF A01; DOE Depository Libraries

Experimental and computational studies of a full scale heat storage with salt hydrate as storage medium and based on the extra water principle are reported. Two different types of full scale heat storage, both making use of an incongruently melting salt hydrate as storage medium and based on the extra water principle, were examined by means of long term experiments. No decrease in the performance of the storages during the long term experiments was observed, and experiences for both storage types are obtained. By means of computer calculations, heat of fusion storage with oil as the heat transfer fluid in direct contact with the storage medium were compared with hot water storage as part of solar heating systems with the Danish Reference Year as a basis. With results of these calculations, examples of economical comparisons between heat of fusion storage and hot water storages are carried out. DOE

N80-28245*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM Final Report

P. Montalenti and R. Piccolo 21 Sep. 1979 143 p refs
(Contract JPL-955197)

(NASA-CR-163219; JPL-9950-330) Avail: NTIS
HC A07/MF A01 CSCL 13F

In order to meet project requirements and be competitive in the 1985 market, the proposed six-passenger vehicle incorporates a high power type Ni-Zn battery, which by making electric-only traction possible, permits the achievement of an optimized control strategy based on electric-only traction to a set battery depth of discharge, followed by hybrid operation with thermal primary energy. This results in a highly efficient hybrid propulsion subsystem. Technical solutions are available to contain energy waste by reducing vehicle weight, rolling resistance, and drag coefficient. Replacing new 1985 full size vehicles of the conventional type with hybrids of the proposed type would result in a U.S. average gasoline saving per vehicle of 1,261 liters/year and an average energy saving per vehicle of 27,133 MJ/year. A.R.H.

N80-28246*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLES DEVELOPMENT PROGRAM. APPENDIX A: MISSION ANALYSIS AND PERFORMANCE SPECIFICATION STUDIES, VOLUME 1 Final Report

M. Traversi and L. A. C. Barbarek (Illinois Inst. of Technology)
20 Apr. 1979 157 p
(Contract JPL-955187)

(NASA-CR-163220; JPL-9950-330) Avail: NTIS
HC A08/MF A01 CSCL 13F

Applicable data was categorized and processed according to vehicle usage and trip parameters with consideration of payload (cargo, people, size) and driving cycles. A mission that maximizes the fuel potential savings for the total 1985 vehicle fleet was selected. Mission requirements that have a bearing on conventional and hybrid vehicle performance and characteristics were identified and formulated and a reference ICE vehicle was selected that meets or exceeds all requirements while maintaining within applicable constraints. Specifications for vehicle performance were established based on mission requirements, mission related vehicle characteristics, and fuel consumption. A.R.H.

N80-28247*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM. APPENDIX A. MISSION ANALYSIS AND PERFORMANCE SPECIFICATION STUDIES. VOLUME 2: APPENDICES Final Report
 M. Traversi and L. A. C. Barbarek (Illinois Inst. of Technology)
 18 May 1979 83 p
 (Contract JPL-955187)
 (NASA-CR-163221; JPL-9950-330) Avail: NTIS
 HC A05/MF A01 CSCL 13F

A handy reference for JPL minimum requirements and guidelines is presented as well as information on the use of the fundamental information source represented by the Nationwide Personal Transportation Survey. Data on U.S. demographic statistics and highway speeds are included along with methodology for normal parameters evaluation, synthesis of daily distance distributions, and projection of car ownership distributions. The synthesis of tentative mission quantification results, of intermediate mission quantification results, and of mission quantification parameters are considered and 1985 in place fleet fuel economy data are included. A.R.H.

N80-28248*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM. APPENDIX B: TRADE-OFF STUDIES, VOLUME 1 Final Report
 M. Traversi and R. Piccolo 11 Jun. 1980 131 p
 (Contract JPL-955187)
 (NASA-CR-163222; JPL-9950-330) Avail: NTIS
 HC A07/MF A01 CSCL 13F

Tradeoff study activities and the analysis process used are described with emphasis on (1) review of the alternatives; (2) vehicle architecture; and (3) evaluation of the propulsion system alternatives; interim results are presented for the basic hybrid vehicle characterization; vehicle scheme development; propulsion system power and transmission ratios; vehicle weight; energy consumption and emissions; performance; production costs; reliability, availability and maintainability; life cycle costs, and operational quality. The final vehicle conceptual design is examined. A.R.H.

N80-28249*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM. APPENDIX C: PRELIMINARY DESIGN DATA PACKAGE, VOLUME 1 Final Report
 R. Piccolo 31 Jul. 1979 259 p
 (Contract JPL-955187)
 (NASA-CR-163223; JPL-9950-330) Avail: NTIS
 HC A12/MF A01 CSCL 13F

The methodology used for vehicle layout and component definition is described as well as techniques for system optimization and energy evaluation. The preliminary design is examined with particular attention given to body and structure; propulsion system; crash analysis and handling; internal combustion engine; DC motor separately excited; Ni-Zn battery; transmission; control system; vehicle auxiliaries; weight breakdown, and life cycle costs. Formulas are given for the quantification of energy consumption and results are compared with the reference vehicle. A.R.H.

N80-28250*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM. APPENDIX B: TRADE-OFF STUDIES. VOLUME 2: APPENDICES Final Report
 M. Traversi and R. Piccolo 15 Jun. 1979 51 p
 (Contract JPL-955187)
 (NASA-CR-163224; JPL-9950-330) Avail: NTIS
 HC A04/MF A01 CSCL 13F

The SPEC '78 computer program which consists of mathematical simulations of any vehicle component and external environment is described as are configuration alternatives for the propulsion system. Preliminary assessments of the fundamental characteristics of the lead-acid and sodium-sulfur batteries

are included and procedures are given for estimating the cost of a new vehicle in mass production. A.R.H.

N80-28251*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM. APPENDIX C: PRELIMINARY DESIGN DATA PACKAGE. VOLUME 2: APPENDICES Final Report
 R. Piccolo 11 Sep. 1979 124 p
 (Contract JPL-955187)
 (NASA-CR-163225; JPL-9950-330) Avail: NTIS
 HC A06/MF A01 CSCL 13F

The design, development, efficiency, manufacturability, production costs, life cycle cost, and safety of sodium-sulfur, nickel-zinc, and lead-acid batteries for electric hybrid vehicles are discussed. Models are given for simulating the vehicle handling quality, and for finding the value of: (1) the various magnetic quantities in the different sections in which the magnetic circuit of the DC electric machine is divided; (2) flux distribution in the air gap and the magnetization curve under load conditions; and (3) the mechanical power curves versus motor speed at different values of armature current. A.R.H.

N80-28252*# Fiat Research Center, Orbassano (Italy).
PHASE 1 OF THE NEAR TERM HYBRID PASSENGER VEHICLE DEVELOPMENT PROGRAM. APPENDIX D: SENSITIVITY ANALYSIS Final Report
 M. Traversi 3 Jul. 1979 50 p
 (Contract JPL-955187)
 (NASA-CR-163226; JPL-9950-330) Avail: NTIS
 HC A03/MF A01 CSCL 13F

Data are presented on the sensitivity of: (1) mission analysis results to the boundary values given for number of passenger cars and average annual vehicle miles traveled per car; (2) vehicle characteristics and performance to specifications; and (3) tradeoff study results to the expected parameters. A.R.H.

08
GENERAL

N80-22846# Department of Energy, Oak Ridge, Tenn. Technical Information Center.

ENERGY INFORMATION DATA BASE CORPORATE AUTHOR ENTRIES, SUPPLEMENT 3 Progress Report, Jun. 1978 - Sep. 1979

Sep. 1979 51 p
(DOE/TIC-4585-R1-Suppl-3) Avail: NTIS HC A04/MF A01

This supplement contains additions to TID-4585-R1 and is intended for use with that publication. Supplements are cumulative from June 1978 until another revision is issued. DOE

N80-22862# Mitre Corp., McLean, Va. METREK Div.
NEW ENGLAND ENERGY DEVELOPMENT SYSTEMS CENTER (NEEDS). AN EXPERIMENT IN UNIVERSITY-INDUSTRY COOPERATIVE RESEARCH. VOLUME 1: SUMMARY OF RESULTS Final Report

Zwi Kohorn Jul. 1979 39 p refs 2 Vol.

(Grant NSF CG-00007)

(PB80-112972; MTR-79W00188-Vol-1; NSF/RA-790260)

Avail: NTIS HC A03/MF A01 CSCL 10A

The organizational structure, operating mechanism, accomplishments, and lessons of the New England Energy Development Systems (NEEDS) Center are reported. The NEEDS was established as an entity to test the effectiveness of Federal cost sharing in stimulating nonfederal investment in university research, and in facilitating the use of research and development results by industry. Twenty-five individual projects are described and categorized as to performance, source of cost sharing, and total project cost. Accomplishments are discussed with respect to (1) linking private sector organizations with universities, (2) simulating cost-sharing from the private-sector, and (3) facilitating use of results. GRA

N80-23685# AEG-Telefunken, Berlin (West Germany). Forschungsinstitut.

DEVELOPMENT OF CURRENT CONVERTERS FOR SWITCHING AND REGULATING TASKS IN ENERGY TECHNOLOGY Final Report

Hans-Peter Beck, Peter Heinmeyer, Detlef Knuth, Werner Lukanz, and Monika Steinwegs Bonn Bundesmin. fuer Forsch. und Technol. Aug. 1979 350 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. und Technol. (BMFT-FB-T-79-12) Avail: NTIS HC A15/MF A01; Fachinformationszentrum Energie, Phys., Math., Eggenstein-Leopoldshafen, West Germany DM 73,10

The design and production of semiconductor switching devices are described. The devices serve as semiconductor power switches in current converting and current regulating applications. Two prototypes were developed, a power switch for 10 MW with a water cooling system and a power switch for 3 MW with an evaporative cooling system. Author (ESA)

N80-24801# Brookhaven National Lab., Upton, N. Y.
LOW-COST GENERAL ENERGY/ANALYTIC INFORMATION SYSTEM

Ann W. Reisman and Jack Allentuck 1979 7 p Presented at the Intern. Conf. on Energy Use Management, Los Angeles, 22 Oct. 1979

(Contract EY-76-C-02-0016)

(BNL-26398; CONF-791009-6)

Avail: NTIS

HC A02/MF A01

Energy planning is frequently complicated by the fact that many countries should not be viewed as single entities, but rather as assemblies of regions. Sub-national regional differences arise from variations in terrain and climate, and demographic and historical patterns as well as combinations of these and

other factors. Planners must consider sub-national regional needs and opportunities in formulating national energy plans. The structure and data requirements for a low cost energy/analytic information system having a regional capability is outlined. The kinds of planning decisions that require energy-information-system support are examined. The information content of an energy information system is summarized and its basic analytic capabilities are described. DOE

N80-24848# United Engineers and Constructors, Inc., Philadelphia, Pa.

ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM: PHASE 1: INITIAL UPDATE Final Report

Dec. 1979 210 p refs

(Contract EN-78-C-02-4954)

(COO-4954-1-Vol-3) Avail: NTIS HC A10/MF A01

Volume 1 describes the EEDB and presents some pertinent update material. The initial appendices make up Volume 2 in which descriptions of the Standard Hypothetical Middletown Sites for nuclear power plants and coal-fired power plants are presented. Additional data in appendices in Volume 2 include information on fuel-cycle work; inflation-free fixed charge rates; capital cost update procedure; and nuclear steam supply system. This Volume 3, contains additional appendices entitled: Practical Target Economics for the Liquid Metal Fast Breeder Reactor Nuclear Power Generating Station; Air-Quality Impact Analysis for determination of the Acceptability of Qualified High and Low-sulfur Coal-fired Facility Designs for the Hypothetical Middletown Site; Synthetic Power Plant Fuels by the Solvent Refined Coal Process; Inflation Free Fuel Cycle Costs for Throwaway and Recycle Cases; Inflated (6%) Fuel Cycle cost for Throwaway and Recycle cases; Inflated (7%) Fuel cost for Throwaway and Recycle Cases; Inflated (8%) Fuel Cycle Costs for Throwaway and Recycle Cases; Fuel Costing Methodology; and Bred-Fuel Scenarios. DOE

N80-25203# Department of Energy, Oak Ridge, Tenn. Technical Information Center.

ENERGY INFORMATION DATA BASE, SERIES TITLES: SUPPLEMENT 7, FEBRUARY 1978 - DECEMBER 1979

Dec. 1979 137 p

(DOE/TIC-4579-R10-Suppl-7) Avail: NTIS HC A07/MF A01

Changes and additions to the authority list for serial titles used by the DOE Technical Information Center are listed. Supplements are cumulative from February 1978 until another revision is issued. DOE

N80-25204# Department of Energy, Oak Ridge, Tenn. Technical Information Center.

ENERGY INFORMATION DATA BASE, CORPORATE AUTHOR ENTRIES: SUPPLEMENT 4, JUNE 1978 - DECEMBER 1979

Dec. 1979 57 p

(DOE/TIC-4585-R1-Suppl-4) Avail: NTIS HC A04/MF A01

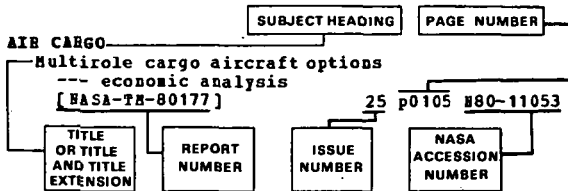
Additions to the authority list for corporate author names are given. Supplements are cumulative from June 1978 until another revision is issued. DOE

SUBJECT INDEX

ENERGY / A Continuing Bibliography (Issue 27)

OCTOBER 1980

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title or title and title extension provides the user with a brief description of the subject matter. The report number helps to indicate the type of document cited (e.g., NASA report, translation, NASA contractor report). The issue page and accession numbers are located beneath and to the right of the title e.g., 25 p0105 N80-11053 Under any subject heading the accession numbers are arranged in sequence with the IAA accession numbers appearing first.

A

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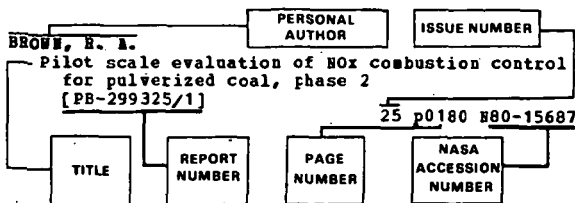
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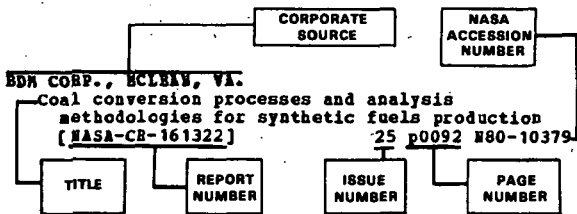
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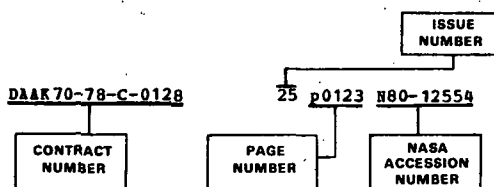
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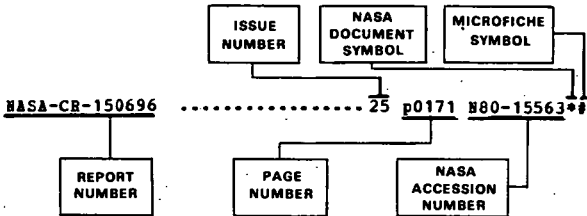
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