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ENERGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

Issue 36

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced between October 1 and December 31, 1982 in

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



Scientific and Technical Information Branch

National Aeronautics and Space Administration

Washington, DC

1983

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INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(36)) lists 1297 reports, journal articles, and other documents announced between October 1, 1982 and December 31, 1982 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.

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 entries are arranged in eight major categories, with *IAA Entries* preceding *STAR Entries* in each category. 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.

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

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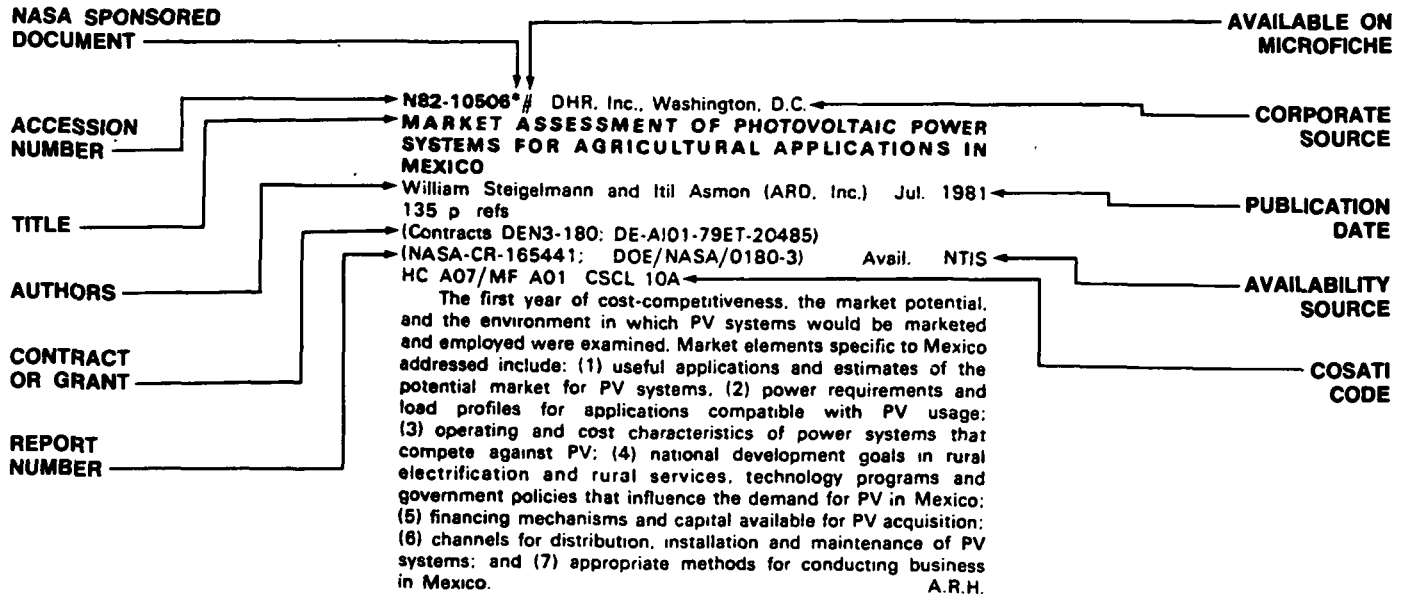
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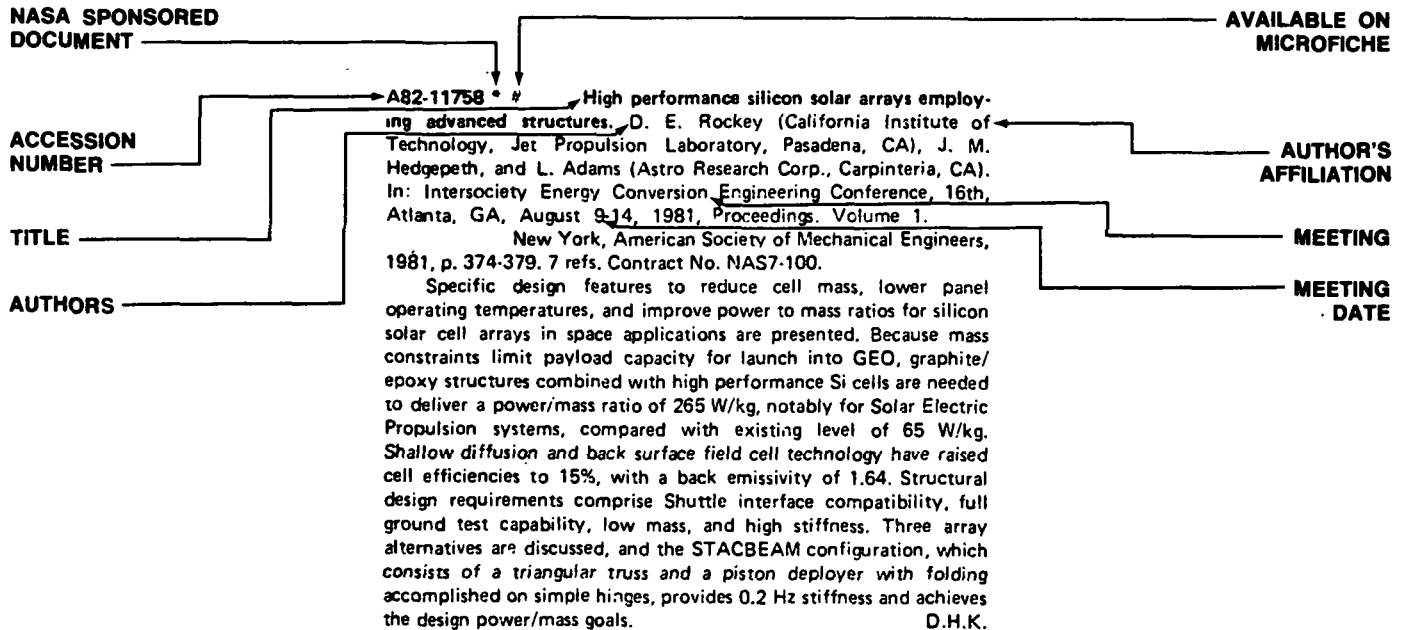
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TYPICAL CITATION AND ABSTRACT FROM IAA



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| 1. Longwall data bank | p138 N82-29679 |
| 2. Direct Energy Conversion, a current awareness bulletin | p175 N82-32860 |

JANUARY 1983

01

ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

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

A82-38109

SMICK - A SCAVENGING MODEL INCORPORATING CHEMICAL KINETICS

D. R. DREWES and J. M. HALES (Battelle Pacific Northwest Laboratories, Richland, WA) *Atmospheric Environment*, vol. 16, no. 7, 1982, p. 1717-1724. Research supported by the Electric Power Research Institute and U.S. Environmental Protection Agency. refs

A scavenging model has been developed as an advanced tool for assessing the wet deposition of reactive gases and aerosols from point-source plumes. The model describes both the microscopic and macroscopic aspects of the plume-rain interaction, and predicts the concentrations of pollutant in rain at ground-level points below the plume. Microscopic interactions treated by the model include simultaneous mass transfer and chemical reaction, both outside and within the falling raindrops. Reversibility is incorporated within the mass-transfer description, thus allowing a realistic treatment of gas scavenging. Application of the model to the washout of SO₂ from power plant plumes, both with and without the assumption of chemical reaction within droplets, is described. These results indicate that sulfate levels found in rainwater below power-plant plumes are not adequately explained by traditional aqueous-phase conversion mechanisms involving oxidation of SO₂ by oxygen, at least when such conversion is limited to the below-cloud region. The model has been documented in user's-manual form, and is suggested for use in the general assessment of deposition impacts of pollution sources, such as fossil power plants. (Author)

A82-38199

DISTRIBUTION PLANNING AND OPERATIONS WITH INTERMITTENT POWER PRODUCTION

F. S. MA and D. H. CURTICE (Systems Control, Inc., Palo Alto, CA) (Institute of Electrical and Electronics Engineers, Winter Meeting, New York, NY, Jan. 31-Feb. 5, 1982.) *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-101, Aug. 1982, p. 2931-2940. refs

The introduction of small-scale dispersed intermittent power production, such as photovoltaic and wind electric generation into distribution systems, will affect distribution system planning and operations. This paper examines the technical and economic impacts on the delivery sources, particularly those problems arising from their intermittent nature. A methodology for distribution planners and operators is presented as a unified framework that assesses the technical and economic impacts on planning and operations. Case studies using distribution system data and renewable resource data from specific utilities are analyzed to gain insights into the technical and economic impacts. The paper concludes with some general observations on how future distribution planning and operating processes may be changed as

the distribution system is integrated with increased intermittent power sources. (Author)

A82-38432

ANALYSIS METHOD FOR NON-SCHEDULABLE GENERATION IN ELECTRIC SYSTEMS

P. M. MORETTI (Oklahoma State University, Stillwater, OK) and B. W. JONES (Kansas State University of Agriculture and Applied Science, Manhattan, KS) *Solar Energy*, vol. 28, no. 6, 1982, p. 499-508. Research supported by the Oklahoma State University. refs

Elements of a cost-benefit analysis of the modification of electrical energy utility system in order to accommodate the introduction of solar and wind electric systems output are presented. A perturbation approach is adopted for the study in order to characterize the average utility load duration, the generation duration, and the kinds of generators using statistical averages, deviations, and variances. The load duration curve and the generation capacity mix are treated as characterizing the system, and total costs and fuel usage are calculated, regarding high cost fuel as a low percentage use item and low-cost fuel, high capital investment equipment as the base load configuration. The addition of unschedulable power was found to imply that base load plants would be most affected, unless wind- or solar-derived electricity meshed well with load curves. The coupling of solar and wind energy conversion systems to storage such as with hydropower is concluded to offer the best possibility for smoothing out differences in the generation-load scenarios. M.S.K.

A82-38462

FUTURE TERMINAL AREA SYSTEMS

P. A. JORGENSEN (Selenia-Industrie Elettroniche Associate S.p.A., Rome, Italy) (*International Federation of Air Traffic Controllers' Associations*, West European Conference, Rome, Italy, Nov. 12-14, 1981.) *The Controller*, vol. 21, May 1982, p. 34, 35. refs

The development of a terminal area computer system able to interface with existing flight management systems is discussed, and this type of system is intended to provide greater fuel conservation and air space capacity, with improved safety during the descent phase of flights. The system must be able to forecast a suitable approach routing, which will allow for a continuous descent of each aircraft, while also providing optimal distribution. Utilizing such a system, a controller would concentrate on monitoring the separation between the aircraft and would only rarely need to intervene in the landing process. Studies are being conducted to determine optimum approach patterns for such a system with regard to fuel conservation, safety and airspace capacity. A graph of the actual measured fuel consumption found for three different patterns - the standard descent profile, the low drag/low power approach, and a low drag/delayed flaps approach - is presented. N.B.

A82-38464

FUEL CONSERVATION: THE AIRLINE - ATC

P. M. GRUNDY *The Controller*, vol. 21, May 1982, p. 39, 40, 47.

The air traffic control system has a greater impact on fuel conservation than any other factor in aviation, the most energy intensive industry in the world. The article discusses various

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

measures that could be adopted by airlines and air traffic controllers to increase fuel conservation. These include: reducing operating empty weights, flying at optimum altitude, direct routing, linear holding, speed control, flight planning, loading for favorable center of gravity to reduce trim drag, minimizing route mileage, and clearance priorities for more fuel demanding aircraft during landing. N.B.

A82-38938#

PNCS - A COMMERCIAL FLIGHT MANAGEMENT COMPUTER SYSTEM

M. W. BIRD (Lear Siegler, Inc., Instrument Div., Grand Rapids, MI) In: Guidance and Control Conference, San Diego, CA, August 9-11, 1982, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1982, p. 113-123. refs (AIAA 82-1515)

The Performance Navigation Computer System (PNCS), a system in which performance optimization, multisensor navigation, automatic guidance, and display techniques have been integrated to provide fuel-efficient operation and a lower workload for the crew is described. The PNCS guidance and flight planning capabilities derive from the integration of the optimum speed and altitude profiles computed by the performance management function with the lateral path and speed/altitude constraints of the flight plan. The performance management functions determine the climb, cruise, and descent profile segments that minimize the total trip cost, while lateral, vertical, and speed commands are fed to the autopilot and autothrottle for automatic guidance to the optimized profile. The navigation data base of the PNCS, which contains airport, route, and navigation aid data, simplifies the selection and modification of flight plans. C.R.

A82-39162

ENVIRONMENTAL PROBLEMS WITH MICROWAVE POWER TRANSFER FROM SATELLITE TO GROUND

Advances in Space Research, vol. 2, no. 3, 1982, p. 94-103.

The environmental effects of the microwave radiation beamed to earth by a proposed solar power satellite are considered. The effects on the public and terrestrial workers, on workers in space and on terrestrial and aquatic ecosystems are discussed in general. Specific attention is given to the tropospheric effects of the microwaves and the intense electromagnetic fields surrounding the receiving rectantenna. These fields would probably be no greater than that produced by a suburban area. The effects on communications systems are now being investigated, including various propagation modes and system degradation models. Preliminary estimates show that functional degradation ranges from a few percent to about a 50 percent increase of threshold values in an average overall operating mode and geographic range. C.D.

A82-39321

FLIGHT MANAGEMENT COMPUTERS [CALCULATEURS DE GESTION DU VOL]

J. GROSSIN (Societe Nationale Industrielle Aerospatiale, Toulouse, France) L'Onde Electrique, vol. 62, June-July 1982, p. 59-66. In French. refs

Flight management computers (FMC) and their role in reducing fuel consumption in commercial aircraft are examined. Research to offset rising fuel costs is concentrating on improving engine efficiency and the aerodynamic performance of the aircraft, and in flight control computers which automate control of flight and systems to the most efficient levels. Implementation of FMC with the Airbus is described, including the retrofit to provide accurate navigation and economical ascent and descent. Flight time at low speed and altitudes is minimized, and systems surveillance and fuel flow are automated. Block diagrams are presented of the systems interconnections with the FMC and the control strategy. Flight plans fed into the FMC yield an optimized flight strategy based on a plan involving lowest cost. The flight is categorized into ascent, cruise, and descent phases. Constraints which can alter the plan consist of changes in altitude to maintain proper

cruise speed, the tempo of the flight in reaching fixed ground reference points, and operational limits of the aircraft. M.S.K.

A82-39496

PRELIMINARY STUDY RESULTS ON POSSIBLE SPACE CONTRIBUTION TO THE SOLUTION OF THE WORLD ENERGY PROBLEMS

C. POHER (Centre National d'Etudes Spatiales, Paris, France) Advances in Earth Oriented Applications of Space Technology, vol. 1, no. 4, 1982, p. 229-233.

With nuclear power being a more likely choice for solving future energy problems in France, the problem arises of the disposal of long term wastes. The reprocessing of wastes is the one possible terrestrial method, but it poses several problems such as the insertion of the waste into fuel rods. The alternative solution is the space disposal of wastes which still requires chemical separation of long and short term wastes and poses a launch risk problem. CNES has made progress toward achieving chemical separation, and it is predicted that this problem as well as the launch risk problem will be nearly solved within 20 years. Also, the Ariane family launchers have the potential to launch wastes economically and with little risk, as the launching pad, in French Guiana, permits aborted missions to land in the ocean. R.K.R.

A82-39540

THE FOURTH DIMENSION

R. L. HEIMBOLD and M. F. LEFFLER (Lockheed-California Co., Burbank, CA) Lockheed Horizons, Summer 1982, p. 24-30.

Problems and solutions for introduction of the Lockheed four-dimensional (4-D) flight management system (FMS) into regular airline traffic are explored. The 4-D system is operated totally by the flight management computer, which directs the plane to appropriate altitudes and speeds for minimum fuel consumption over the entire flight. The altitude is increased as fuel is consumed and the aircraft becomes lighter. Integration of the system into current air traffic involves including accurate wind data, initial estimates of arrival time and options for the flight path, a sufficient capacity for ATC control metering and spacing procedures, and accuracy of high enough order to reduce ATC workloads. Flow integration proceeds 100 mi from the airport and the necessity for a holding pattern results in a revectoring for approach once a go-around has been completed. It is noted that NWS forecasts are inadequate in terms of accuracy of available wind data. M.S.K.

A82-40577#

GEOGRAPHIC/TRANSPORTATIONAL ASPECTS OF THE COMPETITION BETWEEN THE GERMAN FEDERAL RAILWAYS AND PRIVATE AIR TRANSPORT COMPANIES FOR INTERNAL PASSENGER TRAFFIC [DER WETTBEWERB ZWISCHEN DER DEUTSCHEN BUNDESBAHN UND DEN LUFTVERKEHRSGESELLSCHAFTEN IM INNERDEUTSCHEN PERSONENFERNVERKEHR UNTER BERUECKSICHTIGUNG VERKEHRSGEOGRAPHISCHER ASPEKTE]

G. FRISCHKORN Frankfurt am Main, Universitaet, Fachbereich Wirtschaftswissenschaften, Dr. Dissertation, 1979. 252 p. In German. refs

The competition between rail and air traffic systems in the Federal Republic of Germany is discussed. The supply and demand aspects of transportation in this market are analyzed in terms of rail and air networks, and the development of transportation in the general and specific markets is examined. Various criteria for judging the efficiency of rail vs. air are analyzed, including time expenditure, availability, network construction, reliability, punctuality, safety, comfort, energy use, environmental impact, and price. C.D.

A82-40956#

REQUIREMENTS AND TRENDS IN FUEL CONSUMPTION IN TRANSPORT MISSION WITH AIRCRAFT AND SURFACE VEHICLES

G. GABRIELLI In: International Council of the Aeronautical Sciences, Congress, 13th and AIAA Aircraft Systems and Technology Conference, Seattle, WA, August 22-27, 1982, Proceedings. Volume 2. New York, American Institute of Aeronautics and Astronautics, 1982, p. 796-799.

A discussion is presented of the energy utilization factor, f , which relates the payload product of a vehicle, yielded by weight and route distance, to the mechanical energy used. Values of f are presented which have been derived from several hundred sea, land and air vehicles of 15 different types in view of their customary missions. It is demonstrated that turboprop aircraft, and to an even greater degree turbojet aircraft, are the only types of vehicles which offer higher transport speeds without a corresponding reduction in the energy utilization factor. O.C.

A82-40957#

AERODYNAMIC CONCEPTS FOR FUEL-EFFICIENT TRANSPORT AIRCRAFT

G. KRENZ and R. HILBIG (Vereingte Flugtechnische Werke GmbH, Bremen, West Germany) In: International Council of the Aeronautical Sciences, Congress, 13th and AIAA Aircraft Systems and Technology Conference, Seattle, WA, August 22-27, 1982, Proceedings. Volume 2. New York, American Institute of Aeronautics and Astronautics, 1982, p. 800-810. refs

The rapid inflation of jet fuel prices in the last decade contributes largely to the growing operating expenses of the airlines and to a disproportionate share of the Direct Operating Costs (D.O.C.) as well, wherein the fuel share is already dominant. This report describes the influence of the increasing fuel costs on the aircraft design and explains the manner in which the lift/drag ratio as design parameter is steadily increasing in importance compared to the weight. The evaluation of the fundamentals for a new fuel efficient aircraft is a challenge for both, designer and aeronautical research. On the other hand there still exist potentials for performance improvements in terms of L/D for most of the current aircraft in service, as they were generally designed for minimum weight performance. This paper gives examples for aircraft modifications for performance improvement and shows potentials for future designs in the field of aerodynamics. (Author)

A82-40964#

THIRD GENERATION TURBO FANS

J. F. COPLIN (Rolls-Royce, Ltd., Derby, England) In: International Council of the Aeronautical Sciences, Congress, 13th and AIAA Aircraft Systems and Technology Conference, Seattle, WA, August 22-27, 1982, Proceedings. Volume 2. New York, American Institute of Aeronautics and Astronautics, 1982, p. 867-878.

The modular design concept of the RB211 family of turbofan aircraft engines has allowed the progressive improvement of fuel efficiency through refinement of the design of individual components, resulting in gradual increases of optimum pressure and bypass and temperature ratios. The RB211-535E4, which is the latest engine derived from the basic RB211 design and is destined for use by the 757 airliner, incorporates inherent precision tip clearance control, thermal barrier coatings, creep-resistant titanium alloys, supercritical airfoil designs, a single nozzle exhaust, a single stage, wide chord clapperless fan, and three-dimensional core compressor and core turbine designs. Attention is given to the basic research conducted on component efficiency, which involved the use of laser holography and laser anemometry techniques for observing and measuring aerodynamic flow. O.C.

A82-40973#

AIRCRAFT DESIGN FOR FUEL EFFICIENCY

L. O. LEHMAN, D. WOLL, and C. LAMPART (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) In: International Council of the Aeronautical Sciences, Congress, 13th and AIAA Aircraft Systems and Technology Conference, Seattle, WA, August 22-27, 1982, Proceedings. Volume 2. New York, American Institute of Aeronautics and Astronautics, 1982, p. 969-979. refs

U.S. Navy Aircraft Energy Conservation Research, Development, Test and Evaluation Program recommendations to date are presented, with emphasis on those aircraft design approaches which promise the greatest fuel savings for a given level of investment. In addition to design modifications which reduce aerodynamic drag or aircraft weight, attention is given to efficiency-enhancing propulsion system concepts, Flight Performance Advisory/Management Systems which improve mission fuel utilization, and mission planning and training techniques which improve operational effectiveness. The study results cover fighter, attack and patrol aircraft, and includes recommendations for such year 2000 air vehicles as nuclear aircraft and advanced lighter-than-air vehicles. O.C.

A82-41244

SOCIOECONOMIC ASPECTS OF A VALUE ANALYSIS OF WIND ENERGY - ILLUSTRATED FOR THE NETHERLANDS

W. DUB and H. PAPE (Regensburg, Universitaet, Regensburg, West Germany) Energy Sources, vol. 6, no. 3, 1982, p. 245-259. Research supported by the International Energy Agency. refs

A82-41702

THE ECONOMIC IMPORTANCE OF TRIBOLOGY IN THE CONSERVATION OF ENERGY

H. P. JOST In: Tribology: Friction, wear, lubrication. Volume 1 - Abrasive wear, vibration wear, surface treatment, manufacturing operation. Berlin, Springer-Verlag, 1981, p. 9-38. refs

Considerations related to a developing shortage of energy and rising energy costs have led to a number of approaches to decrease energy consumption by conservative measures. In this connection, it appears that possibilities to save energy by reducing the losses due to wear and friction have not sufficiently been taken into account. On the basis of data in a U.S. report, it is concluded that strategies for energy conservation through tribology would make savings of \$40 billion a year possible. A description is presented of specific approaches for achieving these savings. Attention is given to direct savings, indirect savings, savings obtainable without research and development work, savings possible by suitable development work regarding the design of motor vehicles, developments concerning power generation and turbines, and savings through improved performance in manufacturing and process industries. G.R.

A82-41810#

DATA ACQUISITION SYSTEM FOR ENERGY CONSERVATION DEMONSTRATION COMPLEX

D. R. MILLER and G. N. MILLER (Oak Ridge National Laboratory, Oak Ridge, TN) In: International Instrumentation Symposium, 27th, Indianapolis, IN, April 27-30, 1981, Proceedings. Part 2. Research Triangle Park, NC, Instrument Society of America, 1981, p. 577-584. refs

(Contract W-7405-ENG-26)

A data acquisition system (DAS) was developed for unmanned operation at an energy conservation engineering test facility to monitor an Annual Cycle Energy System (ACES) house, a solar wet-plate system house, a standard air-source heat-pump house, and an air-heating-type solar collector in parallel with an air-to-air heat pump experiment. The DAS scans 160 channels each hour and records instantaneous temperature readings, integrated heat flows, weather data, and electric power consumed. The data system comprises standard, commercially available data system components where feasible. Special attention was given to selection of devices yielding high resolution and stability at the liquid flow rates and temperatures typical of such systems. System

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control by a proved computer-controller with an uninterrupted power source has resulted in greater than 99% availability of the DAS. (Author)

A82-41829

A DISTRIBUTED MICROCOMPUTER CONTROL SYSTEM FOR ENERGY MANAGEMENT

K. S. VANGURI and B. HERSHENOV (RCA Laboratories, Princeton, NJ) In: International Instrumentation Symposium, 28th, Las Vegas, NV, May 3-6, 1982, Proceedings. Part 1. Research Triangle Park, NC, Instrument Society of America, 1982, p. 115-123.

It is pointed out that energy shortages and ever increasing energy demands and costs have made the efficient use and conservation of energy a practical necessity. A description is presented of the design and development of a computer-based energy-management system for large commercial multibuilding office complexes. The system was designed as a general purpose distributed computer-control system with potential applications in a number of general areas of factory automation and process control. The system was developed for a specific installation, and developments regarding the use of the system in this installation are examined. G.R.

A82-42091

ADVANCES IN HEAT PIPE TECHNOLOGY; PROCEEDINGS OF THE FOURTH INTERNATIONAL HEAT PIPE CONFERENCE, LONDON, ENGLAND, SEPTEMBER 7-10, 1981

D. A. REAY, (ED.) (International Research and Development Co., Ltd., Newcastle-upon-Tyne, England) Oxford, Pergamon Press, 1981. 755 p \$75

The use of heat pipes in a variety of applications for both terrestrial and spacecraft systems are presented. Topics discussed include the use of heat pipes in thermosyphons, in energy conservation systems, and in spacecraft systems such as heat pipe radiators and power systems. In addition, papers are presented on various aspects of heat pipe theory, and on experimental techniques and life tests used for evaluating the performance characteristics of heat pipes. N.B.

A82-42093

PERFORMANCE CHARACTERISTICS OF GRAVITY-ASSISTED ALUMINUM EXTRUDED HEAT PIPES

I. C. BILEGAN (ICEMENERG, Bucharest, Rumania) and D. FETCU (Brasov, Universitatea, Brasov, Rumania) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 89-94.

Experimental investigation of the heat transfer characteristics of gravity-assisted aluminum extruded heat pipes has been carried out. Relatively high rates of heat transfer have been achieved operating in this manner, with heat pipes containing simple and inexpensive wick and Freon-12 (R-12) as working fluid. The operating temperature, the tilt angle and the length of the heat pipe have been used as parameters. As a result of experimental investigation it can be stated that axial grooved aluminum heat pipes can be used to achieve some inexpensive and compact heat exchangers in waste heat recovery systems at low temperature. (Author)

A82-42103

HEAT PIPE WASTE HEAT RECOVERY BOILERS

D. A. LITWIN and J. MCCURLEY (Q-dot Corp., Dallas, TX) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 213-224.

The use of heat pipes as transport devices in waste heat recovery boilers is examined. Test results show that heat pipes can efficiently extract heat from the hot gas stream and transfer it inside the pressure vessel for the steam generation process. The benefits of incorporating heat pipes into the design of waste heat recovery boilers include a highly compact package, a significant reduction in thermally induced stresses, double isolation

of the steam from the heat source, an extended surface for improved efficiency in heat extraction, improved circulation and stability in the boiling regime, easy cleaning, individually replaceable tubes, and low flue gas pressure drop. N.B.

A82-42105

USE OF WASTE WATER HEAT FOR SUPPLY WATER HEATING BY USE OF HEAT PIPE DIODES

P. BEHRMANN (Dornier System GmbH, Friedrichshafen, West Germany), H. HAEFNER (Daimler-Benz AG, Stuttgart, West Germany), and L. SPEITKAMP In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 235-244.

A hot supply water storage tank, which is heated by waste water heat, has been developed by Dornier System GmbH. Copper heat pipes using water as carrier fluid have been developed for this purpose, which are capable to transfer sufficient heat even at temperatures as low as 10 C. Measurements indicate that up to 90% of the usable waste water heat may be recovered depending on the waste water flow rate and on the complexity of the system. Stratification within the tank allows that more than 75% of the stored energy may be drawn without a significant drop in supply water temperature. (Author)

A82-43076

SMALL POWER PLANTS; SEMINAR ON SMALL POWER PLANTS - TECHNOLOGY AND COST EFFECTIVENESS, TECHNISCHE UNIVERSITAET WIEN, VIENNA, AUSTRIA, JANUARY 15, 16, 1981, REPORTS [KLEINKRAFTWERKE; SEMINAR UEBER KLEINKRAFTWERKE - TECHNIK UND WIRTSCHAFTLICHKEIT, TECHNISCHE UNIVERSITAET WIEN, VIENNA, AUSTRIA, JANUARY 15, 16, 1981, VORTRAEGE]

L. BAUER, (ED.) Vienna, Technische Universitaet Wien (Technische Universitaet Wien, Schriftenreihe. Volume 21), 1981. 334 p. In German.

Progress in the production of small power plants is discussed. The topics considered include small power plants in Switzerland, the BRD, and Hungary, and the use of nontraditional energy sources in the USSR. The economic aspects of small power plants are examined, and direct and indirect means of producing solar energy are studied. The direct forms include the Austrian 10-kW plant, while the indirect forms discussed include water and wind power, biomass, hay, biogas, and wood. Unit power plants are discussed along with geothermal energy, heat pumps, the role of systems analysis, and the impact of energy production on the environment. C.D.

A82-43080

GENERAL ASPECTS OF ENERGY PRODUCTION AND ENVIRONMENTAL IMPACT [ENERGIEERZEUGUNG UND UMWELTBEEINFLUSSUNG: ALLGEMEINE GESICHTSPUNKTE]

H. STEINWANDTER (Wien, Technische Universitaet, Vienna, Austria) In: Small power plants; Seminar on Small Power Plants - Technology and Cost Effectiveness, Technische Universitaet Wien, Vienna, Austria, January 15, 16, 1981, Reports. Vienna, Technische Universitaet Wien, 1981, p. 238-279. In German.

A general review of pollution and its effects on the environment is presented. The polluting activities considered include oil and gas drilling, industrial production, and nuclear power, both by fission and fusion. The effect on land use, purity of water and air, and the heat balance are detailed. The air pollutants sulfur dioxide, oxides of nitrogen, carbon dioxide, and dust are individually discussed. The prospects for future energy demand and climate are assessed. C.D.

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A82-43302

ENERGY RESEARCH AND DEVELOPMENT IN THE BRD [ENERGIEFORSCHUNG UND ENTWICKLUNG IN DER BUNDESREPUBLIK DEUTSCHLAND]

V. HAUFF (Bundesministerium fuer Forschung und Technologie, Bonn, West Germany) In: International Solar Forum, 3rd, Hamburg, West Germany, June 24-27, 1980, Plenary Lectures. Duesseldorf, VDI-Verlag, 1981, p. 1-16. In German.

The energy situation in the BRD is reviewed and measures being taken to cope with the problem, especially ongoing research in solar energy, are discussed. The expansion in the use of solar energy is exemplified by the installation of 2500 solar units in the state of Baden-Wuerttemberg in 1979, saving 800 liters of heating oil per year per unit. Cooperation with other countries, including the third world, in the areas of energy conservation and solar research, is discussed, including demonstration projects in Spain, Australia, and Kuwait. The outlook for wind energy, coal production, and energy conservation is projected. C.D.

A82-43303

RAW MATERIALS CYCLES AND ENERGY USE - ANTHROPOGENIC LOADING AND THE LIMITS TO CARRYING CAPACITY [ROHSTOFFKREISLAEUFE UND ENERGIEVERBRAUCH ANTHROPOGENE BELASTUNG UND GRENZEN DER BELASTBARKEIT]

H. SINN In: International Solar Forum, 3rd, Hamburg, West Germany, June 24-27, 1980, Plenary Lectures. Duesseldorf, VDI-Verlag, 1981, p. 17-55. In German.

The interrelation of raw materials cycles with energy use and environmental degradation is explored. The earth's energy balance, the nitrogen and carbon cycles, the various pollutants such as sulfur dioxide, oxides of nitrogen, and particulates and their sources are discussed. Techniques of industrial production of copper that will save energy, conserve raw materials, and reduce pollution, yet retain current levels or even increase output, are described. The effect that increased use of solar energy can have on such trends is quantitatively investigated. C.D.

A82-43304

BASIC ISSUES IN ENERGY POLICY WITH SPECIAL REGARD TO RENEWABLE ENERGY AND ITS PROMOTION BY THE BRD STATES [ENERGIEPOLITISCHE GRUNDSATZFRAGEN - INSBESONDERE REGENERATIVE ENERGIE UND IHRE UNTERSTUETZUNG DURCH DIE BUNDESSTAENDER]

J. WESTPHAL (Schleswig-Holstein Minister fuer Wirtschaft und Verkehr, Kiel, West Germany) In: International Solar Forum, 3rd, Hamburg, West Germany, June 24-27, 1980, Plenary Lectures. Duesseldorf, VDI-Verlag, 1981, p. 56-67. In German.

Ongoing projects in the BRD with the aim of reducing dependence on imported oil are described and discussed. In Schleswig-Holstein expenditures for insulation, heat pumps, and solar units are being made, and the depreciation allowance for their installation has been increased. About 4,000 marks per housing unit involved in the project is being spent, and serious cost problems are foreseen for any expansion in the project. Therefore, further technological improvements are vitally necessary, and various pilot projects are discussed. C.D.

A82-43305

THE ROLE OF CONSERVATION AND RENEWABLE ENERGIES IN MEETING FUTURE ENERGY DEMAND

G. LEACH (International Institute for Environment and Development, London, England) In: International Solar Forum, 3rd, Hamburg, West Germany, June 24-27, 1980, Plenary Lectures.

A82-43586

PRINCIPLES AND PROBLEMS CONCERNING THE DISPOSAL OF NUCLEAR WASTE WITH THE AID OF ASTRONAUTICS [GRUNDLAGEN UND PROBLEME DER ENTSORGUNG NUKLEARER ABFAELLE MIT MITTELN DER RAUMFAHRT]

R. H. SCHMUCKER (Muenchen, Technische Universitaet, Munich; Bayern-Chemie GmbH, Ottobrunn, West Germany) (Hermann-Oberth-Gesellschaft, Raumfahrtkongress, 30th, Garmisch-Partenkirchen, West Germany, Oct. 1-4, 1981.) Astronautik, vol. 19, no. 3, 1982, p. 69-73. In German. refs

Problems concerning the utilization of nuclear technology are mainly concerned with two aspects, including the safe production of energy in nuclear power stations and the safe disposal of the nuclear waste obtained in connection with nuclear energy production. Problems related to a location of nuclear waste deposits on earth could be avoided by a space disposal of nuclear wastes. The present investigation is concerned with the technological and economical feasibility of nuclear waste disposal in space. It is found that cost considerations do not present a very significant factor, because increases in cost arising in connection with a utilization of space flight technology amount only to a few percent of the total energy production and distribution costs. With respect to the technological implementation of the considered solution, there remain many questions which will have to be answered in connection with an experimental study. The decisive factor, however, is related to an acceptance of the nuclear energy option by society. G.R.

A82-44073#

A STUDY ON EMISSION SOURCES OF SELENIUM IN THE ATMOSPHERE

R. KOBAYASHI and Y. HASHIMOTO (Keio University, Yokohama, Japan) Japan Society of Air Pollution, Journal, vol. 17, no. 2, 1982, p. 96-101. In Japanese, with abstract in English. refs

Selenium and sulfur concentration ratios in snow samples, as well as the distribution, enrichment factor, and size distribution of selenium in aerosol samples were investigated in order to study sources of selenium pollution in the atmosphere. The results showed that the average values for the snow samples were 0.13 micrograms/l for selenium and 1.2 mg/l for sulfur. The average selenium to sulfur concentration ratio in snow samples was found to be in the same order of magnitude as those of fuel oils and rubber products. There was also a significant relationship between selenium and vanadium concentrations in the aerosol samples. The enrichment factor of atmospheric selenium to crustal abundance varied from 530 to 2000. The results also suggested that selenium in fine particles originated from chemical processes, while selenium in coarse particles originated from mechanical processes. It is concluded that the emission sources of selenium in aerosol are combustion processes. C.D.

A82-44316#

THERMAL MODELING OF MULTI-ROOM STRUCTURES

A. F. EMERY, C. J. KIPPENHAN, and D. R. HEERWAGEN (Washington, University, Seattle, WA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 151-158. refs

A series of numerical simulations, based upon the nodal network program UWENSOL, was made to predict the hourly thermal response of a typical Pacific Northwest residence and its daily and annual energy requirements. The calculations showed that the response of the house is dependent upon its configuration, the weather and the manner in which the heating or cooling is done. In general, during winter time in the Pacific Northwest it is possible to adequately simulate the house as a collection of thermally independent zones. This eliminates the need to consider the house as a single structure composed of thermally interacting zones and permits the efficient simulation of houses which are architecturally complicated. However, during very hot summer periods, when natural ventilation is used for cooling and the different

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zones have different average temperatures, there is too much energy conducted through the walls to allow the independent zone simulation to be used and the structure must be treated as an entity. (Author)

A82-44340#

EFFECTS OF THE PROVISIONS OF THE CORPORATE AND PERSONAL INCOME TAX CODES ON SOLAR INVESTMENT DECISIONS

M. R. SEDMAK (Booz, Alln and Hamilton, Inc., Washington, DC) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 475-484.

A quantitative analysis is presented of the effects of the present corporate income tax provisions on corporation decisions to invest in solar, and attention is also given to personal tax provisions and individual decisions to invest in solar. The analysis is based on the assumption that corporations make decisions on capital improvements by relying on life-cycle cost comparisons. Attention is given to the ability of existing solar tax credit laws to distort corporate tax laws sufficiently to offset the capital intensive nature of solar equipment. It is noted that accelerated depreciation and interest on borrowed money are both legitimate corporate tax deductions, and analytical examples are provided of factors which two corporations, with strong and weak financial positions, need to consider before investing in solar. It is demonstrated that federal 25% investment tax credits contribute significantly to corporate investment decisions in solar. Finally, existing personal income tax credits are shown to adequately encourage individual use of solar rather than conventionally fueled systems. M.S.K.

A82-45040

ANALYSIS OF MERITS OF HYBRID WIND/PHOTOVOLTAIC CONCEPT FOR STAND-ALONE SYSTEMS

J. A. CASTLE, J. M. KALLIS, S. M. MOITE, and N. A. MARSHALL (Hughes Aircraft Co., Los Angeles, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 738-744.

Methods for evaluating the merits of hybrid wind/photovoltaic systems for use in stand-alone applications were developed. The optimum mix of wind and photovoltaic power with an electrochemical storage system, with or without fossil fuel generator backup, depends upon the individual subsystem economics. A computer code was developed to calculate the optimum subsystem sizes that minimize the levelized energy cost. The actual merits of a hybrid system over a pure photovoltaic or wind system depend upon many factors: load profile; wind regime; insolation; cost and availability of backup power; the relative costs of wind rotor area, array area, and storage; and subsystem efficiency factors. Examples of optimized hybrid systems for a range of photovoltaic costs and estimated wind and storage costs are shown for an Ely, NV, application, where backup power is allowed to supply 5% of the total annual load. (Author)

A82-45130

THE SOUTHWEST RESIDENTIAL EXPERIMENT STATION - THE FIRST YEAR

H. S. ZWIBEL and J. F. SCHAEFER (New Mexico Solar Energy Institute, Las Cruces, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1370-1375. Research supported by the Massachusetts Institute of Technology.

A history and status report on the Southwest Residential Experiment Station (SW RES) aimed at instituting residential applications of prototype residence-like photovoltaic systems is given. The three-acre SW RES site has an average annual insolation of 2375 kwhr/sq m, one of the highest in the United States. The eight prototypes under construction are aimed at suitability for the meteorological, cultural, and economic climates

of the southwest, design compatibility with residence design with maintenance for one year after turnkey, and a minimum 100 W preproduction module. Useful information resulting from the program includes the redirection of a 4 kW array reducing costs by a factor of 20, awareness of the interference of Spring winds in handling modules larger than 1 ft x 4 ft, and the fact that white aggregate roofing gravel, south of an optimally tilted array, enhances array performance. In addition, each prototype is instrumented for performance monitoring and is equipped with a residential load simulator capable of dissipating from 0 to 26 kW in 100 watt increments. R.K.R.

A82-45131

V-GROOVE FACETED REFLECTOR FOR ENHANCED MODULE OUTPUT

J. A. AMICK (Exxon Research and Engineering Co., Linden, NJ) and W. T. KURTH (Solar Power Corp., Woburn, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1376-1381.

In the manufacture of present-day photovoltaic modules, single crystal wafers of silicon serve as the starting point. Because of the high cost of the silicon, it is not economical to convert the circular wafers into square or rectangular cells, even though these cells would more nearly fill the available area in a module. Accordingly, a substantial portion, typically 20 to 25%, of the module area is not filled with silicon. Incident light falling on these 'interstitial' regions between cells is largely lost, leading to module inefficiencies. One technique for recovering a portion of the 'lost' light is to use a white, scattering background behind the cells. The cell output can generally be improved by 5 to 10%. The present study is concerned with an improved method of recovering the light falling on the interstitial regions by which nearly 50% increase in cell output has been realized in favorable cases. The method makes use of an optically transparent medium above the cells, and a series of V-groove facets provided in the interstitial regions between cells. G.R.

A82-46893

THE HEALTH CONDITION OF APPARENTLY HEALTHY WORKERS AT OIL-PROCESSING PLANTS [SOSTOIANIE ZDOROV'IA PRAKTICHESKI ZDOROVYKH RABOCHIKH NEFTEPERERABATYVAIUSHCHIKH ZAVODOV]

L. M. KARAMOVA and R. S. OSTROVSKAIA (Nauchno-Issledovatel'skii Institut Gigieny Truda i Profzabolevanii, UFA, USSR) Sovetskoe Zdravookhranenie, no. 7, 1982, p. 9-11. In Russian.

A82-47001#

A SOCIO-ECONOMIC EVALUATION OF THE LUNAR ENVIRONMENT AND RESOURCES. III - SELENOSPHERIC ECONOMICS AND CISLUNAR/TERRESTRIAL MARKET ANALYSIS

K. A. EHRICKE (Space Global Co., La Jolla, CA) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 25 p. refs (IAF PAPER 82-235)

Geosocio-economically useful lunar development requires adoption of a development strategy designed to balance investments and returns as attractively as possible. This paper deals with a systematic approach to developing early and profitable returns through an appropriate investment strategy and through cislunar and terrestrial market research. In addition, long-term aspects are outlined, including the production of helium-3 for terrestrial fusion power plants and of water from fusion products and lunar oxygen. (Author)

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A82-47256

THE FOURTH ENERGY ERA

R. H. NANSEN (Boeing Aerospace Co., Seattle, WA) In: Making space work for mankind; Proceedings of the Nineteenth Space Congress, Cocoa Beach, FL, April 28-30, 1982. Cape Canaveral, FL, Canaveral Council of Technical Societies, 1982, p. 1-39 to 1-49.

The use of energy in world history is reviewed, and alternative energy futures are assessed. The eras of wood and coal energy belong to the past, and the present energy crisis indicates that the era of oil energy is coming to an end. Possible modes of meeting the energy need of the future are briefly assessed, including wind power, biomass energy conversion, geothermal energy, ocean thermal gradient, oceanic wave power, ground solar power, conservation, coal and synthetic fuels, oil, nuclear fission, nuclear fusion, and solar power satellites. The latter three are considered superior because electricity is the final product. The solar power satellite is chosen as the answer to the future energy problem because of considerations of potential abundance, environmental acceptability, great flexibility, and low cost C.D.

A82-47275

PROGRESS IN RENEWABLES

R. L. SAN MARTIN (U.S. Department of Energy, Washington, DC) In: Making space work for mankind; Proceedings of the Nineteenth Space Congress, Cocoa Beach, FL, April 28-30, 1982. Cape Canaveral, FL, Canaveral Council of Technical Societies, 1982, p. 7-24 to 7-28.

This is a status report on progress made in the conduct of eleven Federally-supported renewable energy programs. Considerable progress has been made in the establishment and development of an infrastructure to support sustained growth. Unique technical problems led to the research and development of materials and designs which have achieved energy conversion efficiencies of up to 25% for electricity and 92% for heat in solar thermal systems. Overall, enough real progress has been made to provide a sound technology base upon which renewable energy systems industries can reasonably continue development. (Author)

N82-28377# Johns-Manville Sales Corp., Denver, Colo. Research and Development Center.

EFFECT OF OUTSIDE COMBUSTION AIR ON GAS FURNACE EFFICIENCY Final Report, 18 Sep. 1980 - 15 Oct. 1981

T. E. BRISBANE and K. L. HANCOCK Fort Belvoir, Virginia Army Facilities Engineering Support Agency 15 Oct. 1981 117 p

(Contract DAAK70-78-D-0002)

(AD-A113484; USAFESA-TS-2104) Avail: NTIS HC A06/MF A01 CSDL 13A

Retrofit enclosure of gas furnaces to supply outside combustion and dilution air may save up to 6 percent of natural gas usage in cold climates. The cost effectiveness of this retrofit should be calculated for each opportunity as installed costs will vary widely depending on local building codes and furnace location. A freezing hazard exists for water heaters and lines which might be enclosed with furnace. GRA

N82-28482# Carrier Corp., Syracuse, N.Y. Energy Systems Div. **RESIDENTIAL-SCALE ICE-STORAGE SYSTEM FOR SPACE COOLING**

H. H. HOPKINSON 1981 5 p refs Presented at Ann. Contractors' Rev. Meeting on Thermal and Chem. Storage, Washington, D.C., 14-16 Sep. 1981 (Contract W-7405-ENG-26)

(DE82-000165; CONF-810940-19) Avail: NTIS HC A02/MF A01

Energy load management is a necessity to electrical utilities. Thermal cool storage offers the utility a means of load management. The ice bank approach to thermal energy cool storage offers the most potential for development. Seasonal performance of both full and partial storage systems are studied using a Carrier simulation program. These results form the basis for selection of a system to be developed. A conceptual design was established,

and a marketing and economic study were completed. Seasonal performance of the proposed equipment for several locations are determined by computer simulation. DOE

N82-28491# National Bureau of Standards, Washington, D.C. National Engineering Lab.

ANALYSIS OF DATA FROM THE ENERGY MONITORING AND CONTROL SYSTEM AT THE NORRIS COTTON FEDERAL OFFICE BUILDING

Nov. 1981 98 p refs Sponsored in part by DOE

(PB82-138744; NBSIR-81-2358) Avail: NTIS HC A05/MF A01 CSDL 13A

The Norris Cotton Federal Office Building (NCFOB) was designed to serve as a demonstration and a feasibility test for energy conserving building features. A building energy monitoring and control system was operated as a data acquisition system over a 13 month period ending in September 1980. Experience encountered during the checkout and operation of the system is discussed. Results from data reduction procedures used to calculate approximately 160 parameters describing the energy performance of the building are presented on a monthly basis. Hourly data are also presented for daily building operation profiles, building envelope performance, and performance of the mechanical systems. Author (GRA)

N82-28547# SRI International Corp., Menlo Park, Calif.

IMPACT OF ADVANCED POWER SEMICONDUCTOR SYSTEMS ON UTILITIES AND INDUSTRY Final Report

D. P. MASHER and J. S. SMITH Palo Alto, California Electric Power Research Inst. Nov. 1981 103 p refs

(Contract EPRI PROJ. 1201-12)

(DE82-901286; EPRI-EM-2112) Avail: NTIS HC A06/MF A01

The impact that power semiconductors and power conditioning and control (PCC) systems might have on national electrical energy consumption is evaluated. Advanced PCC systems are being incorporated into ac motor drives, lamp ballasts, switching power supplies, and controls for home appliances. Substantial system efficiency improvements are realized when the appropriate PCC system is applied to an existing inefficient process. Three generic PCC systems were identified as having sufficient economic incentives to affect national electrical energy consumption because of their inherent conservation potential. While the potential benefits appear attractive, harmonic currents/voltage, low power factors, and electromagnetic interference generated by PCC systems can lead to a degradation in the present quality of grid power. DOE

N82-28776# Bureau of Mines, Washington, D. C.

BUREAU OF MINES RESEARCH 1981: A SUMMARY OF SIGNIFICANT RESULTS IN MINERAL TECHNOLOGY AND ECONOMICS

J. R. PEDERSON, ed. Dec. 1981 157 p refs

(PB82-159971; BM-SP-8-81) Avail: NTIS HC A08/MF A01 CSDL 081

The Bureau of Mines is responsible for a broad spectrum of programs for meeting the diverse and changing mineral resource needs of the Nation. Bureau program activities are classified into two major functions: (1) Developing new and improved technology that will make the production and processing of minerals more efficient safer and more healthful for mineral workers and the public, and more compatible with a quality environment. (2) Acquiring statistical and economic knowledge related to mineral materials, their availability, production, and use, and performing mineral problem and policy analysis. Significant results in mineral technology and economics, select the scope of the Bureau's mission, and the success with which that mission is being pursued. GRA

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N82-28781# General Accounting Office, Washington, D. C.
PROBABLE IMPACTS OF BUDGETS REDUCTIONS ON THE DEVELOPMENT AND USE OF PHOTOVOLTAIC ENERGY SYSTEMS

26 Mar. 1982 19 p refs

(EMD-82-60) Avail: NTIS HC A02/MF A01

The effects of budget reduction on the development of photovoltaic energy systems are considered. N.W.

N82-28796# California Univ., Livermore. Lawrence Livermore Lab.

STRATEGIES FOR STEAM HANDLING AND H₂S ABATEMENT AT GEOTHERMAL POWER PLANTS IN THE GEYSERS AREA OF NORTHERN CALIFORNIA

W. F. MORRIS and F. B. STEPHENS 5 Aug. 1981 66 p refs
(Contract W-7405-ENG-48)

(DE82-001144; UCRL-53137) Avail: NTIS HC A04/MF A01

Strict limitations on the emission of H₂S from new geothermal power plants in The Geysers area of northern California were imposed by Lake and Northern Sonoma County Air Pollution Control Districts. Lake County, under new source review rules, stipulated that specific technologies should be utilized to limit H₂S emissions to 5 lb/h as a condition for determination of compliance. The status of these technologies as well as other ongoing technology development efforts to conserve steam and abate H₂S are evaluated. DOE

N82-28831# Ball State Univ., Muncie, Ind. Wind Energy Research Team.

DEVELOPMENT OF SLIDE PROGRAM DESCRIBING SITE-SELECTION PROCESS FOR SMALL WIND ENERGY CONVERSION SYSTEMS (SWECS) Semiannual Progress Report

T. OTAWA Dec. 1981 13 p refs

(Contract DE-FG02-81R5-10301)

(DE82-006209; DOE/R5-10301/1) Avail: NTIS HC A02/MF A01

The promotion of better site-selection methods for small wind energy conversion systems (SWECS) is discussed. A slide program is planned which will introduce the general site-selection methods, incorporating the major issues that affect the decision-making process involved in SWECS siting. These major issues are identified as part of the effort to fully examine the state-of-the-art in SWECS siting. DOE

N82-28833# Brookhaven National Lab., Upton, N. Y. Technology and Data Div.

PHOTOVOLTAICS AND ELECTRIC UTILITIES

R. BRIGHT, R. LEIGH, and T. SILLS Dec. 1981 205 p refs
Prepared for Sandia Labs., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789)

(DE82-006994; SAND-81-7027) Avail: NTIS HC A10/MF A01

The long term value of grid connected, residential photovoltaic (PV) systems is determined. The value of the PV electricity is defined as the full avoided cost in accordance with the Public Utilities Regulatory Policies Act of 1978. The avoided cost is computed using a long range utility planning approach to measure revenue requirement changes in response to the time phased introduction of PV systems into the grid. A case study approach to three utility systems is used. The changing value of PV electricity over a twenty year period from 1985 is presented, and the fuel and capital savings due to FY are analyzed. These values are translated into measures of breakeven capital investment under several options of power interchange and pricing. DOE

N82-28837# Atomic Energy of Canada Ltd., Pinawa (Manitoba). Nuclear Research Establishment.

ENERGY IN CANADA. REVIEW AND PERSPECTIVE

R. S. DIXON Dec. 1980 76 p refs In ENGLISH; FRENCH summary

(DE81-700548; AECL-6807; CA8105398) Avail: NTIS (US Sales Only) HC A05/MF A01; DOE Depository Libraries

Canada's historical energy consumption, its current consumption and its likely requirements by the turn of the century are reviewed. It is estimated that at least 50% more energy will be required in the year 2000 than is consumed now, assuming a minimum 2% growth rate in primary energy consumption. Both nonrenewable and renewable energy resources are examined in the light of these energy requirements and the need to substitute alternative energy sources for conventional oil in various end uses. The comparative risks involved in energy production are also reviewed. Most of the increase in energy consumption and the substitution of oil over the next 20 years is likely to be met by conventional energy sources, since indigenous reserves are extensive and the relevant technologies well established. Coal, nuclear and hydro reserves could cover the increase in energy demand until well into the next century, and natural gas reserves are sufficient to bridge the gap during conversion from oil to other energy sources. Nuclear power using advanced fuel cycles and oil from tar sands offer Canada long term security. DOE

N82-28842# California Univ., Riverside. Statewide Air Pollution Research Center.

ATMOSPHERIC CHEMISTRY OF HYDROCARBON FUELS. VOLUME 2: OUTDOOR CHAMBER DATA TABULATIONS, PART 1 Final Report, Mar. 1980 - Sep. 1981

W. P. L. CARTER, P. S. RIPLEY, C. G. SMITH, and J. N. PITTS, JR. Tyndall AFB, Fla. AF Engineering and Services Center
Nov. 1981 336 p 2 Vol.

(Contract F08635-80-C-0086; AF PROJ. 1900)

(AD-A113665; AFESC/ESL-TR-81-53-V-2-P-1) Avail: NTIS HC A15/MF A01 CSCL 04A

A total of 132 single- and multi-day outdoor environmental chamber experiments were conducted, involving nine different aviation and automotive fuels. These included the petroleum-derived JP-4 and JP-8 military aviation fuels, their shale-oil derived analogues, unleaded gasoline, diesel No. 2 fuel, and the experimental high-energy cruise-missile fuels JP-10, RJ-4, and RJ-5. The program was conducted to assess the potential of these fuels to adversely affect air quality. Author

N82-28844# Oak Ridge National Lab., Tenn.

ECOLOGICAL IMPLICATIONS OF AIR POLLUTANTS FROM SYNTHETIC-FUELS PROCESSING

D. S. SHRINER, S. B. MCLAUGHLIN, and G. E. TAYLOR 1981
10 p refs Presented at 3rd Intern. Conf. on Energy Use Management, West Berlin, West Germany, Oct. 26, 1981

(Contract W-7405-ENG-26)

(DE82-002792; CONF-811006-5; PUBL-1787) Avail: NTIS HC A02/MF A01

Determination of potential ecological impacts from air pollutants from synfuels facilities involves four major problem areas: effluent characterization; acute and chronic toxicity of effluents; potential for chemical reaction during atmospheric transport and deposition; and biotransformation and accumulation. Compounds of concern, because of our lack of knowledge about their behavior in the environment, include a variety of organics, reduced sulfur and nitrogen compounds, and certain trace metals. Problems related to air pollutants projected to be released from coal conversion facilities are discussed. An overview is presented of potential process operations. Potential pollutant mixtures are discussed, as are the implications of such mixtures for ecological impacts on a regional scale. DOE

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N82-28845# Oak Ridge National Lab., Tenn.
POTENTIAL COSTS OF COMPLYING WITH EMISSION REGULATIONS FOR AN INDIRECT COAL-LIQUEFACTION PROCESS

S. P. N. SINGH, P. J. JOHNSON, J. F. VILLIERS-FISHER, and R. M. WHAM 1981 9 p refs Presented at the 2nd World Congress of Chem. Eng., Montreal, 4-9 Oct. 1981 (Contract W-7405-ENG-26)

(DE82-001471; CONF-811007-7) Avail: NTIS HC A02/MF A01

Economic assessments were conducted to determine the potential cost of meeting four selected levels of environmental emissions for the Lurgi gasification - ICI methanol synthesis - Mobil MTG indirect coal liquefaction process. Process designs were developed for conceptual plants sited to convert 24,000 tpsd of Wyodak coal into liquids and gaseous products. The results indicate that the stringency of the environmental control levels has a relatively small effect on the ultimate gasoline product price for the environmental constraint levels examined. It would seem to appear that the price likely to be paid to strictly control the release of emissions from coal conversion plants may well be worth the cost of additional deterioration of the environment. T.M.

N82-28846# Tennessee Valley Authority, Muscle Shoals, Ala. Div. of Energy Demonstrations and Technology.
ECONOMICS OF SPRAY-DRYER FGD SYSTEM: THE TWO-STAGE OPEN-LOOP PROCESSES

T. A. BURNETT and W. E. OBRIEN Jun. 1981 139 p refs (Contract EPRI PROJ. 1180-7)

(DE82-900158; EPRI-CS-81-9-LD) Avail: NTIS HC A07/MF A01

Preliminary economics of the two-stage open-loop flue gas desulfurization (FGD) process were determined for both lime and soda ash absorbents. An economic evaluation of a limestone slurry FGD process with an electrostatic precipitator (ESP) for particulate matter removal was included for comparison. The basis was 500-MW power plant burning 3.5% sulfur, 16% ash coal with 90% SO₂ removal and 0.1 lb/MBtu particulate matter emission. DOE

N82-28848# Los Alamos Scientific Lab., N. Mex.
ENVIRONMENTAL AND RADIOLOGICAL SAFETY STUDIES. INTERACTION OF PU-23802 HEAT SOURCES WITH TERRESTRIAL AND AQUATIC ENVIRONMENTS Quarterly Progress Report, 1 Jul. - 25 Sep. 1981

G. M. MATLACK and J. H. PATTERSON Nov. 1981 6 p (Contract W-7405-ENG-36)

(DE82-004681; LA-9070-PR) Avail: NTIS HC A02/MF A01

Information is sought about radioisotope thermoelectric heat sources to improve their safety. Studies of the effects on the heat sources of terrestrial and aquatic environments and also of the effects of the heat sources on various simulated environments are given. Recent data from environmental chamber and aquatic experiments and the present status of the experiments are discussed. DOE

N82-28849# Idaho National Engineering Lab., Idaho Falls.
ZETA POTENTIAL STUDY OF THE WATER TREATMENT OF GEOTHERMAL BRINES

P. M. WIKOFF and D. F. SUCIU Nov. 1981 33 p refs (Contract DE-AC07-76ID-01570)

(DE82-005910; EGG-GTH-5673) Avail: NTIS HC A03/MF A01

Before cooled geothermal fluid is used as a coolant in the operation of a 5MW(e) geothermal pilot power plant, the fluid must be treated to reduce the silica and hardness and to control corrosion. Prior to reinjection, the blowdown is treated to remove the phosphate (one of the corrosion inhibitors added to the system). The zeta potential was studied in order to determine the surface reactions occurring in the flash mixing of the cooled geothermal with magnesium oxide, lime, and polyelectrolyte for silica removal and to determine the optimum polyelectrolyte necessary in the silica reduction system and the reduction of the phosphate in the tower blowdown with ferrous sulfate. A bridging type adsorption occurs in the silica reduction system. The proposed mechanism is described. Between 150 and 250 ppm of magnesium oxide was

necessary to achieve this reduction with one ppm of Betz 1125L. Investigation of the phosphate reduction system showed that a cationic polymer was necessary to achieve good flocculation and settling. DOE

N82-28850# Automation Industries, Inc., Silver Spring, Md. Vitro Labs. Div.

ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK, OCTOBER 1981

Oct. 1981 113 p refs

(Contract DE-AC01-79CS-30027)

(DE82-002706; SOLAR/0010-81/10) Avail: NTIS HC A06/MF A01

Environmental information collected at the sites of the National Solar Data Network is presented in the form of tables for each solar site. The sites are grouped into 12 zones, each of which consists of several adjacent states. The insolation table presents the total, diffuse, direct, maximum, and extraterrestrial radiation for the solar site. It also shows the ratio of total to extraterrestrial radiation as a percent. The temperature table gives the average, daytime, night-time, maximum and minimum ambient temperature and the inlet-water temperature for the site. All of the passive and some of the active sites are equipped with wind sensors which provide information for two wind tables furnishing wind speed and direction. For some sites, a humidity table provides relative humidity for each day. A technical discussion of the instruments and measurements used to obtain these data tables is included. DOE

N82-28871# California Univ., Livermore. Lawrence Livermore Lab.

COMPUTER MODELS TO SUPPORT INVESTIGATIONS OF SURFACE SUBSIDENCE AND ASSOCIATED GROUND MOTION INDUCED BY UNDERGROUND COAL GASIFICATION

B. C. TRENT (Science Applications, Inc.) and R. T. LANGLAND Aug. 1981 39 p refs

(Contract W-7405-ENG-48)

(DE82-004936; UCRL-53029) Avail: NTIS HC A03/MF A01

Surface subsidence induced by underground coal gasification at Hoe Creek, Wyoming, and Centralia, Washington were compared. Calculations with the STEALTH explicit finite difference code match equivalent, implicit finite element method solutions for the removal of underground material. Effects of removing roof material, varying elastic constants, investigating thermal shrinkage, and burning multiple coal seams are studied. A coupled, finite difference continuum rigid block caving code is used to model underground opening behavior. The two methods, numerical and empirical, are most effective when used together. DOE

N82-28912# New Zealand Energy Research and Development Committee, Auckland.

STANDARD WEATHER DATA FOR NEW ZEALAND Final Report

F. N. BLACKWELL May 1981 25 p

(DE82-901427; NZERDC-62) Avail: NTIS (US Sales Only) HC A02/MF A01; DOE Depository Libraries

To accurately predict the performance of air conditioning and other equipment a system was developed to give some indication of hourly weather conditions during a design day. Such a system allows comparison between differing air conditioning systems to considerable accuracy, enables reasonable prediction of energy consumption for a typical year and allows calculation of energy consumption using minimal data and computer time. An algorithm can also be used to predict the performance of cooling equipment, engines and building temperatures. The basis for a weather algorithm, and data on average, minimum, and maximum daily temperatures for each month at various locations in New Zealand and on relative humidities are presented. T.M.

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N82-29057# Los Alamos Scientific Lab., N. Mex.
WEIGHTING FACTORS IN THE DOE-2 COMPUTER PROGRAM
J. F. KERRISK Jun. 1981 85 p refs Sponsored by DOE
(DE81-028593; LA-8886-MS) Avail: NTIS HC A05/MF A01

The DOE-2 computer program uses weighting factors for the calculation of thermal loads and air temperatures in buildings. The weighting factors, which represent parameters in a transfer functions, can be selected from data for typical rooms (precalculated weighting factors) or can be calculated for rooms in the particular building under consideration (custom weighting factors). The method used to calculate-custom weighting factors in DOE-2.1 is described. A preliminary discussion of z transforms and transfer function solutions to differential equations are discussed and a description of how the transfer functions and weighting factors for a room are obtained is presented. Models employed in the calculation of various types of weighting factors are outlined. DOE

N82-29106# Stanford Univ., Calif. Systems Optimization Lab.
PILOT-1980 ENERGY-ECONOMIC MODEL. VOLUME 1: MODEL DESCRIPTION Interim Report
G. B. DANTZIG, B. AVITZHAK, and T. J. CONNOLLY Nov. 1981 322 p refs Sponsored by EPRI
(Contract EPRI PROJ. 652-1)
(DE82-901280; EPRI-EA-2090-VOL-1) Avail: NTIS HC A14/MF A01

PILOT-1980 is a US national energy-economic model that can be used to assess the impact of energy policy decisions and resource availability estimates over the next 40 to 10 years. PILOT's dynamic linear programming formulation allows a full look-ahead capability in a model integrating detailed energy sectors, the general economy, and foreign trade. A utility function measuring consumer's welfare captures price and income substitution effects. The model consists of a detailed description of energy technologies for extraction and conversion of energy resources, linked to a less detailed input-output model of the general economy. An Industrial Energy Services Module uses engineering process-type representations to model demand substitutions in industry, implicitly changing the input-output coefficients. A similar Consumers Energy Services Module gives process-type modeling of demand substitutions in the private sector. The consumers utility function, PILOT's objective function, models price- and income-induced shifts in final demand patterns. DOE

N82-29148# Sargent and Lundy, Engineers, Chicago, Ill.
NON-US ADVANCED LOW-LEVEL RADWASTE TREATMENT SYSTEMS Interim Report
L. C. OYEN and R. F. TUCKER, JR. Sep. 1981 114 p refs
(Contract EPRI PROJ. 1557-1)
(DE82-900852; EPRI-NP-2055) Avail: NTIS HC A06/MF A01

A review of power plant radwaste treatment practices and research in Canada, Japan, Korea and Europe is given. In addition to a review of the available English language literature, visits were made to power plants and research centers in Europe and Japan and to private and government agencies in Korea. The nuclear research centers and power plants which were visited in Japan made use of volume reduction (VR) techniques and on site storage facilities. VR techniques were in use at the two major nuclear research centers in West Germany, and several power plants have made plans to use VR systems. Research on leaching was also being carried out in Japan because they intend to dispose of low level radioactive waste by deep sea disposal. Information concerning the VR systems in Canada included in this report is based on a trip to the Bruce Nuclear Power Development Station in 1977 and on reports and personal communications with Ontario Hydro engineers. The status of the work on radwaste VR systems and radwaste incinerators in the United States is updated along with other significant events concerning VR systems. DOE

N82-29152# Systems Consultants, Inc., Washington, D. C.
ENERGY AND SOLID/HAZARDOUS WASTE
Dec. 1981 238 p refs Prepared in cooperation with Argonne National Lab., Ill.
(Contract DE-AC02-80EV-10154)
(DE82-006964; DOE/EV-10154/2) Avail: NTIS HC A11/MF A01

The past and potential future solid and hazardous waste impacts from energy development are addressed and the major environmental, legislation applicable to solid and hazardous waste generation and disposal are summarized. A glossary of terms and acronyms used to describe and measure solid waste impacts of energy development is included. DOE

N82-29234# Comptroller General of the United States, Washington, D.C.
ELECTRIC VEHICLES: LIMITED RANGE AND HIGH COSTS HAMPER COMMERCIALIZATION
19 Mar. 1982 46 p refs
(EMD-82-38) Avail: NTIS HC A03/MF A01

The state of electric vehicle development is discussed. The readiness and capability of the major automakers to develop and commercialize electric vehicles was assessed. The success of Federal efforts to advance their commercial readiness is also discussed. S.L.

N82-29676*# California Univ., Santa Barbara. Dept. of Geography.
RELATION OF LAND USE/LAND COVER TO RESOURCE DEMANDS
C. CLAYTON Mar. 1981 52 p
(Contract NAG2-20)
(NASA-CR-166369) Avail: NTIS HC A04/MF A01 CSCL 08B

Predictive models for forecasting residential energy demand are investigated. The models are examined in the context of implementation through manipulation of geographic information systems containing land use/cover information. Remotely sensed data is examined as a possible component in this process. B.W.

N82-29711 British Library Lending Div., Boston Spa (England).
STATE OF AND PROSPECTS FOR AUTOMATION OF ENERGY-SUPPLY SOURCES OF IRON AND STEEL INDUSTRY ENTERPRISES
G. Y. KRYUKOV, R. V. LYAMBAKH, L. E. LYASHENKO, and A. D. SERGEEV 5 Jul. 1982 8 p Transl. into ENGLISH from Stal (USSR), v. 4, 1981 p 93-95
(BLLD-M-26558-(5828.4F)) Avail: British Library Lending Div., Boston Spa, Engl.

Automation at various levels of items of the energy management of enterprises belonging to the iron and steel industry is considered in the light of recent developments and the energy-supply situation as a whole. Examples of benefits obtained through automation are given. Author

N82-29712# Regensburg Univ. (West Germany).
WIND TURBINE VALUE ANALYSIS FOR ELECTRIC UTILITIES
W. DUB Jun. 1982 20 p refs Sponsored by International Energy Agency
Avail: NTIS HC A02/MF A01

A methodology for the analysis of the value of large-scale wind turbines to electric utilities, and its application to utility, socioeconomic and meteorological data in two case studies is described. The value analysis was carried out for the year of reference 1985 and included different levels of wind turbine penetration. Results of the value analysis are given. The utility planning procedures in current use and the unique problems of the integration of wind power into the power system are discussed. Observations and conclusions regarding the current and future potential of wind power for utilities are presented. Author

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N82-29715*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

RETROFIT ENERGY CONSERVATION IN RESIDENTIAL BUILDINGS IN SOUTHERN CALIFORNIA

R. H. TURNER, G. C. BIRUR, and C. DAKSLA 15 Jun. 1982
43 p refs Sponsored by NASA and Southern California Edison Co.

(NASA-CR-169137; JPL-PUBL-82-55; NAS 1.26:169137) Avail:
NTIS HC A03/MF A01 CSCL 10A

The common energy conservation techniques (ECTs) that can be retrofit-installed into residential buildings are surveyed. The quantity of saved energy for heating and cooling attributable to each ECT is evaluated for three common modes of heating: natural gas heating at 60/therm; heating via heat pump at \$1.20/therm; and electric resistance heating at \$2.40/therm. In every case, a life cycle cost comparison is made between the long term revenue due to energy conservation and a safe and conventional alternative investment that might be available to the prudent homeowner. The comparison between investment in an ECT and the alternative investment is brought into perspective using the life cycle payback period and an economic Figure of Merit (FOM). The FOM allows for relative ranking between candidate ECTs. Because the entire spectrum of winter heating climates in California is surveyed, the decision maker can determine whether or not a considered ECT is recommended in a given climate, and under what conditions an ECT investment becomes attractive. J.M.S.

N82-29719*# California Univ., Berkeley. Legal Inst. **CURRENT LEGAL AND INSTITUTIONAL ISSUES IN THE COMMERCIALIZATION OF PHOSPHORIC ACID FUEL CELLS Final Report**

J. T. NIMMONS, K. D. SHEEHY, J. R. SINGER, and T. C. GARDNER Jan. 1982 238 p refs
(Contract NAG3-111; DE-AI01-80ET-17088)

(NASA-CR-167867; DOE/NASA/0111-1; NAS 1.26:167867)
Avail: NTIS HC A11/MF A01 CSCL 10A

Legal and institutional factors affecting the development and commercial diffusion of phosphoric acid fuel cells are assessed. Issues for future research and action are suggested. Perceived barriers and potential opportunities for fuel cells in central and dispersed utility operations and on-site applications are reviewed, as well as the general concept of commercialization as applied to emerging energy technologies. Author

N82-29734*# Department of Energy, Washington, D. C. **FEDERAL ENERGY R AND D PRIORITIES. REPORT OF THE RESEARCH AND DEVELOPMENT PANEL, ENERGY RESEARCH ADVISORY BOARD**

Nov. 1981 82 p
(DE82-007065; DOE/TIC-2007065) Avail: NTIS HC A05/MF A01

An assessment of the US Department of Energy's major program areas is presented. This assessment features an evaluation technique in which each member evaluated 49 program areas covering all DOE energy R and D programs in terms of seven criteria for energy supply and conservation programs and five criteria for science and technology base programs. Each member evaluated the relative importance of these criteria and judged whether more, less, or the same amounts of money relative to the President's request for FY 1982 should be allocated to the various programs. The judgements of the members were combined numerically to arrive at figures of merit for each program on the relative priorities of energy echnologies and whether financial allocations to each program should be increased, held the same or decreased relative to the President's request for FY 1982. The resulting figure of merit was used to rank the programs in order of importance. Criteria used in evaluating the priority of each technology were selected and the definitions for each criterion agreed upon were technology potential, urgency, economic potential, benefit/cost, energy/national security, health/safety/environment, and Federal RD and D role. The criteria for the science and technology base programs were scientific

potential, risk/benefit, mission impact, urgency and federal role. A detailed definition of these criteria is given. DOE

N82-29743*# Bechtel Corp., San Francisco, Calif. **ENERGY-SUPPLY PLANNING-MODEL DOCUMENTATION. VOLUME 1: USER MANUAL Final Report**

Sep. 1981 471 p Prepared for Brookhaven National Lab.
(Contract DE-AC02-76CH-00016)

(DE82-006285; BNL-30278-VOL-1) Avail: NTIS HC A20/MF A01

The model modified to address issues of importance to energy planning for developing countries and has been adapted for use in studies for Egypt, Indonesia, Peru, Portugal and South Korea. Computer programs were developed to assist in the adaptation process. The characteristics of the ESPM model are given. The information required to make ESPM applications once the model has been made operational on a computer system is provided. An overview of all the ESPM subprograms, including descriptions of the functions and application of each subprogram is provided. Data input forms, a detailed description of each input, and sample run decks and reports for each subprogram are included. DOE

N82-29751*# California Univ., Livermore. Lawrence Livermore Lab.

LIVERMORE ENERGY POLICY MODEL AND PROJECTIONS OF ENERGY FUTURES FOR THE GAS RESEARCH INSTITUTE

R. CASTLETON Jun. 1981 38 p refs

(Contract W-7405-ENG-48)

(DE82-006054; UCRL-53170) Avail: NTIS HC A03/MF A01

The Energy and Resource Planning Group at the Lawrence Livermore National Laboratory (LLNL) was asked by the Gas Research Institute to evaluate ten of their research projects relative to proposed funding levels for 1982. These energy technology projects included gas from unconventional and synthetic sources as well as utilization technologies. The primary tool used in the evaluation was the LLNL Policy Model (EPM). The report gives background information about the study, the basic assumptions used in the study, and some conclusions, and presents selected supporting results from the EPM runs. DOE

N82-29757*# Oak Ridge National Lab., Tenn. Energy Div. **ENERGY USE FROM 1973 TO 1980: THE ROLE OF IMPROVED ENERGY EFFICIENCY**

E. HIRST, R. W. BARNES, S. M. COHN, K. R. CORUM, D. L. GREENE, D. M. HAMBLIN, G. KULP, D. B. REISTER, and T. A. VINEYARD Dec. 1981 57 p refs

(Contract W-7405-ENG-26)

(DE82-010331; ORNL/CON-79) Avail: NTIS HC A04/MF A01

The post-embargo period is examined in terms of energy use in each of the major sectors: residential and commercial buildings, transportation, and industry. The analysis deals with two issues: what changes occurred in energy use during this period relative to pre-embargo trends, and why these changes occurred. Energy use in 1980 (76 Quads) was substantially lower than pre-embargo trends would suggest (by roughly 20 Quads). About half of this 20 Quad reduction was due to slower growth in economic activity. The remainder was due to improvements in energy efficiency, spurred primarily by rising fuel prices and also by government and utility conservation programs. The 1980 increase in overall energy efficiency (ten Quads) was due primarily to technical efficiency improvements (60%) and secondarily to operational changes (40%). DOE

N82-29763*# Office of Energy Resources, Augusta, Maine. **COMPREHENSIVE ENERGY RESOURCES PLAN**

1981 165 p

(DE82-901889; NP-2901889) Avail: NTIS HC A08/MF A01

Historical trends, current status, and projections of sources and uses of energy in Maine are presented. An overview of conservation opportunities and current programs in four broad categories; residential, commercial/institutional, industrial, and transportation is provided. Cogeneration and district heating are discussed. The potentials and limits for the development of each

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of Maine's major renewable energy resources and some of the current government programs relating to them are discussed. Some of the most significant factors and issues regarding use of nonrenewable energy resources in Maine are described. The potential for energy exchange with Canada is briefly discussed.
DOE

N82-29771# Office of Appropriate Technology, Sacramento, Calif. Community Assistance Group.

LOCAL ENERGY INITIATIVES: A SECOND LOOK. A SURVEY OF CITIES AND COUNTIES, CALIFORNIA, 1981

T. TOMASI 1981 135 p refs Prepared in cooperation with California Energy Commission and Southwest Innovation Group, Inc.

(PB82-152976) Avail: NTIS HC A07/MF A01 CSCL 10A

The energy activities of local government throughout California were surveyed. Published are: a survey of cities and counties, California 1980. The report based on that survey is distributed to all the state's local governments. Local energy initiatives, are extension of the same project.
GRA

N82-29773# National Bureau of Standards, Washington, D.C. National Engineering Lab.

DEVELOPMENT OF AN ENERGY TEST METHOD FOR A DEDICATED WATER-HEATING HEAT PUMP

C. A. WAN, R. L. PALLA, JR., and J. E. HARRIS Jan. 1982 54 p refs Sponsored in part by DOE and ORNL

(PB82-161449; NBSIR-81-2372) Avail: NTIS HC A04/MF A01 CSCL 13A

Test method for measuring the energy consumption of water heaters was modified to include a dedicated water heating heat pump, system equipped with a 50 gallon electric water heater tank. Laboratory tests results and which provided the basis for the test methods used are presented. Tests included determination of recovery efficiency, standby loss, and water heater jacket loss -- all under static or no draw conditions -- and a dynamic test in which water is withdrawn according to a typical use schedule. Energy requirements predicted by the proposed procedure were in good agreement with measured energy consumption for the dynamic test.
GRA

N82-29775# Oak Ridge National Lab., Tenn. Environmental Sciences Div.

ENVIRONMENTAL SCIENCE DIVISION Annual Progress Report, period ending 30 Sep. 1980

S. I. AUERBACH Mar. 1981 234 p refs

(Contract W-7405-ENG-26)

(ORNL-5700; PUBL-1730) Avail: NTIS HC A11/MF A01

Fossil energy systems emphasized development of data for comparative technology assessments. Emphasis continued to shift toward large scale, longer term studies with planning and initiation of pond experiments for assessing effects and fate of synthetic oil spills. Greater efforts were expended in evaluating potential hazards of solid residues with efforts initiated to compare combustion and conversion ashes and to identify the potential role of microbial systems in mobilizing trace elements contained in the residues. The bioaccumulation of Tc under field and small pond conditions provided more realistic concentration factors for regulatory models. More information on the chemistry of Pu in natural waters, the dissolution characteristics of Pu contaminated soil, and the bioaccumulation of the transuranium elements was obtained. Laboratory studies made substantial progress in defining a simple geochemical model for predicting Tc-99 migration from breached repositories. Environmental impact assessments were prepared on specific energy projects regarding nuclear power plants, uranium mines and mills, geothermal power plants and process heat users, oil fired power plants ordered to burn coal, the fusion energy development program, and a large facility to process high level nuclear waste from defense plants. Guidance documents were prepared in consideration of environmental matters especially related to competitive procurement and large demonstration facilities.
S.L.

N82-29779# Argonne National Lab., Ill. Integrated Assessments and Policy Evaluation Group.

EFFECTS OF ATMOSPHERIC DEPOSITION OF ENERGY-RELATED POLLUTANTS ON WATER QUALITY: A REVIEW AND ASSESSMENT

M. J. DAVIS May 1981 98 p refs

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

(DE82-007036; ANL/AA-26) Avail: NTIS HC A05/MF A01

The effects on surface-water quality of atmospheric pollutants that are generated during energy production are reviewed and evaluated. Atmospheric inputs from such sources to the aquatic environment may include trace elements, organic compounds, radionuclides, and acids. Combustion is the largest energy-related source of trace-element emissions to the atmosphere. Several simple models for lakes and streams are developed and are applied to assess the potential for adverse effects on surface-water quality of trace-element emissions from coal combustion. The character of acid precipitation is reviewed, with emphasis on aquatic effects, and the nature of existing or potential effects on water quality, aquatic biota, and water supply is considered. Methods for identifying regions sensitive to acid inputs are reviewed. The observed impact of acid precipitation ranges from no effects to elimination of fish populations. Coal-fired power plants and various stages of the nuclear fuel cycle release radionuclides to the atmosphere. Radioactive releases to the atmosphere from these sources and the possible aquatic effects of such releases are examined.
DOE

N82-29781# California Univ., Livermore. Lawrence Livermore Lab.

COSO GEOTHERMAL ENVIRONMENTAL OVERVIEW STUDY ECOSYSTEM QUALITY

P. LEITNER Sep. 1981 56 p refs

(Contract W-7405-ENG-48)

(DE82-006930; UCRL-15427) Avail: NTIS HC A04/MF A01

The Coso Known Geothermal Resource Area is located just east of the Sierra Nevada, in the broad transition zone between the Mohave and Great Basin desert ecosystems. The prospect of large-scale geothermal energy development here in the near future has lead to concern for the protection of biological resources. The objectives are the identification of ecosystem issues, evaluation of the existing data base, and recommendations of additional studies needed to resolve key issues. High-priority issues include the need for site-specific data on the occurrence of plant and animal species of special concern, accurate and detailed information on the nature and extent of the geothermal resource, and implementation of a comprehensive plan for ecosystem protection.
DOE

N82-29782# Oak Ridge National Lab., Tenn. Energy Div.

ENVIRONMENTAL ASSESSMENT OF SYNFUELS PROJECTS

C. R. BOSTON 1980 13 p Presented before the City Council of Oak Ridge, Tenn., Oak Ridge, Tenn., 30 Oct. 1980 Submitted for publication

(Contract W-7405-ENG-26)

(DE82-002727; DOE/TIC-2002727) Avail: NTIS HC A02/MF A01

Environmental assessments of synfuels demonstration projects are discussed. The preparation of environmental impact statements for all six DOE demonstration plants is reviewed. The synfuels technologies include high-Btu gasification, medium-Btu gasification and liquefaction.
DOE

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N82-29786# Acurex Corp., Mountain View, Calif. Energy and Environmental Div.

KINETICS OF NO SUB X FORMATION DURING EARLY STAGES OF PULVERIZED-COAL COMBUSTION Quarterly Report, 1 Oct. - 31 Dec. 1981

E. K. CHU, J. M. KENNEDY, W. V. KRILL, and S. L. PESSAGNO
1981 18 p

(Contract DE-AC22-80PC-30295)

(DE82-010520; DOE/PC-30295/5; QR-5) Avail: NTIS HC A02/MF A01

Baseline testing with Utah coal was initiated with the stirred reactor experimental apparatus. The addition of natural gas to the coal injection jet was implemented to improve the reactor temperature profile. After some adjustments to the coal testing procedure, unique high temperature data relating NO emissions to residence time and equivalence ratio was obtained. The experimental reactor configuration and testing procedure were revised to improve data quality for kinetic model correlation. The gaseous emission data from the revised approach appeared to be in the right trend. The solid data, however, were not consistent with the gaseous emission data. Corrective action on the solid sampling technique is currently underway. DOE

N82-29788# GCA Corp., Chapel Hill, N.C. Technology Div.

SURVEY OF CADMIUM EMISSION SOURCES Final Report

Sep. 1981 163 p refs

(Contract EPA/68-02-3168)

(PB82-142050; EPA-450/3-81-013) Avail: NTIS HC A08/MF A01 CSCL 13B

Technical data are presented to support decision making on the need for listing cadmium under Section 108(a)(1), Section 112(b)(1)(A), or Section 111(b)(1)(A) as required by Section 122 of the Clean Air Act, as amended in 1977. Data are presented describing potential sources of cadmium emissions, control techniques used for cadmium emission control, estimated controlled and uncontrolled cadmium emissions, estimated ambient air quality, and compliance status. The results of special dispersion modeling are presented for incineration, interaction of smelters and for interaction of sources in the New York City - New Jersey area. GRA

N82-29789# Carnegie-Mellon Univ., Pittsburgh, Pa. Center for Energy and Environmental Studies.

MULTI-OBJECTIVE DECISION-MAKING FOR ENVIRONMENTAL REGULATIONS: AIR POLLUTANT EMISSION STANDARDS FOR COAL-FIRED BOILERS, EXECUTIVE SUMMARY

D. R. LINCOLN, N. DAMODARAN, B. W. CROZIER, and E. S. RUBIN May 1981 18 p 2 Vol.

(Contract NSF PRA-79-13069)

(PB82-146184; NSF/PRA-81011) Avail: NTIS HC A02/MF A01 CSCL 13B

Alternative air emission standards for coal fired boilers within a multiobjective decision framework were examined. Interpollutant tradeoffs were considered in an examination of environmental regulatory policy. A multi-objective framework linking an environmental assessment model with a quantitative human decision-making model for evaluating multimedia environmental impacts of coal fired boilers was developed. The assessment models employ computer simulation of alternate coal-to-electric and coal-to-steam boiler systems. Pollution control technologies are presented for utility systems and industrial boilers. An interactive computer decision model (DECMOD) was developed to assess total social costs. Interview used to obtain information are described. It is indicated that: (1) it is possible to quantitatively model preferences for emission standards for coal fired burners; and (2) preferences can be determined for a broad range of standards after obtaining responses to a relatively limited series of questions. GRA

N82-29841# Skidaway Inst. of Oceanography, Savannah, Ga.
NEARSHORE TRANSPORT PROCESSES AFFECTING THE DILUTION AND FATE OF ENERGY RELATED CONTAMINANTS Progress Report, 1 Oct. 1980 - 31 May 1982

J. O. BLANTON 1 Dec. 1981 40 p refs

(Contract DE-AS09-80EV-10331)

(DE82-010311; DOE/EV-10331/2) Avail: NTIS HC A03/MF A01

Energy related activities in the South Atlantic Bight resulting in increased transport and handling of fossil fuels and nuclear material are described. These activities can result in elevated concentrations of pollutants whose transport and fate are governed by oceanographic processes. Research progress toward an understanding of the tidal and wind generated circulation patterns that govern transport and fate of material are discussed. DOE

N82-29845# South Carolina Wildlife and Marine Resources Dept., Charleston. Marine Resources Research Inst.

SOUTH ATLANTIC OCS AREA LIVING MARINE RESOURCE STUDY. VOLUME 1: AN INVESTIGATION OF LIVE BOTTOM HABITATS SOUTH OF CAPE FEAR, NORTH CAROLINA Final Report

Oct. 1981 329 p refs 4 Vol.

(Contract DI-AA551-CT9-27)

(PB82-160102; BLM/YL/ES-81-09) Avail: NTIS HC A15/MF A01 CSCL 08A

Benthic and nektonic communities associated with representative live bottom habitats on the continental shelf of the South Atlantic Bight were characterized. Factors which might influence these communities, particularly the potential for impact by offshore oil and gas activities were studied. Nine live bottom areas located off South Carolina, Georgia and Florida were studied. GRA

N82-29846# South Carolina Wildlife and Marine Resources Dept., Charleston. Marine Resources Research Inst.

SOUTH ATLANTIC OCS AREA LIVING MARINE RESOURCES STUDY. VOLUME 2: AN INVESTIGATION OF LIVE BOTTOM HABITATS NORTH OF CAPE FEAR, NORTH CAROLINA Final Report

Oct. 1981 146 p refs 4 Vol.

(Contract DI-AA551-CT9-27)

(PB82-160110; BLM/YL/ES-81-10) Avail: NTIS HC A07/MF A01 CSCL 08A

Benthic and nektonic communities associated with representative live bottom habitats on the continental shelf of the South Atlantic Bight were studied. Factors which might influence these communities, particularly the potential for impact by offshore oil and gas activities were studied. Three study sites at the edge of the continental shelf in a 55-100m depth zone, near Cape Fear, North Carolina were studied. GRA

N82-30136# R and D Associates, Arlington, Va.

SUGGESTED CHANGES IN THE DEPARTMENTAL REVIEW PROCESS TO IMPROVE ENERGY TECHNOLOGY BASE MANAGEMENT Final Technical Report, Oct. 1980 - Apr. 1981

J. BENGSTON, R. B. DAVIDSON, and H. W. HEVERT Apr. 1981 52 p

(Contract DE-AC01-80ER-30005)

(DE82-004929; DOE/ER-30005/T1; RDA-TR-116500-001) Avail: NTIS HC A04/MF A01

The DOE procedures for technology base planning and assessment are reviewed. On the basis of this review, two recommendations for improved procedures are made. First, DOE should develop the capability to establish, maintain, and use a comprehensive, current inventory of technology base activities. Second, DOE should develop means for describing technology base plans and activities within DOE R and D programs in a way which is suitable for use in Department-wide review of the energy technology base. DOE

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N82-30304# School of Aerospace Medicine, Brooks AFB, Tex. **HUMAN-FACTORS EVALUATION OF C-141 FUEL SAVINGS ADVISORY SYSTEM Final Report, Dec. 1979 - Feb. 1981**

L. P. PERELLI Dec. 1981 33 p refs
(Contract AF PROJ. 7930)
(AD-A114931; SAM-TR-81-37) Avail: NTIS HC A03/MF A01
CSCL 01C

The Air Force installed a Fuel Savings Advisory System (FSAS) in three C-141 aircraft and performed an operational test and evaluation. At the request of the USAF Airlift Center, observers from the USAF School of Aerospace Medicine evaluated human-engineering, workload, and fatigue aspects of FSAS during three long-duration missions. Pilot's subjective fatigue/workload reports, interviews with crewman, and human-engineering analyses indicated that the FSAS was satisfactory for use in MAC airlift operations. Human-engineering solutions are provided, also suggestions for future improvement of the FSAS. Author (GRA)

N82-30424# Army Construction Engineering Research Lab., Champaign, Ill.

VALIDATION DATA FOR MECHANICAL SYSTEM ALGORITHMS USED IN BUILDING ENERGY ANALYSIS PROGRAMS Final Report

W. DOLAN Feb. 1982 177 p
(Contract IAA-EM-78-1-01-4207)
(AD-A115182; CERL-TR-E-177) Avail: NTIS HC A09/MF A01
CSCL 13A

This report describes a study which collected data developers can use to validate the algorithms used by building energy analysis computer programs to model system and central plant performance of typical heating, cooling, and ventilating (HVAC) systems. Building energy analysis programs compute (1) loads imposed on building environmental control systems for each zone, (2) loads imposed on central equipment (using the zone loads and system performance algorithms), and (3) the primary energy demanded by the central- and zone-specific components. The information collected during this study made it possible to compare actual system performances with computer-generated results of system performances. In addition, this study identified some problems common to HVAC systems, including (1) often unreliable controls performance such as drifting away from calibration and poor repeatability, and (2) as-delivered components which do not operate at manufacturers' specifications. GRA

N82-30426# Louisiana State Univ., Baton Rouge. Energy Programs Office.

TECHNICAL SUPPORT FOR GEOPRESSURED-GEOTHERMAL WELL ACTIVITIES IN LOUISIANA Final Report, 27 Sep. 1978 - 31 Dec. 1980

F. M. WRIGHTON, D. DEBOUT, D. R. CARVER, C. C. GROAT, and A. E. JOHNSON, JR. 31 Aug. 1981 215 p
(Contract DE-AS05-78ET-27160)
(DE82-000498; DOE/ET-27160/T1) Avail: NTIS HC A10/MF A01

The data analysis is based on the Brazoria Texas well and the balance of the modeling work is theoretical. Progress in the regional assessment of the geopressured-geothermal resource in Louisiana is reported. Environmental monitoring effort established monitoring systems and baseline environmental measurements. Efforts to improve the techno-economic model, improve the estimates of methane in solution, and to evaluate newly identified sites are described. DOE

N82-30559# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

DESIGN AND ANALYSIS TOOL VALIDATION

R. JUDKOFF Jul. 1981 5 p refs Presented at the DOE Passive and Hybrid Solar Energy Program Update, Washington, D.C., 9-12 Aug. 1981

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-001543; SERI/TP-721-1327; CONF-810832-7) Avail:
NTIS HC A02/MF A01

A procedure for the validation of building energy analysis simulation codes (BEAS) is developed. These codes are being used increasingly in the building design process, both directly and as the basis for simplified design tools and guidelines. The importance of the validity of the BEAS in predicting building energy performance is obvious when one considers the money and energy that could be wasted by energy-inefficient design. Little or no systematic effort was made to ensure the validity of the various BEAS. The validation work consists of three distinct parts: comparative study, analytical verification, and empirical validation. The procedures were developed for the first two parts and were implemented on a sampling of the major BEAS; results show major problems in one of the BEAS tested. DOE

N82-30598# Federal Energy Regulatory Commission, Washington, D. C. Office of Electric Power Regulation.

WATER RESOURCES APPRAISAL FOR HYDROELECTRIC LICENSING: UPPER JAMES RIVER BASIN, VIRGINIA

Sep. 1981 59 p
(DE82-001859; FERC-0085) Avail: NTIS HC A04/MF A01

The water resources of the upper James River basin which covers 3330 sq. mi. in Virginia and West Virginia were evaluated. Data are presented on the physiography and economy of the basin, its existing and potential water resource development, existing hydroelectric projects, projected water requirements, flood control, and cooling water requirements for thermal power plants. GRA

N82-30627 Washington Univ., Seattle.

THERMAL MODELING OF MULTI-ROOM STRUCTURES

A. F. EMERY, C. J. KIPPENHAN, and D. R. HEERWAGEN *In* ASME Solar Eng., 1981 p 151-157 1981 refs
Avail: Issuing Activity

A series of numerical simulations, based upon the nodal network program UWENSOL, was made to predict the hourly thermal response of a typical Pacific Northwest residence and its daily and annual energy requirements. The calculations showed that the response of the house is dependent upon its configuration, the weather and the manner in which the heating or cooling is done. In general, during winter time in the Pacific Northwest it is possible to adequately simulate the house as a collection of thermally independent zones. This eliminates the need to consider the house as a single structure composed of thermally interacting zones and permits the efficient simulation of houses which are architecturally complicated. However, during very hot summer periods, too much energy is conducted through the walls to allow the independent zone simulation to be used and the structure must be treated as an entity. Author

N82-30630 Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ANALYSIS OF THE PERFORMANCE AND SPACE CONDITIONING IMPACTS OF DEDICATED HEAT PUMP WATER HEATERS

L. MORRISON and J. SWISHER *In* ASME Solar Eng., 1981 p 175-186 1981 refs
Avail: Issuing Activity

The development and testing of the newly-marketed dedicated heat pump water heater (HPWH) are described. This system utilizes an air-to-water heat pump, costs about \$1,000 installed, and obtains a coefficient of performance (COP) of about 2.0 in laboratory and field tests. To investigate HPWH performance and space conditioning impacts, a simulation was developed to mode the thermal performance of a residence with resistance baseboard

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heat, air conditioning, and either heat pump or resistance water heating. The building characteristics are adapted for three U.S. geographical areas (Madison, Wisconsin; Washington, D.C.; and Ft. Worth, Texas), and the system is simulated for a year with typical weather data. The thermal network includes both a house node and a basement node so that the water heating equipment can be simulated in an unconditioned basement in Northern cities and in a conditioned first-floor utility room in Southern cities.

Author

N82-30632 Wisconsin Univ., Madison. Solar Energy Lab.
A REGIONAL COMPARISON OF SOLAR, HEAT PUMP, AND SOLAR HEAT PUMP SYSTEMS

B. E. MANTON and J. W. MITCHELL *In ASME Solar Eng.*, 1981 p 196-203 1981 refs Sponsored by DOE

Avail: Issuing Activity

The thermal and economic performance of the parallel and series solar-heat pump systems, stand-alone solar and stand-alone heat pump systems for residential space and domestic hot water heating is being compared for the United States using FCHART 4.0. The results are useful for a regional assessment of the viability of the different systems, and for assessing policies that will encourage the implementation of the most energy efficient system.

A.R.H.

N82-30639 Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

THE IMPLEMENTATION OF AN ANALYTICAL VERIFICATION TECHNIQUE ON THREE BUILDING ENERGY ANALYSIS CODES: SUNCAT 2.4, DOE 2.1, AND DEROB III

D. WORTMAN, B. ODOHERTY, and R. JUDKOFF *In ASME Solar Eng.*, 1981 p 268-276 1981 Sponsored by DOE

Avail: Issuing Activity

An analytical verification technique for building energy analysis codes was developed. For this technique, building models are developed that can be both solved analytically and modeled using the analysis codes. The output of the codes is then compared with the analytical solutions. In this way, the accuracy of selected mechanisms in the codes can be verified. The procedure consists of several tests and was run on SUNCAT 2.4, DOE 2.1, and DEROB III. The results are presented and analyzed.

Author

N82-30642 California Univ., Berkeley. Lawrence Berkeley Lab. Passive Solar Analysis and Design Group.

VERIFICATION OF BLAST BY COMPARISON WITH MEASUREMENTS OF A SOLAR DOMINATED TEST CELL AND A THERMALLY MASSIVE BUILDING

F. BAUMAN, B. ANDERSON, W. CARROLL, R. KAMMERUD, and N. E. FRIEDMAN *In ASME Solar Eng.*, 1981 p 299-308 1981 refs

(Contract W-7405-ENG-48)

Avail: Issuing Activity

As part of an ongoing effort to use empirical data to test computational accuracy of the building energy analysis computer program BLAST (2) two verification studies are reported. In the first, comparisons between temperatures measured in a direct solar gain test cell and temperatures predicted by the program have been made. The comparisons were performed for two distinct climate periods; the simulations were driven by weather data collected at the test cell site in Los Alamos, New Mexico. The test cell configuration and weather data manipulations are described; quantitative evaluations of the comparisons between measured and predicted interior temperatures are presented; limitations of the comparisons are discussed; and sensitivities of the simulation results to uncertainties in the measured parameters are examined.

Author

N82-30654 California Univ., San Diego, La Jolla. Energy Center.

A COMPARISON OF RADIANT INTERCHANGE ALGORITHMS
J. A. CARROLL *In ASME Solar Eng.*, 1981 p 399-407 1981 refs

(Contract DE-AC02-80CS-30260)

Avail: Issuing Activity

A new algorithm for modeling radiant energy interchanges in rooms is compared to other algorithms. First the various methods are described and geometry-related errors are identified. Next other errors common to most of the methods are analyzed. Then the effect of these radiant interchange errors on simulation results is indicated. Tables show the magnitude of the errors associated with each method in a variety of test cases.

R.J.F.

N82-30655 Midwest Research Inst., Golden, Colo. Building Systems Development Branch.

EFFECTS OF INTERNAL GAIN ASSUMPTIONS IN BUILDING ENERGY CALCULATIONS

C. CHRISTENSEN and R. PERKINS (Colorado Univ., Denver) *In ASME Solar Eng.*, 1981 p 408-414 1981 refs Sponsored by DOE

Avail: Issuing Activity

The utilization of direct solar gains in buildings can be affected by operating profiles, such as schedules for internal gains, thermostat controls, and ventilation rates. Building energy analysis methods use various assumptions about these profiles. The effects of typical internal gain assumptions in energy calculations. Heating and cooling loads from simulations using the Department of Energy 2.1 computer code are compared for various internal-gain inputs: typical hourly profiles, constant average profiles, and zero gain profiles. Prototype single-family-detached and multi-family-attached residential units are studied with various levels of insulation and infiltration. Small detached commercial buildings and attached zones in large commercial buildings are studied with various levels of internal gains. The results indicate that calculations of annual heating and cooling loads are sensitive to internal gains, but in most cases are relatively insensitive to hourly variations in internal gains.

R.J.F.

N82-30675 Massachusetts Inst. of Tech., Cambridge. Energy Lab.

STANDARDS, WARRANTIES, AND COMMERCIALIZATION OF NEW ENERGY TECHNOLOGIES

D. BOTTARO *In ASME Solar Eng.*, 1981 p 572-580 1981 refs

Avail: Issuing Activity

The functions of standards for solar technologies and the economic effects which standards have upon markets are described. Three types of effects are discussed: upon demand for products using the technology, upon cost, and upon the market structure and competitive behavior of the industries producing the products.

E.A.K.

N82-30678 Stevens Inst. of Tech., Hoboken, N. J.

THE STEVENS-LEVOLOR ENVIRONMENTAL SIMULATOR AND THE STUDY OF INTERIOR SHADING FOR ENERGY EFFICIENT WINDOWS

R. L. VANDYCK and T. P. KONEN *In ASME Solar Eng.*, 1981 p 597-609 1981 refs

Avail: Issuing Activity

A window systems and experiments in a unique environmental simulator with an artificial sun were tested. It is shown that interior venetian blind shading is an effective window energy management technique. Predictive methods of generating shading coefficients applicable to modern venetian blinds is confirmed. The findings indicating light colored, as well as highly reflective blinds yielded as significant energy savings.

E.A.K.

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N82-30708*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NECAP 4.1: NASA'S ENERGY-COST ANALYSIS PROGRAM INPUT MANUAL

R. N. JENSEN May 1982 127 p
(NASA-TM-83239; NAS 1.15:83239) Avail: NTIS HC A07/MF A01 CSCL 10A

The computer program NECAP (NASA's Energy Cost Analysis Program) is described. The program is a versatile building design and energy analysis tool which has embodied within it state of the art techniques for performing thermal load calculations and energy use predictions. With the program, comparisons of building designs and operational alternatives for new or existing buildings can be made. The major feature of the program is the response factor technique for calculating the heat transfer through the building surfaces which accounts for the building's mass. The program expands the response factor technique into a space response factor to account for internal building temperature swings; this is extremely important in determining true building loads and energy consumption when internal temperatures are allowed to swing. R.J.F.

N82-30718# Committee on Science and Technology (U. S. House).

REAGAN ADMINISTRATION POLICIES FOR NEW ENERGY TECHNOLOGIES

P. F. ROTHBERG, ed., M. R. SEGAL, ed., and R. CIVIAK, ed. Washington GPO 1982 84 p Rept. presented to the Subcomm. on Energy Develop. and Appl. and the Subcomm. on Energy Res. and Production of the Comm. on Sci. and Technol., 97th Congr., 2nd Sess., Jun. 1982 Proc. of a Seminar held 15 Oct. 1981 Prepared by Congressional Research Service, Library of Congress (GPO-94-284) Avail: SOD HC

Energy policies are summarized. An analysis of selected advantages and disadvantages of these policies are presented. Chapters III-V are discussions by CRS experts. The possible of these policies in three specific types of energy production--synfuels processes, renewable energy systems, and nuclear energy technologies are discussed. S.L.

N82-30719# Committee on Science and Technology (U. S. House).

ENERGY EFFICIENCY IN FLORIDA'S FUTURE

Washington GPO 1982 244 p refs Hearing before the Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., 97th Congr., 1st Sess., no. 79, 26 Oct. 1981 (GPO-91-487) Avail: Subcommittee on Energy Development and Applications

Florida's efforts to increase energy efficiency are discussed. The roles of government, industry, and citizens are discussed. Numerous programs that will result in energy conservation are described. R.J.F.

N82-30720# Committee on Science and Technology (U. S. House).

ELECTRIC ENERGY SYSTEMS AND ENERGY STORAGE

Washington GPO 1982 285 p refs Hearing before the Subcomm. on Energy Res. and Production of the Comm. on Sci. and Technol., 97th Congr., 1st Sess., no. 75, 8 Dec. 1981 (GPO-90-261) Avail: Subcommittee on Energy Research and Production

The energy storage and electric energy systems research and development programs are reviewed, in light of information which indicates these two programs may be terminated. The impact of the withdrawal of Federal participation in these programs is considered. S.L.

N82-30721# RAND Corp., Santa Monica, Calif.

PROMOTING ENERGY EFFICIENCY THROUGH IMPROVED ELECTRICITY PRICING: A MID-PROJECT REPORT

J. P. ACTION, D. F. KOHLER, B. M. MITCHELL, and R. E. PARK Mar. 1982 117 p refs Sponsored in part by the John A. Hartford Foundation and by the Ford Foundation (Contract NSF DAR-80-12664) (RAND/N-1843-HF/FF/NSF) Avail: NTIS HC A06/MF A01

Five related areas of electricity demand analysis under alternative rate forms were studied. Adjustments by large commercial and industrial customers are examined. Residential demand under time of day (TOD) pricing is examined. A methodology for evaluating alternative rate structures is developed and applied. Author

N82-30729# Department of Energy, Washington, D. C. Office of Market Analysis.

INTERNATIONAL ENERGY INDICATORS

E. ROSSI, JR., ed. Dec. 1981 30 p
(DE82-010236; DOE/IA-0010/16) Avail: NTIS HC A03/MF A01

Data on international energy indicators were tabulated and graphically represented. The following data are presented: world crude oil production, 1974 to October 1981; OPEC crude oil productive capacity; world crude oil and refined product inventory levels, 1975 to October, 1981; oil consumption in OECD countries, 1975 to October 1981; USSR crude oil production and exports, 1975 to October 1981; free world and US nuclear electricity generation, 1973 to December, 1981 and current capacity. Specific US data presented are: US domestic oil supply, 1977 to June, 1981; US gross imports of crude oil and products, 1973 to October, 1981; landed cost of Saudi crude current and 1974 dollars; US coal trade, 1975 to September, 1981; US natural gas trade, 1981; and energy/GNP ratio. DOE

N82-30733# California Univ., Livermore. Lawrence Livermore Lab.

HOT-DRY-ROCK ENERGY: REVIEW OF ENVIRONMENTAL ASPECTS

K. OBANION 13 Oct. 1981 40 p refs
(Contract W-7405-ENG-48)
(DE82-003283; UCRL-53204) Avail: NTIS HC A03/MF A01

The potential environmental and socioeconomic impacts of the production of energy contained in hot dry rock (HDR) was surveyed. The most important uncertainty among the environmental concerns is the seismic response of HDR formations to short duration fluid injections at pressures above fracture thresholds; continued monitoring at HDR development sites is necessary. The indirect jobs resulting from such development, which could cause significant demographic impacts in sparsely populated regions are of great importance. However, such indirect growth is not expected to begin until a large, stable HDR industry is established in a region, which makes impacts permanent rather than transient. GRA

N82-30738# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

OVERVIEW OF SYSTEMS ANALYSIS, MARKET ASSESSMENT AND CONTROLS WORK

M. L. WARREN Aug. 1981 15 p refs Presented at the Active Solar Contractors' Rev. Meeting, Washington, D.C., 9-11 Sep. 1981
(Contract W-7405-ENG-48)
(DE82-001015; LBL-13052; CONF-810912-14) Avail: NTIS HC A02/MF A01

Heat pump analysis, absorption and Rankine cooling analysis, and desiccant cooling analysis are reported. National energy savings, meeting cost and performance goals, recent simulation analysis, and controls research are discussed. DOE

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N82-30742# Argonne National Lab., Ill. Energy and Environmental Systems Div.

DISCUSSION PAPER ON ENERGY GRANT ALTERNATIVES
B. HUMPHREY, D. CLIFFORD, F. GUNNISON (Science Applications, Inc.), and J. TATAR Jun. 1981 25 p refs
(Contract W-31-109-ENG-38)
(DE82-003263; ANL/CNSV-TM-83) Avail: NTIS HC A02/MF A01

The federal grant-in-aid system consisting of categorical grants, block grants, and general revenue sharing are discussed and compared. The types of complications that may arise from implementation of these grants proposals are discussed. Some proposals for the possible consolidation of programs that the Department of Energy offices now administer are summarized.

DOE

N82-30744# Aerospace Corp., Germantown, Md.
FOURTH US DEPARTMENT OF ENERGY BATTERY AND ELECTROCHEMICAL CONTRACTORS' CONFERENCE ABSTRACTS VISUAL PRESENTATIONS

Jun. 1981 475 p Conf. held at Washington, D.C., 2-4 Jun. 1981
(Contract DE-AI01-79ET-25204)
(DE82-000075; CONF-810642-ABSTS) Avail: NTIS HC A20/MF A01

Various aspects of electrochemistry and battery technology are discussed. Topics include near term batteries, solar applications, advanced batteries (fused salt electrolytes) electrolyte technology, fuel cells for electric vehicles, and systems analysis studies.

DOE

N82-30746# Brookhaven National Lab., Upton, N. Y.
APPLICATION OF THE BROOKHAVEN ENERGY-ECONOMIC ASSESSMENT MODEL IN THE PORTUGAL-U.S. COOPERATIVE ASSESSMENT

S. ROGERS, G. MCGRANAHAN, S. KYLE, and V. MUBAYI Jun. 1981 74 p refs
(Contract DE-AC02-76CH-00016)
(DE82-003256; BNL-51424) Avail: NTIS HC A04/MF A01

The application of the Brookhaven Energy Economic Assessment Model (BEEAM) in the Portugal-US Cooperative Energy Assessment is described. Two projections of economic growth were used to drive the model. The main objectives in applying BEEAM were to investigate the detailed structure of energy demand at a sectoral level; the primary energy resources required to meet the final energy demand; the overall balance of trade due to both energy and nonenergy imports; the consistency or lack thereof between the projected sectoral growth rates; and the implication of the growth rates in regard to aggregate levels fixed capital formation. The impacts of the accelerated and moderate energy conservation cases developed on energy demand, resource requirements, and the balance of trade were also determined. The structure of BEEAM, which consists of an energy-denominated input-output representation of the economy coupled to an energy supply-demand network and its mode of application in the Portugal assessment are described.

DOE

N82-30758# Argonne National Lab., Ill.
ENERGY AND MATERIALS FLOWS IN THE CEMENT INDUSTRY

J. E. SAPP Jun. 1981 230 p refs
(Contract W-31-109-ENG-38)
(DE82-001609; ANL/CNSV-17) Avail: NTIS HC A11/MF A01

The cement industry is a large user of energy. In 1976, for example, the cement industry consumed 0.7% of the nation's direct energy, using 50 million tons of coal, 5.5 million barrels of fuel oil, 88,107 million cubic feet of natural gas, and 10,558 million kilowatt hours of electricity. Earlier, in 1971 when the cement industry was sixth in total energy use for heat and power among SIC four digit industries, cement production consumed the most coal in that SIC group. From 1947 through 1976, the period covered by this study, cement industry energy consumption increased by 58%. However, process improvements during that period reduced the

direct energy needed to produce a metric ton of cement 23% for dry processors and 17% for wet processors. There are constraints but further energy reductions are possible for individual producers through continued equipment modernization.

DOE

N82-30759# Stockholm Univ. (Sweden). Inst. of Physics.
LONG RANGE ENERGY DEMAND

T. R. GERHOLM, S. MEISELS, L. BRANDELL, T. THEDEEN, L. CLAESSEON, and P. NAESMAN Jan. 1982 80 p refs In SWEDISH; ENGLISH summary
(Contract NE-31.17.1)
(USIP-82-02) Avail: NTIS HC A05/MF A01

A mathematical model of energy consumption was developed, taking into account annual energy price increase and price elasticity. The parameters of this formula were determined by statistical analysis, using historical data for the world divided into seven major regions with similar economic systems. The model can be used for long range forecasting assuming no trend break occurs. Calculations are presented up to 2020, for all seven world regions and for Sweden, the error being within - 15% and + 15% with a confidence of 95 %. The results are compared with actual outcome for 1979 and with other similar projections. A possible extension of the model to include major deviations from current trends by soft modeling techniques is discussed.

Author (ESA)

N82-30760# Technische Universitaet, Munich (West Germany). Lehrstuhl C fuer Thermodynamik.

ENERGY CONSERVATION IN BUILDINGS USING ADJUSTABLE LOUVER SYSTEMS Final Report, Mar. 1981

K. GEHLISCH Bonn Bundesministerium fuer Forschung und Technologie Apr. 1982 216 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-82-037; ISSN-0340-7608) Avail: NTIS HC A10/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 38

Energy saving by installation of movable louvers in front of walls and windows was investigated relative to the heating and cooling of buildings. Computer simulation of diurnal and annual variation of direct and diffuse insolation, long wave atmospheric radiation, air temperature and cloudiness was conducted. Annual heating and cooling loads per square meter window surface (double glazing; southern orientation) and per square meter wall surface (with and without insulation; south, east, and west orientation) were numerically evaluated, using an implicit differential method with a 1 hour time step. The mathematical model describes both convective heat transfer on either side of the wall and long wave as well as short wave radiation between wall, louvers and the surroundings. The annual energy saving by application of a louver system with optimum tilt angle amounts to 30%.

Author (ESA)

N82-30769# Meteorology Research, Inc., Altadena, Calif.
MEASUREMENT OF SULFATE AEROSOLS FROM WESTERN LOW-RANK COAL-FIRED BOILERS WITH FGD: RESULTS OF TESTS AT COAL CREEK UNIT 1

J. L. DOWNS 6 Oct. 1981 50 p
(Contract DE-AC18-80FC-10182)
(DE82-001123; DOE/FC-10182/T14; MRI-81-R1841) Avail: NTIS HC A03/MF A01

A test to investigate the quantity and type of aerosol sulfates emitted from Western low-rank coal-fired utility boilers with flue gas desulfurization (FGD) systems is discussed. The average particulate removal efficiency of the module tested was 79 percent as calculated from the instack filter results. The absolute amount of sulfate was roughly the same at inlet and outlet. The impactor total mass loading results are in fair agreement with those measured with the instack filters. The size dependent particulate removal by the scrubber may be characterized by the size at 50 percent collection efficiency, or cut point of the scrubber. The cut point is about 1.5 micrometers physical diameter. The average SO₂ removal efficiency of the FGD module was 95 percent, based on the wet chemical SO₂ measurements. On the average, based on the instack filter results, 13 percent of the particulate mass

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loading at the inlet sulfate. At the outlet, this fraction increased to 33 percent. DOE

N82-30770# Meteorology Research, Inc., Altadena, Calif.
MEASUREMENT OF SULFATE AEROSOLS FROM WESTERN LOW-RANK COAL-FIRED BOILERS WITH FGD: RESULTS OF TESTS AT MILTON R. YOUNG UNIT 2

J. L. DOWNS 6 Oct. 1981 51 p
(Contract DE-AC18-80FC-10182)
(DE82-001124; DOE/FC-10182/T13; MRI-81-R1840) Avail:
NTIS HC A04/MF A01

Part of a program to investigate the quantity and type of aerosol sulfates emitted from Western low-rank coal-fired utility boilers with flue gas desulfurization systems is discussed. The average particulate removal efficiency of the module tested was 38 percent, as calculated from instack filter results for 10, 11, and 12 June. The impactor total mass loading results are in fair agreement with those measured with the instack filters. The size dependent particulate removal by the scrubber may be characterized by the size at 50 percent collection efficiency, or the cut point of the scrubber. The cut point is about 1.2 micrometers physical diameter. The average SO₂ removal efficiency of Module A11, based on the continuous monitor results, was 91 percent. On the average, based on the instack filter results, 40 percent of the particulate mass loading at the inlet is sulfate. At the outlet, this fraction was 27 percent. The absolute amount of sulfate is roughly the same at inlet and outlet. DOE

N82-30898# Decision Focus, Inc., Palo Alto, Calif.
AN ANALYTIC FRAMEWORK FOR ALLOCATING R AND D RESOURCES AT GRI Annual Report, Sep. 1980 - Jun. 1981

R. A. MARSHALLA, D. M. NESBITT, and D. B. OMAN Nov. 1981 296 p
(Contract GRI-5080-310-0326)
(PB82-168428; GRI-80/0092) Avail: NTIS HC A13/MF A01
CSCL 05A

A comprehensive technique that eliminates the need for direct subjective estimates of market outcomes was developed. Engineering assessments of technical outcomes are inherently more reliable because they can be unambiguously defined. A comprehensive energy economy model to compute their market impacts on a consistent basis is used. The new technique avoids inconsistencies and explicitly takes into account all technical and economic uncertainties that may affect project areas. The new technique is fully compatible with the PAM and applies to efficient utilization as well as supply project areas. GRA

N82-31059# Mathematical Sciences Northwest, Inc., Bellevue, Wash.

REFERENCE MANUAL OF DATA SOURCES FOR LOAD FORECASTING Final Report

L. ANDREWS and C. MCDONALD Sep. 1981 480 p refs
Sponsored by EPRI
(Contract EPRI PROJ. 1478-1)
(DE82-900319; EPRI-EA-2008) Avail: NTIS HC A21/MF A01

The quality and availability of data for use in electricity load forecast models are examined. The data sources available for more than 100 variables used in these forecast models are documented, and the quality of the data is evaluated. Also, a description of aggregate econometric and disaggregate econometric or end-use models is presented. Forecasting issues, such as methods of incorporating the effects of conservation programs or government regulations in the forecast, are discussed. The customer survey method of forecasting is presented in detail. The discussion covers survey methodology, sample questionnaires, and recommendations for dealing with the problems associated with the low response rate typical of mail surveys. In particular, it is recommended that a telephone followup survey be made of the mail-survey nonrespondents. DOE

N82-31154# Committee on Science and Technology (U. S. House).

SCIENCE, TECHNOLOGY, AND AMERICAN DIPLOMACY 1982
Washington GPO 1982 380 p refs Presented to the Comm. on Sci. and Technol. and the Comm. on Foreign Affair, 97th Congr., 2nd Sess., Jun. 1982

(GPO-94-472) Avail: Committee on Science and Technology
The U.S. Government's domestic and international activities in the fields of science and technology are discussed. Programs relating to health, agriculture, energy technology, environment protection, oceans, and other areas of mutual interest are discussed. R.J.F.

N82-31157*# Gibbs and Hill, Inc., New York.
OPERATIONS ANALYSIS OF GRAVITY ASSISTED RAPID TRANSIT Final Report

30 Oct. 1981 51 p refs
(Contract JPL-955934)
(NASA-CR-169240; NAS 1.26:169240) Avail: NTIS HC A04/MF A01 CSCL 13F

Gravity assisted rapid transit (GART) with 6 percent grades before and after each station are compared with conventional systems in terms of energy consumption, run time, line capacity and schedule stability under abnormal circumstances. Parametric analyses of run times and energy consumption include the impact of alternate accelerating and braking levels. The capacity analysis uses a network simulation program to determine the location and severity of all signal delays. Based on results of initial simulations, the block design was revised to eliminate bottlenecks in normal operations. The systems are then compared at headways of 80 to 180 seconds. One month of incidence reports of a modern operating transit system are reviewed to determine the failures to be simulated. The impact of failures resulting in station delays (30 to 360 seconds), speed limit reduction (20 mph and 30 mph to one or more trains), vehicle performance (75 percent acceleration) are compared at scheduled headway of 90 to 180 seconds. Author

N82-31651# Research Triangle Inst., Research Triangle Park, N.C.

TES/HEAT-PUMP PERFORMANCE EVALUATION

T. W. SIGMON 1981 7 p refs Presented at the Thermal and Chem. Storage Ann. Rev. Meeting, Washington, D.C., 14-16 Sep. 1981
(Contract W-7405-ENG-26)

(DE82-000111; CONF-810940-18) Avail: NTIS HC A02/MF A01

A technique that utilizes a modified version of the conventional heat pump bin procedure to project use by thermal energy (TES) heat pump and conventional heat pump systems is described. Information for evaluation of various program alternatives for the development of TES/heat pump systems is presented. The modified bin procedure was used in conjunction with an annualized life cycle cost algorithm to evaluate each system from both a technical and economic perspective. Three levels of analysis were completed to identify the system or systems with the lowest life cycle cost for various application scenarios. More detailed analyses of the steady state performance and operation of selected systems are presented. DOE

N82-31765 International Inst. for Applied Systems Analysis, Laxenburg (Austria).

A LONG-TERM MACROECONOMIC EQUILIBRIUM MODEL FOR THE EUROPEAN COMMUNITY Ph.D. Thesis - Karlsruhe Univ., West Germany

H. H. ROGNER Apr. 1982 91 p refs
(IASA-RR-82-13; ISBN-3-7045-0035-6) Avail: Issuing Activity

A version of MACRO, a highly aggregated, long-term, two-sector general equilibrium model, developed to examine energy-economy linkage, calibrated for the European community, is presented. Based on a range of energy supply scenarios, the impact of rising energy costs on economic activity, the feasibility of common assumptions about price-induced conservation, and the impact of continued high energy levels of energy imports on trade balance were examined, in order to assess model performance. Results

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suggest that the model meets the requirements for a consistency check of member country energy strategies. Author (ESA)

N82-31766 International Inst. for Applied Systems Analysis, Laxenburg (Austria).
EVOLUTION OF FUTURE ENERGY DEMANDS TILL 2030 IN DIFFERENT WORLD REGIONS: AN ASSESSMENT MADE FOR THE TWO INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS (IIASA) SCENARIOS

A. M. KHAN and A. HOELZL Apr. 1982 140 p refs (IIASA-RR-82-14; ISBN-3-7045-0034-8) Avail: Issuing Activity
Trends in energy demand, per capita consumption, production, and transportation were assessed for all the major world regions, except China and Asian countries with centrally planned economies. High and low economic growth rates relative to 1975, were considered. Energy demand in developed regions is expected to increase by a factor of 1.8 to 2.6. In developing regions it increases by a factor of 7 to 12. Per capita consumption in developed regions increases from a level of 2.8 to 7.9 kw to 3.9 to 11.6 kw; in developing countries it increases from 0.2 to 0.8 kw to 0.5 to 4.6 kw. The share of electricity in final energy continues to increase. Manufacturing activities remain the major energy consumers. Fossil fuels will remain the most important energy source.

Author (ESA)

N82-31767 International Inst. for Applied Systems Analysis, Laxenburg (Austria).
THE GROWTH OF ENERGY CONSUMPTION AND PRICES IN THE USA, WEST GERMANY, AND THE UK, 1950 TO 1980
C. P. DOBLIN May 1982 152 p refs (IIASA-RR-82-18; ISBN-3-7045-0028-3) Avail: Issuing Activity

The relationship between energy price and consumption was studied, especially reactions to oil price rises in the 1970's. Industrial, domestic, and road transportation energy consumption were examined. Until 1973, consumption rose steadily, while the inflation-adjusted price dropped. Immediate reaction to the two large price rises was a drop in consumption, but overall consumption continued to grow when the growth in total energy consumption was reversed. This change is due to adverse business conditions, displacement of coal by oil, oil by gas, and mineral fuels by electricity in given sectors, switches to less energy intensive activities, a change in the mix of gross national products, and weather conditions, as well as by price rises. Energy conservation measures had little impact.

Author (ESA)

N82-31768# Weil (Warren) Associates, Inc., Washington, D.C.
FEDERAL EMPLOYEE ENERGY AWARENESS PROGRAM GUIDE

Sep. 1981 68 p refs (Contract DE-AC08-80CS-21388) (DOE/CS-21388/2) Avail: NTIS HC A04/MF A01

The planning and management of an employee energy awareness program aimed at reconditioning employees concerning the necessity for energy conservation is described. The program aims to introduce some specific energy conserving behaviors, and to provide motivation for these behaviors. Advice is given on how to structure programs, set goals, implement strategies, and establish procedures for program evaluation and change. R.J.F.

N82-31770*# Computer Sciences Corp., Hampton, Va.
NECAP - NASA'S ENERGY COST ANALYSIS PROGRAM. OPERATIONS MANUAL Final Report

D. L. MINER Jun. 1982 85 p refs (Contract NAS1-16078) (NASA-CR-165802; NAS 1.26:165802) Avail: NTIS HC A05/MF A01 CSCL 10A

The use of the NASA'S ENERGY COST ANALYSIS PROGRAM (NECAP) is described. Supplementary information on new capabilities and program options is also provided. The Control Data Corporation (CDC) NETWORK OPERATING SYSTEM (NOS) is discussed. The basic CDC NOS instructions which are required to successfully operate NECAP are provided. Author

N82-31772*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

WORKSHOP ON AN ASSESSMENT OF GAS-SIDE FOULING IN FOSSIL FUEL EXHAUST ENVIRONMENTS

W. J. MARNER, ed. and R. L. WEBB, ed. Jul. 1982 154 p refs Workshop held at Boulder, Colo., 8-9 Oct. 1981 (Contract NAS7-100; DE-AI07-80ID-12138) (NASA-CR-169269; JPL-PUB-82-67; NAS 1.26:169269; DOE/ID-12138/1) Avail: NTIS HC A08/MF A01 CSCL 10B

The state of the art of gas side fouling in fossil fuel exhaust environments was assessed. Heat recovery applications were emphasized. The deleterious effects of gas side fouling including increased energy consumption, increased material losses, and loss of production were identified. S.L.

N82-31790# California Univ., Berkeley. Lawrence Berkeley Lab.

DAYLIGHTING AS A DESIGN AND ENERGY STRATEGY: OVERVIEW OF OPPORTUNITIES AND CONFLICTS

S. SELKOWITZ Jun. 1981 10 p Presented at the Energy and Big Building Design Symp., Philadelphia, 25-26 May 1981 Submitted for publication (Contract W-7405-ENG-48)

(DE82-001022; LBL-13171; CONF-8105107-2; EEB-W-81-14) Avail: NTIS HC A02/MF A01

The potentials and problems associated with using daylight both to improve visual performance and interior aesthetics and to reduce electrical lighting energy consumption and peak electric loads are reviewed. Use of daylighting as a design strategy is not always synonymous with effective use of daylighting as an energy-saving strategy unless both approaches are jointly pursued by the design team. Criteria for visual performance, disability and discomfort glare, historical perspectives on daylight utilization, building form as a limit to daylight penetration, beam sunlighting strategies, luminous efficacy of daylight versus efficient electric light sources, comparative thermal impacts, peak load and load management potential, and nonenergy benefits are reviewed. Although the energy benefits of daylighting can be oversold, it is concluded that in most cases a solid understanding of the energy and design issues should produce energy efficiency and pleasing working environments. DOE

N82-31791# Department of Energy, Washington, D. C. Energy Information Administration.

THE NATIONAL INTERIM ENERGY-CONSUMPTION SURVEY: EXPLORING THE VARIABILITY IN ENERGY CONSUMPTION, A SUPPLEMENT

R. LATTA Oct. 1981 40 p (DE82-002002; DOE/EIA-0272/S) Avail: NTIS HC A03/MF A01

The variability in energy consumption is examined in single family detached units using fuel oil, kerosene, electricity, and natural gas. DOE

N82-31792# Roskilde Univ. (Denmark). Inst. for Studiet af Matematik og Fysik Samt Deres Functioner i Undervisning, Forskning og Anvendelser

PLANNING AND POLICY CONSIDERATIONS RELATED TO THE INTRODUCTION OF RENEWABLE ENERGY SOURCES INTO ENERGY SUPPLY SYSTEMS. ENERGY SERIES NO. 3

B. SORENSEN Jan. 1981 59 p refs (DE82-900828; TEKST-41) Avail: NTIS HC A04/MF A01

Elements of a methodology for long term energy planning with particular reference to the introduction of renewable energy technologies, and a methodology for comparative assessment of energy systems are discussed. The discussion comprises technical and economic viability, indirect economy, environmental and social impacts, as well as the influence of uncertainty on the assessment. The role of renewable energy in future energy supply systems is discussed, with separate treatment of the situation in developing countries and in highly industrialized countries. Finally, mechanisms for the mobilization of technical and financial requirements are touched upon. DOE

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N82-31793# Oak Ridge National Lab., Tenn. Engineering Technology Div.

MINNEAPOLIS DISTRICT-HEATING OPTIONS

T. K. STOVALL, R. J. BORKOWSKI, M. A. KARNITZ, S. STROM (City of Minneapolis), and K. LINWICK (Minnegasco Energy Center) Oct. 1981 93 p refs
(Contract W-7405-ENG-26)
(DE82-002004; ORNL/TM-7780) Avail: NTIS HC A05/MF A01

The feasibility of a large-scale district heating system for the Minneapolis central city area was investigated. The analysis was based on a previous city of St. Paul Hot-water district heating study and other studies done by a Swedish engineering firm. Capital costs such as building and heat source conversion, pipeline construction, and equipment were used in comparing the projected expenses of various district heating scenarios. Options such as coal, refuse-derived fuel burning, and cogeneration at the Riverside Power Station were discussed as energy supplies for a cost-effective district heating system. DOE

N82-31806# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

INTEGRATED ALTERNATIVE ENERGY SYSTEMS FOR USE IN SMALL COMMUNITIES

J. THORNTON Jan. 1982 27 p refs Presented at the Seminar on Solar Energy Appl. for Buildings, Mexico City, 17-19 Nov. 1980.

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-007769; SERI/TP-731-1057) Avail: NTIS HC A03/MF A01

This paper summarizes the principles and conceptual design of an integrated alternative energy system for use in typical farming communities in developing countries. A system is described that, utilizing the Sun and methane produced from crop waste, would supply sufficient electric and thermal energy to meet the basic needs of villagers for water pumping, lighting, and cooking. The system is sized to supply enough pumping capacity to irrigate 101 ha (249 acres) sufficiently to optimize annual crop yields for the community. Three economic scenarios were developed, showing net benefits to the community of \$3,578 to \$15,547 annually, payback periods of 9.5 to 20 years, and benefit-to-cost ratios of 1.1 to 1.9. DOE

N82-31807# Argonne National Lab., Ill. Energy and Environmental Systems Div.

GUIDE TO THE ECONOMIC ANALYSIS OF COMMUNITY ENERGY SYSTEMS

W. P. PFERDEHIRT, K. G. CROKE (Illinois Univ., Chicago), A. P. HURTER (Northwestern Univ.), A. S. KENNEDY, and C. LEE Aug. 1981 66 p refs

(Contract W-31-109-ENG-38)
(DE82-011465; ANL/CNSV-TM-92) Avail: NTIS HC A04/MF A01

This guidebook provides a framework for the economic analysis of community energy systems. The analysis facilitates a comparison of competing configurations in community energy systems, as well as a comparison with conventional energy systems. Various components of costs and revenues to be considered are discussed in detail. Computational procedures and accompanying worksheets are provided for calculating the net present value, straight and discounted payback periods, the rate of return, and the savings to investment ratio for the proposed energy system alternatives. These computations are based on a projection of the system's costs and revenues over its economic lifetimes. The guidebook also discusses the sensitivity of the results of this economic analysis to changes in various parameters and assumptions. DOE

N82-31811# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

ENERGY-TECHNOLOGY EVALUATION UTILIZING LINEAR PROGRAMMING MODEL

D. HILL Oct. 1981 10 p refs Presented at the 4th World Energy Eng. Congr., Atlanta, 12-15 Oct. 1981

(Contract DE-AC02-76CH-00016)
(DE82-009162; BNL-30885; CONF-811030-4) Avail: NTIS HC A02/MF A01

Formulation of MARKAL (for MARKET ALlocation), a time phased linear program for each member state of the International Energy Agency to describe the potential changes in its energy system during the period 1980 to 2020 is discussed. The MARKAL model consists of a set of inequations that describe the constraints on the energy system; e.g., each energy service demand must be satisfied, the consumption of each specific fuel cannot exceed its supply, the amount of electricity that can be produced on a summer day cannot exceed the total installed capacity of electric generating plants taking into account probable unavailable capacity, the growth in capacity from one time period to the next cannot exceed a specified rate, the amount of oil that can be produced by enhanced recovery techniques in the inequations describe for each time period the capacity of each technology that may be installed, the flow of energy through them, and the production of electricity, heat, and fuel products or energy services. There are essentially seven types of variables and fourteen principal types of inequations. The merits of such models are discussed, using as illustrations some of the results of the US case. DOE

N82-31817# Technische Hochschule, Aachen (West Germany). Verkehrswissenschaftliches Inst.

SPECIFIC ENERGY USE IN TRAFFIC. DETERMINATION AND COMPARISON OF SPECIFIC ENERGY CONSUMPTIONS.

VOLUME 1: TEXT Final Report [SPEZIFISCHER ENERGIEEINSATZ IM VERKEHR ERMITTLUNG UND VERGLEICH DER SPEZIFISCHEN ENERGIEVERBRAEUCHE]

W. SCHWANHAEUSSER, B. GOLLING, W. SIMON, H. C. ROESGEN, W. NICOLL, W. SCHNEIDER, U. DESEL, H. RADERMACHER, H. POHLMANN, R. FRIEDEL et al. Jul. 1981 327 p refs In GERMAN Sponsored by Bundesministers fuer Verkehr 2 Vol.

(FE-82007-80-VOL-1) Avail: NTIS HC A15/MF A01

The specific energy use by traffic in the Federal Republic of Germany was investigated by refined technical-physical calculation methods. All energetically important influence factors and their interactions were studied, resulting in the calculation model MICSIM. Results were converted into primary energy consumption values. One hundred and twenty seven representative means of transportation were investigated, covering the whole spectrum of the most important modern means of transportation. Author (ESA)

N82-31818# Technische Hochschule, Aachen (West Germany). Verkehrswissenschaftliches Inst.

SPECIFIC ENERGY USE IN TRAFFIC. DETERMINATION AND COMPARISON OF SPECIFIC ENERGY CONSUMPTIONS.

VOLUME 2: TABLES [SPEZIFISCHER ENERGIEEINSATZ IM VERKEHR ERMITTLUNG UND VERGLEICH DER SPEZIFISCHEN ENERGIEVERBRAEUCHE]

W. SCHWANHAEUSSER 1981 221 p In GERMAN 2 Vol.

(FE-82007/80-VOL-2) Avail: NTIS HC A10/MF A01

The specific energy use by traffic in the Federal Republic of Germany was investigated using refined technical physical calculation methods. All energetically important influence factors and their interactions were systematically studied, resulting in the calculation model MICSIM. Results were converted into primary consumption values. In all, 127 representative means of transportation were investigated, covering the whole spectrum of the most important modern means of transportation. Author (ESA)

N82-31819# Stuttgart Univ. (West Germany). Abteilung Reaktorsicherheit und Umwelt.

ALTERNATIVE DEVELOPMENT POSSIBILITIES OF THE TRANSPORTATION ENERGY DEMAND IN BADEN-WUERTTEMBERG, WEST GERMANY Ph.D. Thesis [ALTERNATIVE ENTWICKLUNGSMOEGELICHKEITEN DES ENERGIEBEDARFS IM BEREICH VERKEHR IN BADEN-WUERTTEMBERG]

T. LEVAN Aug. 1981 156 p refs In GERMAN (IKE-K-54-7; ISSN-0173-6892) Avail: NTIS HC A08

The development possibilities of the transportation energy demand in Baden-Wuerttemberg were qualitatively and quantitatively investigated using a traffic model, in order to serve as a basis for transportation strategy and structuring. The traffic model was set up using established hypothetical interactions and statistical data on traffic. In order to quantize the model equations regression analysis was used. The impact of technological and economic developments on traffic and energy demand is discussed. Author (ESA)

N82-31820# Stuttgart Univ. (West Germany). Abteilung Reaktorsicherheit und Umwelt.

CALCULATION OF THE FINAL ENERGY DEMAND FOR THE FEDERAL REPUBLIC OF GERMANY WITH THE SIMULATION MODEL MEDEE-2 [DIE BESTIMMUNG DES ENERGIEBEDARFS DER BUNDESREPUBLIK DEUTSCHLAND MIT HILFE DES SIMULATIONSMODELLS MEDEE-2]

U. LOEFFLER and H. WEIBLE Aug. 1981 82 p refs In GERMAN; ENGLISH summary (IKE-K-66; ISSN-0173-6892) Avail: NTIS HC A05/MF A01

The final energy demand for the Federal Republic of Germany was calculated. The model MEDEE-2 describes, in relationship to a given distribution of the production of single industrial sectors, of energy specific values and of population development, the final energy consumption of the domestic, service industry and transportation sectors for a given region. The input data, consisting of constants and variables, and the proceeding, by which the projections for the input data of single sectors are performed, are discussed. The results of the calculations are presented and are compared. The sensitivity of single results in relation to the variation of input values is analyzed. Author (ESA)

N82-31822# Science Applications, Inc., La Jolla, Calif. **ENERGY EFFICIENCY IMPROVEMENT OF RESIDENTIAL AND COMMERCIAL GAS APPLIANCES, PHASE 2 Final Report, Dec. 1979 - Jun. 1981**

D. L. PETERKA, T. C. LARSON, and R. C. ERICKSON Jan. 1982 159 p refs (Contract GRI-5011-345-0095) (PB82-169681; SAI-444-81-202-LJ; GRI-81/0014) Avail: NTIS HC A08/MF A01 CSCL 10A

A preliminary market survey was conducted which included retailers, consumers, and manufacturers of commercial water heaters. The major goals of the survey were to determine acceptable cost increments, payback periods, add marketing avenues, as well as to determine the current attitudes about commercial water heaters. A parametric market penetration model was also developed to predict market shares as a function of payback period and first cost premiums. The model accounts for consumer behavior as determined from the surveys as well as the barriers identified. GRA

N82-31831# Swedish Water and Air Pollution Research Lab., Goeteborg.

STRESS IN ECOSYSTEMS

A. JERNELOEV and U. WAHLGREN Mar. 1981 13 p refs (DE82-901366; IVL-B-599) Avail: NTIS (US Sales Only) HC A02/MF A01; DOE Depository Libraries

A stress concept which relates to energy flows through ecosystems is suggested. The need of quantifying of responses to external pressure is pointed out. The efficiency of the systems is defined as the degree of utilization of the available energy, and these factors are used for definitions of stress. The concepts are

visualized in quantities obtained from simple Lotka-Volterra type equations. DOE

N82-31835# Oak Ridge National Lab., Tenn. **SYMPOSIUM ON INTERMEDIATE-RANGE ATMOSPHERIC-TRANSPORT PROCESSES AND TECHNOLOGY ASSESSMENT**

Oct. 1981 455 p refs Symp. held at Gatlinburg, Tenn., 1 Oct. 1980

(Contract W-7405-ENG-26)

(DE82-000889; CONF-801064) Avail: NTIS HC A20/MF A01

Studies of air pollution transport are given. Emphasis is placed on the modeling of atmospheric transport processes. DOE

N82-31843# Department of Energy, Washington, D. C. **ENVIRONMENTAL ASSESSMENT: DEPARTMENT OF ENERGY FINANCIAL INCENTIVES FOR PRODUCTION OF UP TO 60,000 BARRELS PER DAY OF ETHANOL**

Nov. 1981 138 p refs

(DE82-010683; DOE/EA-0140) Avail: NTIS HC A07/MF A01

This environmental assessment evaluates all phases of fuel ethanol production and use and compares program alternatives. It is expected that the production and use of 60,000 bbl/d of ethanol should produce no major environmental effects. Environmental residuals, health and safety concerns, and institutional issues associated with the conversion, distribution, and end use of ethanol are all amenable to control or mitigation through currently available techniques or solutions. Additional production of feedstocks to meet the 60,000 bbl/d goal raises the most concern, but the amount of new cropland required appears to be manageable from an environmental perspective. As a result, no insurmountable environmental impacts are expected from the ethanol production goal of 60,000 bbl/d. DOE

N82-32054 International Inst. for Applied Systems Analysis, Laxenburg (Austria).

ACTIVITIES OF THE INTERNATIONAL SCIENTIFIC RESEARCH INSTITUTIONS Annual Report, 1981

1981 70 p refs Original doc. contains color illustration

Avail: Issuing Activity

Energy systems, food and agriculture, Earth resources and the environment, human settlements and services, and management sciences research is summarized. Energy needs were analyzed. National agricultural models were developed. The greenhouse effect was studied. Migration and spatial population growth patterns were analyzed. Author (ESA)

N82-32125# Department of Energy, Washington, D. C. Div. of High Energy Physics.

INTERIM REPORT OF THE SUBPANEL ON LONG RANGE PLANNING FOR THE US HIGH ENERGY PHYSICS PROGRAM OF THE HIGH ENERGY PHYSICS ADVISORY PANEL

Nov. 1981 31 p

(DE82-004032; DOE/ER-0112) Avail: NTIS HC A03/MF A01

The subpanel strongly recommends that the ISABELLE project go forward and be completed during this decade. ISABELLE provides a major new facility that will enable the U.S. high energy physics program to remain active and healthy during this decade and into the next. The construction of ISABELLE and the other essential components of the US program require a minimum annual level of support that averages \$440M (FY 1982 dollars) in DOE funds per year. If support at this level cannot be made available in time for ISABELLE completion within this decade, the ISABELLE project cannot be continued. DOE

N82-32201# Oak Ridge National Lab., Tenn. Energy Div. **POTENTIAL FOR DISTRICT HEATING: AN HISTORICAL OVERVIEW**

M. A. BRODERS Oct. 1981 73 p refs

(Contract W-7405-ENG-26)

(DE82-001959; ORNL/TM-7791) Avail: NTIS HC A04/MF A01

A brief historical overview of district heating is presented. Attention is focused on the potential of district heating to meet

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our nation's energy conservation, environmental, and social objectives. Basic terms are defined and the principle of district heating operation is described. District heating thermal energy sources, transmission and distribution piping, and consumer secondary heating systems are discussed in very general terms. For comparison, the history and status of district heating in Europe is also summarized. The advantages of district heating are outlined, and the primary factors that impeded the implementation of district heating in the United States are discussed. DOE

N82-32204# Department of Energy, Washington, D. C.
ELECTRIC AND HYBRID VEHICLES PROGRAM Annual Report to Congress, Fiscal Year 1981
Mar. 1982 21 p refs
(DE82-009484; DOE/CE-0028; AR-5) Avail: NTIS HC A02/MF A01

The emphasis in the Electric and Hybrid Vehicles Program shifted from vehicle demonstration and preparation for production readiness to research, development, test, and evaluation of advanced technologies to achieve the attributes necessary to make electric and hybrid vehicles a practical transportation alternative. Research and development efforts in batteries and propulsion components, as well as total vehicle systems, continue to reveal significant progress toward providing industry with technology options that will result in vehicles with greater public acceptance. DOE

N82-32352# Operations Research, Inc., Silver Spring, Md.
AIRCRAFT ENERGY CONSERVATION DURING AIRPORT GROUND OPERATIONS Final Report
J. BAUCHSPIES, F. COSTELLO, J. FELDER, J. THOMPSON, and H. HILLIARD Washington FAA Mar. 1982 313 p
(Contract DTFA01-80-C-10132)
(AD-A116138; FAA-EE-82-8; ORI-TR-1974) Avail: NTIS HC A14/MF A01 CSCL 01B

This study identifies and assesses potential fuel conservation options which are available for use during ground operations at Dulles International (IAD) and Washington National (DCA) airports. The study also identifies and analyzes ground operations fuel savings options which have been considered and/or implemented by the various airlines operating at IAD and/or DCA since 1971. In addition, an evaluation of computer models which could be used for analyzing these fuel conservation options at other airports is included. The impact of socio/economic factors such as safety, environment, limitation on expansion and restrictions on accommodating forecast activity at DCA and IAD were considered during the analysis of each option. Author (GRA)

N82-32380*# Boeing Commercial Airplane Co., Seattle, Wash.
Preliminary Design Dept.
INTEGRATIVE APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT. INITIAL ACT CONFIGURATION DESIGN STUDY Final Report, Aug. 1978 - Sep. 1979
Jul. 1980 412 p refs
(Contract NAS1-14742; NAS1-15325)
(NASA-CR-159249; NAS 1.26:159249; D6-48662) Avail: NTIS HC A18/MF A01 CSCL 01C

The performance and economic benefits of a constrained application of Active Controls Technology (ACT) are identified, and the approach to airplane design is established for subsequent steps leading to the development of a less constrained final ACT configuration. The active controls configurations are measured against a conventional baseline configuration, a state-of-the-art transport, to determine whether the performance and economic changes resulting from ACT merit proceeding with the project. The technology established by the conventional baseline configuration was held constant except for the addition of ACT. The wing, with the same planform, was moved forward on the initial ACT configuration to move the loading range aft relative to the wing mean aerodynamic chord. Wing trailing-edge surfaces and surface controls also were reconfigured for load alleviation and structural stabilization. J.M.S.

N82-32524# ESCOR, Inc., Northfield, Ill.
LANDFILL METHANE RECOVERY. PART 1: ENVIRONMENTAL IMPACTS Final Report, Sep. 1980 - Sep. 1981
R. E. ZIMMERMAN and M. E. GOODKIND Oct. 1981 100 p refs
(Contract GRI-5080-351-0343)
(PB82-181298; GRI-80/0084-PT-1) Avail: NTIS HC A05/MF A01 CSCL 21D

The potential environmental and safety impacts of landfill methane recovery are discussed. The conclusion is that the range of uses for landfill gas and relative simplicity of the supply process make this technology suitable for investigation by both private industry and public utilities. The environmental and safety issues of most concern are those that exist because of uncertainties in the effects of human exposure to gas contaminants and also due to lack of data on possible contaminants in the gas. Research recommendations were directed toward reduction of these uncertainties. GRA

N82-32844# Oak Ridge National Lab., Tenn. Energy Div.
LARGE CLIMATE-MODERATING ENVELOPES FOR ENCLOSED STRUCTURES. A PRELIMINARY EVALUATION OF ENERGY CONSERVATION POTENTIAL
R. L. WENDT, G. E. GILES, and J. E. PARK Dec. 1981 113 p refs
(Contract W-7405-ENG-26)
(ORNL/TM-8018) Avail: NTIS HC A06/MF A01

A preliminary estimate of the energy conservation benefits of a large climate moderating envelope (LCME). A hypothetical LCME design was chosen and a coupled fluid dynamic and energy transport analysis was performed to estimate the energy conservation potential of this design. The heat transfer models included insolation, outside air temperature and wind, thermal radiation exchange with the sky and between the fabric and ground and thermal storage in the earth mass beneath the LCME. The energy transported within the fluid by the buoyancy driven circulation was modeled as an incompressible fluid utilizing the Boussinesq approximation. The climatic conditions were assumed to vary in smooth repeating daily cycles. The numerical simulation of climatic variation was continued until the results within the LCME achieved a repeating daily cycle. The results for selected seasonally characteristic days were utilized to estimate the annual energy consumption of structures within an LCME relative to similar structures exposed to the exterior environment. Author

N82-32858*# Boeing Commercial Airplane Co., Seattle, Wash.
System Technology Staff.
INTEGRATED ENERGY MANAGEMENT STUDY. ENERGY EFFICIENT TRANSPORT PROGRAM Contractor Final Report, 10 Aug. 1977 - 7 Jan. 1978
Mar. 1979 102 p refs
(Contract NAS1-14742)
(NASA-CR-158980; NAS 1.26:158980; D6-46700) Avail: NTIS HC A06/MF A01 CSCL 10B

The Integrated Energy Management (IEM) Study investigated the practicality and feasibility of a closed-loop energy management system for transport aircraft. The study involved: (1) instrumentation and collection of in-flight data for a United Airlines 727-200 flying 80 revenue flights throughout the United Airlines network, (2) analysis of the in-flight data to select representative city pairs and establish operational procedures employed in flying a reference flight profile, (3) simulation of the reference profile in a fast-time model to verify the model and establish performance values against which to measure IEM benefits, (4) development of IEM algorithms, and (5) assessment of the IEM concept. Author

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N82-32859*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
ENERGY SAVING CONCEPTS RELATING TO INDUCTION GENERATORS

F. J. NOLA Aug. 1980 12 p refs
(NASA-TP-1719; NAS 1.60:1719) Avail: NTIS HC A02/MF A01
CSCL 10B

Energy saving concepts relating to induction generators are presented. The first describes a regenerative scheme using an induction generator as a variable load for prime movers under test is described. A method for reducing losses in induction machines used specifically as wind driven generators is also described. S.L.

N82-32866# Army Cold Regions Test Center, Fort Greely, Ark. Civil Engineering Research Branch.

EVALUATING THE HEAT PUMP ALTERNATIVE FOR HEATING ENCLOSED WASTEWATER TREATMENT FACILITIES IN COLD REGIONS

C. J. MARTEL and G. E. PHETTEPLACE May 1982 26 p refs
(Contract DA PROJ. 4A7-62730-AT-42)
(AD-A116385; CRREL-SR-82-10) Avail: NTIS HC A03/MF A01
CSCL 13A

This report presents a five-step procedure for evaluating the technical and economic feasibility of using heat pumps to recover heat from treatment plant effluent. The procedure is meant to be used at the facility planning level by engineers who are unfamiliar with this technology. An example of the use of the procedure and general design information are provided. Also, the report reviews the operational experience with heat pumps at wastewater plants located in Fairbanks, Alaska, Madison, Wisconsin, and Wilton, Maine. Author (GRA)

N82-32874# National Center for Resource Recovery, Washington, D. C.

REVIEW OF COMPARATIVE ENERGY USE IN MATERIALS POTENTIALLY RECOVERABLE FROM MUNICIPAL SOLID WASTE

M. L. RENARD Mar. 1982 79 p refs
(Contract DE-AC01-76CS-20167)
(DE82-012375; DOE/CS-20167/12) Avail: NTIS HC A05/MF
A01

Published literature on the energy savings that might be realized from manufacturing four materials present in municipal solid waste (MSW), using recycled rather than virgin materials is reviewed. The four materials examined are glass, paper, steel, and aluminum. An attempt is made to assess this energy savings, reported by diverse sources, on a consistent basis or at least by pointing out the conceptual bases on which the results were obtained. Significant savings in manufacturing energy are achievable for aluminum, steel, glass, and certain grades of paper. These materials are all potentially recoverable from the municipal solid waste stream, but must be of a purity and in a form acceptable to the respective industries for reuse in manufacturing. DOE

N82-32878# Prototech, Inc., Newton Highlands, Mass.
ENERGY SAVINGS BY MEANS OF FUEL-CELL ELECTRODES IN ELECTROCHEMICAL INDUSTRIES Final Report, 1 Aug. 1980 - 31 Jul. 1981

A. BAR-ILAN, W. JUDA, and B. P. FINNIGAN 20 Nov. 1981
83 p refs
(Contract DE-AC02-78ET-25309)
(DE82-010485; DOE/ET-25309/34; COO-4881-34) Avail: NTIS
HC A05/MF A01

A pretreatment protocol for improvement in the performance of Prototech's zinc electrowinning cell with purification of the Zn SO₄ feed solution, was developed. Measurable improvements in cell voltage and current efficiency, and a reduction in energy consumption was obtained. The anode operating potential determination together with the overall (anode-to-cathode) cell potential, evaluate cell performance with alternative platinum catalysts, porous supports and current collectors. Life tests were

carried out with a number of types with various loadings of platinum and with a standard loading of palladium. Testing with anodes with all levels of platinum loading demonstrated sustained energy efficient performance. Hydrogen gas feed and liquid recirculation with depth were adjusted. The additives used to pretreat the feed were modified. A depth cell was tested at depths of 1, 2, and 3 feet. Increase in cell voltage with increased cell size was largely offset by replacement of the edge wise graphite current collector with a porous metallic current collector, as well as by improved contact between electrode and current collector. DOE

N82-32893# United Nations Economic Commission for Europe, Geneva (Switzerland).

COMPENDIUM ON LOW AND NON-WASTE TECHNOLOGY, MONOGRAPHS 1-20

Feb. 1982 289 p Partly in FRENCH, RUSSIAN and ENGLISH
Sponsored in part by EPA
(PB82-166976; ECE/ENV/36) Avail: NTIS HC A13/MF A01
CSCL 10A

Process technologies which reduce or eliminate wastes and reduce energy usage are described. The low and nonwaste technologies are described and compared to the conventional technologies that were replaced. GRA

N82-32894# United Nations Economic Commission for Europe, Geneva (Switzerland).

COMPENDIUM ON LOW AND NON-WASTE TECHNOLOGY, MONOGRAPHS 21-46

Feb. 1982 285 p In ENGLISH, FRENCH and RUSSIAN
Sponsored in part by EPA
(PB82-166984) Avail: NTIS HC A13/MF A01 CSCL 10A

The monographs contain descriptions of process technologies which reduce or eliminate wastes and reduce energy usage. The low and non-waste technologies are described and compared to the conventional technologies that have been replaced. GRA

N82-32967# Oak Ridge National Lab., Tenn. Health and Safety Research Div.

ENHANCED BENZOAPYRENE METABOLISM IN HAMSTER EMBRYONIC CELLS EXPOSED IN CULTURE TO FOSSIL-SYNFUEL PRODUCTS

D. D. SCHURESKO, G. D. GRIFFIN, M. C. MACLEOD, and J. K. SELKIRK 1981 7 p refs Presented at the 6th Symp. on Polycyclic Aromatic Hydrocarbons, Columbus, Ohio, 27 Oct. 1981
(Contract W-7405-ENG-26)

(DE82-002904; CONF-811086-3) Avail: NTIS HC A02/MF A01
The enzyme aryl hydrocarbon mono-oxygenase (AHM) is involved in the initial metabolism of polynuclear aromatic (PNA) compounds to excretable polar derivatives. The utilization of AHM induction as a biochemical indicator of exposure to PNA's is investigated in cultured mammalian cells exposed to fossil synfuel materials. GRA

N82-33215# National Science Foundation, Washington, D.C. Div. of Policy Research and Analysis.

MOBILIZATION OF THE PRIVATE SECTOR IN EFFECTIVE DEVELOPMENT OF FUSION ENERGY: PAPERS FOR AND A SUMMARY OF A WORKSHOP

1981 104 p Workshop held in Washington, D.C., 29-30 Sep. 1980
(PB82-173469; NSF/PRA-81023) Avail: NTIS HC A06/MF A01
CSCL 18A

Four papers and a summary of a workshop on the mobilization of the private sector in developing fusion energy is reported. The workshop is one of a series which assesses Federal policy options relating to the commercialization of selected energy technologies viewed as alternatives to petroleum-derived fuels. The papers focused on the potential roles to be played by fusion energy in the future electric generating industry; current commitments and participation of the private sector in fusion energy development; suggestions for policy incentives to enhance private participation in fusion research; organization, staffing, and operating a center for fusion engineering; the industrial structure and practices in

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developing and deploying power generating facilities and their implications in relation to fusion energy development; and characteristics required by any new energy-producing technology such as low capital and operating costs and minimal environmental output. Author

N82-33392*# Teledyne Continental Motors, Mobile, Ala. Aircraft Products Div.

EXHAUST EMISSIONS REDUCTION FOR INTERMITTENT COMBUSTION AIRCRAFT ENGINES Final Report

B. J. REZY, K. J. STUCKAS, J. R. TUCKER, and J. E. MEYERS
May 1982 55 p refs

(Contract NAS3-19755)
(NASA-CR-167914; NAS 1.26:167914) Avail: NTIS HC A04/MF A01 CSCL 21E

Three concepts which, to an aircraft piston engine, provide reductions in exhaust emissions of hydrocarbons and carbon monoxide while simultaneously improving fuel economy. The three chosen concepts, (1) an improved fuel injection system, (2) an improved cooling cylinder head, and (3) exhaust air injection, when combined, show a synergistic relationship in achieving these goals. In addition, the benefits of variable ignition timing were explored and both dynamometer and flight testing of the final engine configuration were accomplished. S.L.

N82-33393*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.

THE CF6 JET ENGINE PERFORMANCE IMPROVEMENT: LOW PRESSURE TURBINE ACTIVE CLEARANCE CONTROL

B. D. BECK and W. A. FASCHING Jun. 1982 159 p refs
(Contract NAS3-20629)

(NASA-CR-165557; NAS 1.26:165557; R82AEB462) Avail: NTIS HC A08/MF A01 CSCL 21E

A low pressure turbine (LPT) active clearance control (ACC) cooling system was developed to reduce the fuel consumption of current CF6-50 turbofan engines for wide bodied commercial aircraft. The program performance improvement goal of 0.3% delta sfc was determined to be achievable with an improved impingement cooling system. The technology enables the design of an optimized manifold and piping system which is capable of a performance gain of 0.45% delta sfc. E.A.K.

N82-33394*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.

ENERGY EFFICIENT ENGINE: TURBINE TRANSITION DUCT MODEL TECHNOLOGY REPORT

K. LEACH and R. THURLIN Aug. 1982 113 p refs
(Contract NAS3-20646)

(NASA-CR-167996; NAS 1.26:167996; PWA-5594-215) Avail: NTIS HC A06/MF A01 CSCL 21E

The Low-Pressure Turbine Transition Duct Model Technology Program was directed toward substantiating the aerodynamic definition of a turbine transition duct for the Energy Efficient Engine. This effort was successful in demonstrating an aerodynamically viable compact duct geometry and the performance benefits associated with a low camber low-pressure turbine inlet guide vane. The transition duct design for the flight propulsion system was tested and the pressure loss goal of 0.7 percent was verified. Also, strut fairing pressure distributions, as well as wall pressure coefficients, were in close agreement with analytical predictions. Duct modifications for the integrated core/low spool were also evaluated. The total pressure loss was 1.59 percent. Although the increase in exit area in this design produced higher wall loadings, reflecting a more aggressive aerodynamic design, pressure profiles showed no evidence of flow separation. Overall, the results acquired have provided pertinent design and diagnostic information for the design of a turbine transition duct for both the flight propulsion system and the integrated core/low spool. J.M.S.

N82-33822# Resource Planning Associates, Inc., Cambridge, Mass.

THE POTENTIAL FOR INDUSTRIAL COGENERATION DEVELOPMENT BY 1990 Final Report

31 Jul. 1981 158 p refs
(RA-81-1455) Avail: NTIS HC A08/MF A01

The cogeneration study focused on five industries that constitute three quarters of industrial steam demand: pulp and paper, chemicals, petroleum refining, steel, and food processing. These industries use almost one fifth of the total energy consumed in the United States. The analysis reflected the investment and regulatory concerns in the United States. The analysis reflected the investment used by industrial and utility managers. Phone discussions were held with approximately 70 companies to verify and augment the process and energy use data for the five industries. S.L.

N82-33825*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NECAP 4.1: NASA'S ENERGY COST ANALYSIS PROGRAM ENGINEERING MANUAL

R. N. JENSEN May 1982 430 p refs
(NASA-TM-83240; NAS 1.15:83240) Avail: NTIS HC A19/MF A01 CSCL 10A

The detailed procedure and algorithms used by the NASA Energy-Cost Analysis Program (NECAP) for determining and minimizing building energy consumption are provided. Author

N82-33826*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NECAP 4.1: NASA'S ENERGY COST ANALYSIS PROGRAM ENGINEERING FLOW CHART

R. N. JENSEN May 1982 166 p refs
(NASA-TM-83242; NAS 1.15:83242) Avail: NTIS HC A08/MF A01 CSCL 10A

Flow charts for one NASA Energy-Cost Analysis Program (NECAP) to determine and to minimize building energy consumption are provided. Author

N82-33829*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ON THE ROAD PERFORMANCE TESTS OF ELECTRIC TEST VEHICLE FOR CORRELATION WITH ROAD LOAD SIMULATOR Final Report

M. O. DUSTIN and R. J. SLAVIK Aug. 1982 27 p refs
(Contract DE-A101-77CS-51044)

(NASA-TM-82900; E-1283; DOE/NASA/51044-25; NAS 1.15:82900) Avail: NTIS HC A03/MF A01 CSCL 13F

A dynamometer (road load simulator) is used to test and evaluate electric vehicle propulsion systems. To improve correlation between system tests on the road load simulator and on the road, similar performance tests are conducted using the same vehicle. The results of track tests on the electric propulsion system test vehicle are described. The tests include range at constant speeds and over SAE J227a driving cycles, maximum accelerations, maximum gradability, and tire rolling resistance determination. Road power requirements and energy consumption were also determined from coast down tests. S.L.

N82-33839# Little (Arthur D.), Inc., Cambridge, Mass.

RESIDUAL ENERGY APPLICATION PROGRAM: UTILIZATION OF HIGH-TEMPERATURE WASTE HEAT BY MEANS OF RANKINE-CYCLE ENGINES. A TECHNICAL SUMMARY Final Report

Oct. 1981 49 p
(Contract DE-AC05-79ET-60035)
(DE82-010376; DOE/ET-60035/T3; ADL-36011) Avail: NTIS HC A03/MF A01

High temperature residual or waste heat which is directly discharged by industries and utilities in the form of exhaust gases and which can be converted to useful energy through the use of Rankine bottoming cycle (RBC) engines is discussed. The potential markets for RBC's in industrial processing, the gas pipeline industry,

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and municipal and public utilities are discussed. The potential oil savings and foreseeable factors that can affect RCB market penetration in these industries are summarized. The operating principles and system efficiency of a Rankine cycle system are discussed. In selecting a Rankine engine for a given application, consideration must be given to the thermodynamic properties and thermal stability of its working fluid as well as to the fluid's safety properties. DOE

N82-33850# City of Columbia, Mo.
DEVELOPMENT OF A WASTE-TO-ENERGY PLAN: CITY OF COLUMBIA, MISSOURI
Feb. 1982 93 p
(Contract DE-FG01-79CS-20239)
(DE82-009288; DOE/CS-20239/1) Avail: NTIS HC A05/MF A01

The development of a practical plan whereby energy can be recovered from the solid wastes generated in the Columbia, Missouri area is discussed. This plan proceeds only to the point at which the City of Columbia and the University of Missouri can determine their most appropriate course of action. The approaches explored in the development of the plan include: use of shredded solid waste in the existing stoker-fired boilers and use of unprocessed solid waste as fuel in modular burning units equipped with waste heat boilers for the production of steam. This approach would be applicable to the University of Missouri system, which has the potential capability of utilizing all of the steam which could be produced from the available waste and also would potentially be applicable for local industrial uses. The other approach is the use of the gases of combustion from the primary chambers of modular burning units for direct injection into the furnace of an existing gas-fired municipal boiler. This approach was extended to include coal-fired boilers as well. A general assessment of hazardous wastes generated in the community was done. DOE

N82-33851# Acres American, Inc., Buffalo, N.Y.
INTEGRATED ENVIRONMENTAL AND SAFETY ASSESSMENT OF SELECTED MECHANICAL ENERGY STORAGE SYSTEMS Final Report
Jan. 1982 315 p refs Prepared in cooperation with Nuclear Utility Services, Inc., Rockville, Md.
(Contract EPRI PROJ. 1317-2)
(DE82-902073; EPRI-EA-2231) Avail: NTIS HC A14/MF A01

The environmental, safety, and social impacts of two mechanical storage systems, underground pumped hydro (UPH) and compressed air energy storage (CAES) are similar to those of existing peaking power plants. These impacts, with engineering factors, form a methodology for selecting sites for these two systems. Application of this methodology to a hypothetical case indicates that, although design alternatives which mitigate adverse environmental impacts are recommended, site selection effectively limits the environmental effect of CAES or UPH plants. Public perception of CAES and UPH energy storage facilities should generally be positive, provided that those affected are informed and allowed to participate in the siting process. DOE

N82-33853# Southern Solar Energy Center Planning Project, Atlanta, Ga.
RESIDENTIAL HEATING AND COOLING LOADS AND COSTS FOR THE SOUTH

A. S. LAU and T. D. HYATT Jan. 1982 29 p refs
(Contract DE-AC02-79CS-30166)
(DE82-009504; SSEC/TP-41300) Avail: NTIS HC A03/MF A01

Typical residential heating and cooling loads for 24 southern cities and six other US cities were analyzed. A 1536-square-foot house was examined, with concrete slab floor, frame construction, ventilated attic, and glazing area equivalent to 12% of the floor area. Five basic variations of this house were analyzed: two insulation levels with two compass orientations each, and a Sun-tempered case. The building load calculations were based on a non-rigorous methodology typically used within the building community today. The estimated heating and cooling loads and the impact of insulation, orientation, and sun-tempering are

illustrated with regional maps. Typical fuel costs and heating systems are also examined and shown to have a major role in determining whether the building design emphasis should be on heating or cooling. DOE

N82-33860# Synergistic Design and Engineering, Minneapolis, Minn.
HOME RETROFITTING FOR ENERGY CONSERVATION AND SOLAR CONSIDERATIONS
Oct. 1981 98 p refs Prepared for the Mid-American Solar Energy Complex, Minneapolis
(Contract DE-AC02-79CS-30150)
(DE82-013420; MASEC-SCR-81-091) Avail: NTIS HC A05/MF A01

A manual which explains both the key concepts behind the need for and the home energy efficiency improvement is reviewed. A comprehensive picture of how home energy use is effected by the inhabitants and by the structure itself is presented. The manual explains: looking at energy, how the heat transfer occurs between houses and humans, energy audits and how to use them, energy conservation actions to do now to reduce energy use. Schemes to reduce infiltration, how to increase insulation, and what to do with windows and doors, heating and heat distribution systems, and water heaters are included. Solar energy options are explained, as well as financing and tax credits. DOE

N82-33874# Fuel and Energy Consultants, Inc., New York, N.Y.
ASSESSMENT OF ENERGY SAVING TECHNOLOGIES WITH POTENTIAL FOR APPLICATIONS IN US INDUSTRIES
Jan. 1982 215 p
(Contract DE-AC06-76RL-01830)
(DE82-012571; DOE/NBB-0002) Avail: NTIS HC A10/MF A01

The purpose of this study was to assess and evaluate information on energy technologies displayed at international trade shows was assessed and evaluated. Technologies that had potential for saving energy in applications in US industries were identified. These technologies are identified and concise summaries on potential energy savings, economics, basic operational considerations, and potential applications are prepared. An objective of this study was to determine whether international trade shows can provide a convenient and useful forum for the identification of energy saving technologies which could have wider applications in US industry. Forty-four technologies were chosen for inclusion which are grouped into the following categories: heat recovery devices, heat exchangers, heat pumps, and various other technologies. Some of the technologies include: a low energy drying system, solid waste in cement manufacturing, boiler fuel optimization system, multifuel boiler plant and coal combustion efficiency improvements. DOE

N82-33875# Pacific Northwest Lab., Richland, Wash.
IDENTIFICATION OF ENERGY CONSERVATION RESEARCH OPPORTUNITIES: A REVIEW AND SYNTHESIS OF THE LITERATURE
W. J. HOPP, G. J. HANE, W. E. GURWELL, S. G. HAUSER, R. E. WILLIFORD, T. A. WILLIAMS, and W. B. ASHTON Mar. 1982 293 p refs
(Contract DE-AC06-76RL-01830)
(DE82-015028; PNL-3966) Avail: NTIS HC A13/MF A01

Thirty-eight studies of energy conservation research opportunities are reviewed. The 38 studies chosen for review include many of the major efforts in the identification of energy conservation research and development (R and D) opportunities and provide a representative sample of the types of studies that were performed. The sample includes studies that focus on specific energy use (e.g., auto transport), as well as studies that focus on specific types of research (e.g., materials science). The sample also includes studies that can be further contrasted in terms of long-term vs. short-term projects, evolutionary vs. revolutionary ideas, generic vs. process-specific activities, and technology base research vs. hardware development. Each of these perspectives contributes toward assuring coverage of the breadth of energy conservation R and D opportunities. In each review the technical

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or end-use focus is described, the research ideas identified in the study are listed, and a critical summary is given. The reviews also indicate whether the studies present end-use consumption data, estimate potential energy savings, estimate times to commercialization, summarize existing research programs, or describe the identification methodology. DOE

N82-33882# New York State Dept. of Environmental Conservation, Albany.
ELECTRICAL ENERGY CONSUMPTION AND HEATING REQUIREMENTS OF MUNICIPAL WASTEWATER TREATMENT PLANTS Final Report
M. H. WANG and L. K. WANG Feb. 1982 35 p refs Prepared for Lenox Inst. for Research, Inc., Mass.
(PB82-183393; LIR/12-81/1) Avail: NTIS HC A03/MF A01
CSCL 10A

Electrical energy consumption models were developed. The unit operations/processes of pumping, screening and comminution, grit removal, sedimentation, chlorination, gravity thickening, anaerobic digestion, vacuum filtration, incineration, and diffused air flotation are examined. The mathematical models of total heating requirements of biological wastewater treatment plants are also presented. GRA

N82-33884# Massachusetts Inst. of Tech., Cambridge. Energy Lab.
ENERGY LABORATORY DATA AND MODEL DIRECTORY Final Report
S. LAHIRI and J. CARSON Jul. 1981 180 p refs
(PB82-180274; MIT-EL-81-025) Avail: NTIS HC A09/MF A01
CSCL 10A

Over the past several years M.I.T. faculty, staff, and students have produced a substantial body of research and analysis relating to the production, conversion, and use of energy in domestic and international markets. Much of this research takes the form of models and associated data bases that have enduring value in policy studies (models) and in supporting related research and modeling efforts (data). For such models and data it is important to ensure that the useful life cycle does not end with the conclusion of the research project. This directory is an important step in extending the usefulness of models and data bases available at the M.I.T. Energy Laboratory. It will be updated from time to time to include new models and data bases that have been developed, or significant changes that have occurred. Author

N82-33885# Montana Energy and MHB Research and Development Inst., Inc., Butte. Center for Innovation.
THE MONTANA ENERGY AND MHD DEVELOPMENT INSTITUTE, INC. Final Report
Oct. 1981 124 p
(Contract EDA-05-06-01815-40)
(PB82-176926; EDA-82-0020) Avail: NTIS HC A06/MF A01
CSCL 05C

The business of commercializing a new product, service, or technique is examined. In most instances, inventors are not equipped to provide, either from their own capabilities or through paying for others, the necessities. The services of legitimate organizations, such as the Center for Innovation, are very badly needed. The center's operation deals primarily with independent inventors versus those associated with large or even small corporations. GRA

N82-33888# National Oceanic and Atmospheric Administration, Washington, D. C.
OCEAN THERMAL ENERGY CONVERSION, FISCAL YEAR 1981. PUBLIC LAW 96-320 Report to Congress
Feb. 1982 42 p
Avail: NTIS HC A03/MF A01 CSCL 10A

The background of Ocean Thermal Energy Conversion (OTEC) which deals with the national interest and the nature of the industry, and OTEC technology, the legal regime, environmental considerations and the international impact and future of OTEC are discussed. At the current time no amendments to the ACT

are recommended. Several areas in which technical amendments would clarify the original intent of the Act are analyzed. The most significant of these relates to the specific requirements for issuance of OTEC licenses for facilities that are located partly on land and partly in ocean waters. GRA

N82-33895# Tennessee Valley Authority, Muscle Shoals, Ala. Div. of Energy Demonstrations and Technology.
PRELIMINARY ECONOMIC ANALYSIS OF NO SUB X FLUE-GAS TREATMENT PROCESSES USING TVA AND EPRI ECONOMIC PREMISES Final Report
J. D. MAXWELL, T. W. TARKINGTON, and T. A. BURNETT Dec. 1981 238 p refs Sponsored by Electric Power Research Inst. (Contract EPRI PROJ. 783-3)
(DE82-902223; EPRI-CS-2075) Avail: NTIS HC A11/MF A01

A preliminary level economic evaluation is made using design premises to compare seven flue gas treatment (FGT) processes for removal of nitrogen oxides (NO sub x) from power plant flue gas. The case examined is a 500 MW unit burning 3.5% sulfur coal and emitting 600 ppm NO sub x in the flue gas. A minimum removal efficiency of 90% for sulfur oxides (SO sub x) and NO sub x and 99.5% for particulates is assumed. To permit comparisons of the dry NO sub x FGT systems with the wet SO sub x - NO sub x systems, which also remove particulates, the costs of both a limestone slurry flue gas desulfurization (FGD) unit and an electrostatic precipitator (ESP) are added to the cost of the dry NO sub x - only processes and the cost of an ESP is added to the cost of the dry SO sub x NO sub x process. The wet SO sub x - NO sub x system and dry NO sub x systems (either SO sub x - NO sub x or NO sub x - only processes) have capital cost ranges of 205 \$/kW to 482 \$/kW, and 165 \$/kW to 175 \$/kW, respectively. DOE

N82-33896# Institute of Ecology, Indianapolis, Ind.
PROSPECTIVE SIGNIFICANCE OF TEMPERATE-ZONE CARBON POOL TRANSIENTS, 1980 - 2010
T. V. ARMENTANO and O. L. LOUCKS 1981 34 p refs
Presented at the Symp. on Global Dyn. of Biospheric Carbon, Bloomington, Ind., 17 Aug. 1981
(Contract DE-AC02-81EV-10725)
(DE82-011866; DOE/EV-10725/1) Avail: NTIS HC A03/MF A01

The extent to which the temperate zone sink for carbon will be limited by increased forest utilization which is a major question for biospheric carbon balances over the next two decades is discussed. Over the past 100 years, shifts in global carbon pools have operated asynchronously, with carbon storage at any time dependent on the net difference between opposing fluxes. The regrowth and soil sequestering transients of the last 60 years in the temperate zone tended to balance releases of carbon from other sources. Increased utilization of forests and other biospheric pools for fibre and energy may bring about similar responses worldwide with the temperate zone behaving more as a source of carbon dioxide. It is shown that the net carbon increment in US forests could be greatly reduced or eliminated in 20 to 30 years if an annual harvest rate of wood equivalent to 10 quads of energy prevails. The increment would be lost even if complete use of logging and manufacturing residues were attained. It is concluded that without complete residue utilization for energy, the carbon increment would be depleted more rapidly. DOE

N82-33897# Battelle Columbus Labs., Ohio.
NITROGEN OXIDE TRANSFORMATIONS IN POWER-PLANT PLUMES Interim Report
G. M. SVERDRUP, C. W. SPICER, and M. R. KUHLMAN Jan. 1982 158 p refs Sponsored by Electric Power Research Inst. (Contract EPRI PROJ. 1369-1)
(DE82-901847; EPRI-EA-2217) Avail: NTIS HC A08/MF A01

The chemical transformations which nitrogen oxides might undergo after emission from fossil fueled power plants are described. Kinetic data are obtained on the conversion of NO to NO2 and further oxidation of NO2 to form gaseous and particulate nitrates to be used in the development of chemical component

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for inclusion in reactive plume models. The models assess the impact of emitted NO/sub x/ on downwind air quality with resulting impacts on health and visibility, as well as acid precipitation. The objectives are to: (1) identify those reactions involving NO/sub x/ which are potentially important in power plant plumes; (2) acquire chemical kinetic data on those reactions where uncertainty exists; and (3) provide improved chemical kinetic models for estimation of the fate of NO/sub x/ in power plant plumes. The experimental design involves experiments on near and far field homogeneous chemistry and heterogeneous chemistry. DOE

N82-33898# Battelle Columbus Labs., Ohio.
EVALUATION OF TERRESTRIAL MICROCOSMS FOR ASSESSING ECOLOGICAL EFFECTS OF UTILITY WASTES Interim Report

P. VANVORIS, M. F. ARTHUR, and D. A. TOLLE Apr. 1982
175 p refs Sponsored by Electric Power Research Inst.
(Contract EPRI PROJ. 1224-5)
(DE82-903730; EPRI-EA-2364) Avail: NTIS HC A08/MF A01

The utility of microcosms (intact agricultural soil cores) in assessing ecosystem response to various levels of fly ash was determined. The suitability of microcosms as a technique for evaluating the potential environmental impacts of utility wastes prior to the adoption of this approach as a required test protocol was investigated. Soil water from both microcosms and field plots was analyzed for nutrient loss and pH. Microcosms and field plots were compared for net primary productivity and the uptake of 16 potentially toxic trace elements. It is found that microcosms are a cost effective technique for tracking ecosystem processes such as nutrient loss and trace element uptake. Chemical characterization of the fly ash and trends in nutrient loss data indicate that nitrate nitrogen is the best early warning indicator of system disruption from fly ash application. DOE

N82-33901# Lovelace Biomedical and Environmental Research Inst., Albuquerque, N. Mex. Inhalation Toxicology Research Inst.
POTENTIAL HEALTH AND ENVIRONMENTAL EFFECTS OF LIGHT-DUTY DIESEL VEHICLES, 2

R. G. CUDDIHY, W. C. GRIFFITH, C. R. CLARK, and R. O. MCCLELLAN Oct. 1981 107 p refs
(Contract DE-AC04-76EV-01013)
(DE82-014390; LMF-89) Avail: NTIS HC A06/MF A01

Occupational risks in the diesel reference industries, characteristics of light duty diesel vehicle emissions, potential environmental impacts of light duty diesel vehicles, exposures of people to diesel exhaust emissions, models for evaluating health risks to people from exposures to diesel vehicle exhaust, projected health risks from use of light duty diesel vehicles, and research needs are discussed. Results of computer simulation studies indicated that if diesel engines were used in 20% of light duty vehicles, little change would be expected in urban air concentrations of vapor phase hydrocarbons, nitrogen oxides, nitric and nitrous acid, ozone, hydrogen peroxide, and carbon monoxide. Several methods were developed to estimate cancer risk in people exposed to diesel exhaust particles. Results of two of the methods indicated that there would be 0.1 and 0.15 cancers per 100,000 people per SIGMA q/m sub 3 average lifetime exposure to diesel particles. DOE

N82-33902# Lenox Inst. for Research, Inc., Mass.
SYMPOSIUM ON ENVIRONMENTAL TECHNOLOGY AND MANAGEMENT

L. K. WANG, ed. Jan. 1982 109 p refs Symp. held at New York, N. Y., 12 Oct. 1980; sponsored by the Chinese-American Engineering and Management Inst. and the Chinese-American Academic Professional Association
(PB82-185273; LIR/12-81/5) Avail: NTIS HC A06/MF A01
CSCL 13B

Hazardous waste disposal techniques are discussed in relation to petroleum refining and nuclear wastes. The environmental impacts are considered for sludge leachate treatment and coal utilization. S.L.

N82-33903# National Academy of Sciences - National Research Council, Washington, D. C. Commission on Natural Resources.
COAL MINING AND GROUND-WATER RESOURCES IN THE UNITED STATES Final Report

1981 214 p refs
(PB82-182056; LC-81-83977; ISBN-0-309-03186-9) Avail: NTIS
HC A10/MF A01 CSCL 13B

The widespread concern in this country over possible consequences for our water resources of the relatively recent emphasis on development of fossil fuels and the reclamation and use of land that will follow it is noted. The response to the public concern as reflected in legislation and policy focused on two issues. One is that water resources are not everywhere or always present in sufficient quantity or quality to satisfy the needs of the energy industry. The other is that, as a result of energy industry and land reclamation activity, the quality of the water that is available may be significantly degraded. Coal mining is discussed as one of many uses competing for the nation's ground water resources. Principles that govern the functioning of hydrogeologic systems and the various institutions that oversee ground water allocation are discussed. GRA

N82-33907# Hammond (Katherine A. Green), Houston, Tex.
ENVIRONMENTAL ASPECTS OF POTENTIAL PETROLEUM EXPLORATION AND EXPLOITATION IN ANTARCTICA: FORECASTING AND EVALUATING RISKS Final Report

K. A. G. HAMMOND Feb. 1982 34 p refs
(PB82-169772; MMC-81/06) Avail: NTIS HC A03/MF A01
CSCL 13B

Information concerning the possible environmental and other effects of offshore oil and gas exploration and exploitation in the Antarctic is given. A variety of factors that should be considered to determine whether the risk of possible adverse effects is unacceptable are discussed. Information which will be required to make the 'risk' determinations is identified. GRA

N82-34296# General Accounting Office, Washington, D. C. Procurement Logistics and Readiness Div.
AIRCRAFT THRUST/POWER MANAGEMENT CAN SAVE DEFENSE FUEL, REDUCE ENGINE MAINTENANCE COSTS AND IMPROVE READINESS

29 Jul. 1982 52 p refs
(AD-A117935; GA/PLRD-82-74) Avail: NTIS HC A04/MF A01
CSCL 05A

The Department of Defense spends billions of dollars annually on aircraft fuel and engine maintenance. Thrust/power management offers Defense the potential to save fuel and reduce engine maintenance by improving fuel efficiency and extending engine parts life. Improved fuel efficiency can increase flying hours and thus improve aircrew proficiency and readiness. Extended engine life can reduce frequency of maintenance and thereby increase aircraft availability and readiness. An effective thrust/power management program is vital to the Defense mission from a readiness, energy, and maintenance standpoint. The implications on readiness are quickly apparent when considering that flying hours were reduced in face of rapidly rising fuel costs. When considering the billions of dollars spent of aircraft fuel and maintenance, thrust/power management offers great potential for reducing these costs. GRA

N82-34299# American Univ., Washington, D. C. Inst. for Applied Public Financial Management.

ESTABLISHING A RELIABLE SOURCE OF FUEL FOR DEPARTMENT OF DEFENSE REQUIREMENTS: EFFECTIVE PETROLEUM, OIL AND LUBRICANT FINANCIAL MANAGEMENT Final Report

T. F. SCHERER Dec. 1981 99 p refs Sponsored in part by the Defense Fuel Supply Center
(PB82-170812; REPT-115-80-7) Avail: NTIS HC A05/MF A01
CSCL 05A

Procurement options available as a result of changes in the energy market are analyzed. Both direct and indirect methods of acquiring products are considered. It is shown that the only viable

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solution to DFSC's problem lies in purchasing the desired quantities using direct acquisition methods and by reducing the cost incurred to a refiner for supplying military products. GRA

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Includes solar collectors, solar cells, solar heating and cooling systems, and solar generators.

A82-38124 SUNFUELS

R. J. KING (Science Applications, Inc., McLean, VA) Progress in Energy and Combustion Science, vol. 8, no. 2, 1982, p. 121-134. refs

Sunfuels are fuels and energy-rich chemicals, such as hydrogen, carbon monoxide and ethanol, that are directly or indirectly produced using solar resources, and can serve as a solar source of synthetic liquid and gaseous fuels. Four different sunfuel systems are currently being investigated: solar coal gasification, radiant flash pyrolysis of biomass (for example, cellulose converted into ethylene), thermochemical production of hydrogen, and solar production of furfural. Block schematics of the processes, diagrams of their major components, and sample yields using various starting materials are included. For each system, the chemical reactions and types of raw materials involved are given, and the applications of solar energy to the process is discussed in detail along with the potential for commercial utilization. In addition, results of prototype production tests are also given, which show that in coal gasification, for example, 48% of the solar energy arriving at the focus external to the reactor chamber is stored as chemical energy in the form of the product gas. N.B.

A82-38135 ECONOMIC MOTIVATION FOR PHOTOVOLTAIC CONCENTRATOR TECHNOLOGY

E. C. BOES, B. D. SHAFER, and D. G. SCHUELER (Sandia National Laboratory, Albuquerque, NM) Solar Cells, vol. 6, June 1982, p. 3-15. refs

A brief description is given of photovoltaic concentrators and their major components. The economics of the concentrators is treated in terms of the key parameters of concentrator cell cost, overall array cost, array conversion efficiency and concentration ratio. A status report, including a description of current designs and their measured performances and estimated costs, is given. A table giving the characteristics of the photovoltaic concentrator array field installations that are either completed or in the process of being installed is included. Attention is given to the high conversion efficiency that would be achieved using multiple band gap devices. C.R.

A82-38136 REVIEW OF SILICON SOLAR CELLS FOR HIGH CONCENTRATIONS

R. J. SCHWARTZ (Purdue University, West Lafayette, IN) Solar Cells, vol. 6, June 1982, p. 17-38. refs

The factors that limit the performance of high concentration silicon solar cells are reviewed. The design of a conventional high concentration cell is discussed, together with the present state of the art. Unconventional cell designs that have been proposed to overcome the limitations of the conventional design are reviewed and compared. The current status of unconventional cells is reviewed. Among the unconventional cells discussed are the interdigitated back-contact cell, the double-sided cell, the polka dot cell, and the V-groove cell. It is noted that all the designs for unconventional cells require long diffusion lengths for high efficiency operation, even though the demands in this respect are less for those cells with the optical path longer than the diffusion path. C.R.

A82-38137 MEASUREMENT TECHNIQUES FOR CONCENTRATOR PHOTOVOLTAIC CELLS

R. D. NASBY (Sandia National Laboratory, Albuquerque, NM) and R. W. SANDERSON (Arizona State University, Tempe, AZ) Solar Cells, vol. 6, June 1982, p. 39-47. Research supported by the U.S. Department of Energy and Sandia National Laboratory. refs

It is noted that concentrator solar cells operate in a high irradiance environment that differs considerably from the 1-sun environment of flat-plate solar cells. As a consequence of this high irradiance, additional difficulties are encountered in accurately measuring cell performance. This has spurred the development of special measurement techniques. Attention is given here to the additional problems in concentrator cell measurements. Consideration is given to the effects of nonuniform illumination and temperature. C.R.

A82-38138 HIGH EFFICIENCY P+/+N-N/+ SILICON CONCENTRATOR SOLAR CELLS

R. D. NASBY, C. M. GARNER, F. W. SEXTON, J. L. RODRIGUEZ, B. H. ROSE, and H. T. WEAVER (Sandia National Laboratory, Albuquerque, NM) Solar Cells, vol. 6, June 1982, p. 49-58. Research supported by the U.S. Department of Energy. refs

Efficiencies of 20% are measured for solar concentrations from 20 to 100 suns on planar p(+)-n-n(+) silicon concentrator cells. The cells are fabricated on 0.3 ohm-cm n-type (100) float zone silicon wafers 300 microns thick. To attain a high efficiency in these cells, phosphorus gettering is employed to maintain long minority carrier lifetime in the base; a thermal oxide is grown on the front surface to reduce the surface recombination velocity. Minority carrier lifetimes of 50-100 microseconds are measured on these cells with a new measurement technique involving pulsing the cell with an IR source and measuring the decay of both the short-circuit current and the open-circuit voltage. Spectral quantum efficiency data also suggest long base lifetimes and effective front-surface passivation. C.R.

A82-38139 HIGH EFFICIENCY SILICON CONCENTRATOR SOLAR CELLS

S. KHEMTHONG and P. A. ILES (Applied Solar Energy Corp., City of Industry, CA) Solar Cells, vol. 6, June 1982, p. 59-77. refs

An account is given of the present state of development of high efficiency silicon solar cells for use at high concentration levels (20X-100X). The design factors and process steps giving the best performance within the available process technology are analyzed. Noting that cell efficiency has exceeded 20%, the possibilities are discussed for further improvements in efficiency, for larger-area cells, and for operation at higher insolation levels (greater than or equal to 100X). The measured temperature coefficients and the testing requirements are presented. Also given are some production run results showing the possibility of scaling up the processes developed for these cells. C.R.

A82-38140 ION IMPLANTATION PROCESSING FOR HIGH PERFORMANCE CONCENTRATOR SOLAR CELLS AND CELL ASSEMBLIES

P. R. YOUNGER and S. N. BUNKER (Spire Corp., Bedford, MA) Solar Cells, vol. 6, June 1982, p. 79-86. refs

The current status of ion implantation processing for high performance concentrator solar cells is surveyed. Implantation parameters and conditions for both thermal and pulse electron beam annealing are discussed, and production cell current-voltage characteristics and distributions are presented. Noting that peak performance reaches 18%, development efforts for performance enhancement techniques, for example, surface passivation and implantation gettering, are discussed. Also presented are line focus cell assembly design features. The many advantages of ion implantation include precise process reproducibility, tight performance distributions, 100% process yield, high production rate, low energy and materials consumption, and elimination of wet chemistry processing and end-product wastes. C.R.

A82-38141

THE ETCHED MULTIPLE VERTICAL JUNCTION SILICON PHOTOVOLTAIC CELL

J. GOODRICH, J. CHAPPLE-SOKOL, G. ALLENDORF, and R. FRANK (Sandia National Laboratory, Albuquerque, NM) Solar Cells, vol. 6, June 1982, p. 87-101. Research supported by the U.S. Department of Energy and National Patent Development Corp. refs

A silicon concentrator cell with a novel design which greatly reduces internal series resistance losses, thus permitting operation to 1000 suns or more, is described. In this etched multiple vertical junction (EMVJ) design, diffusions and metallizations are both embedded in deeply etched grooves normal to the cell surface; the grooves are formed by anisotropic etching in 110-line-type Si. Because of this, there is no current flow within the junction planes and the surface area available for metallization is large in comparison with the obscured surface area. In contrast to horizontal junction concentrator cells, the efficiency of the EMVJ cell continues to increase with increasing intensity, to incident intensities of 500-1000 suns. It is noted that at present cells having only an SiO₂ antireflection coating yield an efficiency of 18.5% at 500 suns. It is thought that with an improved antireflection coating and other optimizations, efficiencies of well over 20% will be possible. C.R.

A82-38142

THE FABRICATION AND PERFORMANCE OF ORGANOMETALLIC VAPOR PHASE EPITAXIAL AL_xGA_{1-x}AS/GAAS CONCENTRATOR SOLAR CELLS

P. E. GREGORY, P. G. BORDEN, M. J. LUDOWISE, R. J. OWEN, N. KAMINAR, R. A. LARUE, and R. J. BOETTCHER (Varian Associates Solid State Laboratory, Palo Alto, CA) Solar Cells, vol. 6, June 1982, p. 103-118. Research supported by Sandia National Laboratory. refs

A description is given of the fabrication, testing and use of Al_xGa_{1-x}As/GaAs concentrator solar cells. It is noted that these cells have the highest efficiency reported to date for fully packaged cells, nearly 24% at 200 suns and 25 C. The cells have been used in a 12-cell module that has demonstrated a 17.1% peak overall conversion efficiency, the highest module efficiency ever achieved with single-band gap cells. Accelerated aging tests suggest that the cells are quite rugged. Also discussed is the thermal and electrical characterization of the cells by flash testing. C.R.

A82-38197

MULTI-POWER PORT GAS TURBINE CONFIGURATIONS FOR SOLAR COGENERATION APPLICATIONS

D. DAMSKER and P. A. CURTO (Gibbs and Hill, Inc., New York, NY) (IEEE, ASME, and ASCE, Joint Power Generation Conference, St. Louis, MO, Oct. 4-8, 1981.) IEEE Transactions on Power Apparatus and Systems, vol. PAS-101, Aug. 1982, p. 2591-2596.

New system configurations and control techniques which account for the nuances inherent in solar input-gas turbine cogeneration power plants are presented. Compensation for diurnal and seasonal variations, weather conditions, operation in non-steady-state modes, and in the presence of high exhaust back pressures at the outlet of the turbines all require innovations in order to minimally change existing turbine designs when introducing a solar source into the fuel sector. The usage of multiple power ports to the machines, and/or multishaft machines, or even variable torque converters is suggested. Specific attention is given systems powered by an energy gained from a central solar power tower surrounded by heliostats. Control processes which alter the temperature/pressure inputs to drive assemblies are offered as means to ensure continuous shaft speeds. M.S.K.

A82-38326

EPITAXIAL-DIFFUSION SILICON PHOTOELECTRIC CELLS OF P/+/-N-N/+/- TYPE [KREMNEVYE**EPITAKSIAL'NO-DIFFUZIONNYYE FOTOLEKTRICHESKIE PREOBRAZOVATELI TIPA P/+/-N-N/+/-]**

B. M. ABDURAKHMANOV, V. A. KIRICHENKO, E. A. ROMANOVSKII, M. S. SAIDOV, A. M. TUZOVSKII, and V. P. CHIRVA (Akademiia Nauk Uzbekskoi SSR, Institut Elektroniki, Tashkent, Uzbek SSR) Geliotekhnika, no. 2, 1982, p. 3-6. In Russian.

Results are presented on the manufacture and properties of solar cells based on rejected silicon epitaxial n-n(+) structures. A regression model is described which makes it possible to predict the efficiency of these cells as a function of the parameters of the initial structures. Results show that autoepitaxial silicon structures that have been rejected as microelectronic components can be used to manufacture ground-based solar cells of sufficiently high efficiency. B.J.

A82-38327

SOLAR CELLS ON THE BASIS OF HETEROJUNCTIONS IN THE POLYCRYSTALLINE CADMIUM SULFIDE-CHROMIUM TELLURIDE SYSTEM [FOTOELEMENTY NA OSNOVE GETEROPEREKHODOV V SISTEME POLIFRISTALLICHESKII SUL'FID KADMIIA-TELLURID KHROMA]

E. M. KONSTANTINOVA, N. R. STRATIEVA, S. K. KYNEV, and L. V. VASILEV (B'lgarska Akademiia na Naukite, Tsentralna Laboratoriia po Sl'ncheva Energiia i Novi Energiini Iztochnitsi, Sofia, Bulgaria) Geliotekhnika, no. 2, 1982, p. 23-25. In Russian. refs

Electrochemical processing of polycrystalline cadmium sulfide was used to produce Cu(2-x)Te-CdS and CrS-CdS heterojunctions for use in solar cells. Cells based on these heterojunctions do not exhibit time-dependent degradation of parameters, and CrS-CdS cells exhibit a broad spectral sensitivity in the solar-spectrum maximum region. The dark and light volt-ampere characteristics of the heterojunctions are presented for an illumination of 100 mW/sq cm. B.J.

A82-38328

VELOCITY CHARACTERISTICS OF REFLECTORS IN SOLAR TOWER SYSTEMS [SKOROSTNYE KHARAKTERISTIKI OTRAZHATELEI SES BASHENOSTO TIPA]

R. R. APARISI, D. I. TEPLIAKOV, and B. G. KHANTSIS (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR) Geliotekhnika, no. 2, 1982, p. 26-32. In Russian.

An analysis is presented of the velocities of azimuthal and zenithal rotations of reflectors in solar tower systems in relation to reflector arrangement, geographic latitude, and season of the year. Two methods are used in the analysis: (1) the direct calculation of heliostat rotation velocity at successive moments of time; and (2) a generalized representation of reflector velocity fields. Research and engineering applications of the calculations are discussed. B.J.

A82-38375

IN₂O₃-P SI HETEROJUNCTION SOLAR CELLS

K. ITO and T. NAKAZAWA (Shinshu University, Nagano, Japan) Electronics and Communications in Japan, vol. 63, June 1980, p. 90-105. Translation. refs

Heterojunction solar cells consisting of indium oxide films formed on a p-type silicon substrate by the reactive deposition method are investigated. It is noted that solar cells having indium oxide films 0.30 micron thick have a short-circuit current density comparable to the theoretically estimated value. Solar cells having an extremely thin interfacial oxide layer between the substrate and the indium oxide film are fabricated. It is found that cells formed by an interfacial layer sandwiched between the indium oxide film and the beryllium film exhibit a slow degradation effect. It is also established that a highly transparent, highly conductive indium oxide film can be obtained at a substrate temperature of 150 C during evaporation. The film possesses a resistivity of 0.0008

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ohm-cm and an optical transmission of 80% in the visible region.
C.R.

A82-38433 SIMPLIFIED RELATIONSHIPS FOR ESTIMATING SOLAR RADIATION INCIDENT ON ANY FLAT SURFACE

K. J. A. REVFEIM (New Zealand Meteorological Service, Wellington, New Zealand) *Solar Energy*, vol. 28, no. 6, 1982, p. 509-517. refs

Solar radiation flux on a sloping surface is related to solar radiation flux on an equivalent horizontal surface. Formulae for integrated daily direct radiation on a sloping surface, by itself, and as a ratio to integrated daily direct radiation on a horizontal surface, are summarised. Vertical over horizontal surface ratios of integrated daily direct radiation are calculated, with a without atmospheric attenuation, and compared with observed values. Similar ratios for one degree-of-freedom flat-plate tracking collectors are used to derive settings of the tracking systems that give maximum direct radiation income. The results show that the commonly used sloping surface/horizontal surface radiation ratios which ignore attenuation can be substantially in error. (Author)

A82-38434 DESIGN, ANALYSIS AND OPTIMIZATION OF SOLAR INDUSTRIAL PROCESS HEAT PLANTS WITHOUT STORAGE

J. M. GORDON and A. RABL (Solar Energy Research Institute, Golden, CO; Princeton University, Princeton, NJ) *Solar Energy*, vol. 28, no. 6, 1982, p. 519-530. Research supported by the Solar Energy Research Institute. refs

A82-38674 SOLAR-POWERED DUAL ABSORPTION SYSTEM - SELECTION CRITERIA USING FUZZY DECISION ANALYSIS

H. SOFRATA and A. F. ABDUL-FATTAH (Riyadh, University, Riyadh, Saudi Arabia) *Applied Energy*, vol. 11, July 1982, p. 223-232. refs

A fuzzy sets decision model was employed to evaluate the choice between a simple and a dual cycle solar absorption refrigeration and air conditioning system. A Li-Br dual cycle was considered, which employs solar heat to supply generator power to cool both the absorber and condenser. The options for system configurations and components such as cooling water, capital cost, running cost, installation, O and M, and design were ranked in several categories from poor to good, with particular attention to applications in arid climates. The MAFDA computer program was employed for the analysis, which led to the conclusion that dual cycle system is preferable for regions such as Saudi Arabia. M.S.K.

A82-38675 ANALYSIS OF A FLAT PLATE COLLECTOR WITH FLUID UNDERGOING PHASE CHANGE

N. D. KAUSHIKA, S. C. BHARADWAJ (Indian Institute of Technology, New Delhi, India), and S. C. KAUSHIK (Queensland, University, Brisbane, Australia) *Applied Energy*, vol. 11, July 1982, p. 233-242.

This paper presents a theoretical analysis of the performance of a flat plate solar collector with the heat removal fluid undergoing a phase change. The resultant efficiency expression is a modified Hotel-Whillier-Bliss equation. Numerical computations are made to investigate the effect of vaporization and operational parameters on the collector's performance. The collector's efficiency increases with the increase in liquid length until a point is reached when the region of superheating the vapor disappears. The efficiency is higher when a heat removal fluid of high latent heat of vaporization is used in the collector. An increase in the saturation temperature of the working fluid (with increase of pressure) in the collector reduces its efficiency. (Author)

A82-38716 THE PHYSICAL BEHAVIOUR OF AN N(+)/P SILICON SOLAR CELL IN CONCENTRATED SUNLIGHT

P. C. DHANASEKARAN and B. S. V. GOPALAM (Indian Institute of Technology, Madras, India) *Solid-State Electronics*, vol. 25, Aug. 1982, p. 719-722. refs

The performance of a simple n(+)/p silicon solar cell at various illumination levels is analyzed using a modified form of the Gummel (1964) and De Mari (1968) numerical algorithms. Attention is given to such effects of high doping as bandgap narrowing. The effective recombination lifetime of the charge carriers due to both Shockley-Read-Hall recombination via traps and Auger recombination is allowed for. The base acceptor doping concentration here is 10 to the 16th/cu cm. The light concentration varies from 1 to 200 AM1. The physical mechanisms of the device at various levels of illumination are analyzed by determining the cell parameters, namely saturation current density, short circuit current density, ideality factor, and fill factor. The ideality factor that is close to 1 at low illumination is seen as suggesting that the cell is controlled by diffusion-recombination processes. The high value of the ideality factor at high illumination, which is significantly greater than 1 but less than 2, is attributed to a high-injection effect. C.R.

A82-38717 HIGH INJECTION PHENOMENA IN P/PLUS/IN/PLUS/ SILICON SOLAR CELLS

A. LUQUE and J. EQUEN (Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Madrid, Spain) *Solid-State Electronics*, vol. 25, Aug. 1982, p. 797-809. refs

A simple analysis of p(+)/in(+)/silicon solar cell structures is undertaken on the basis of the quasi-neutrality condition (n equals p). It is noted that the only differential equation to be solved in the model is the one of classical continuity. Only in the boundary conditions do nonlinearities appear. It is shown that the model can be applied to p(+)/nn(+)/ or n(+)/pp(+)/ cells under conditions of very high injection. High carrier concentrations are required to support the current flow even in short-circuit conditions, thereby enhancing the recombination (which is reduced by high injection lifetime increases). Under-linearity between the short-circuit current and the photon flux is deduced at very high irradiance. The short-circuit current under bifacial illumination is found to be higher than the sum of those currents under front and back illumination, thus leading to inherently better bifacial cells. C.R.

A82-38718 CORRECTION OF THE TEMPERATURE EFFECT ON THE SOLAR CELL I/SC-V/OC/ CHARACTERISTIC

E. SANCHEZ and G. L. ARAUJO (Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Madrid, Spain) *Solid-State Electronics*, vol. 25, Aug. 1982, p. 817-819. refs

A simple method for determining the thermal resistance of a solar cell from its experimental I(short circuit)-V(open circuit) characteristic is described. Knowledge of this parameter makes it possible to obtain the cell junction temperature and, consequently, the real I(short circuit)-V(open circuit) characteristic of the cell. The method, which does not require any additional measurements is applied to a variety of devices. Reasonable agreement between theory and experiment is obtained. The approximations that the method assumes are thought to be reasonable for a number of solar cells. C.R.

A82-39468

INVESTIGATION OF CADMIUM TELLURIDE SOLAR CELLS OBTAINED BY ION IMPLANTATION [ISSLEDOVANIIE FOTOPREOBROIZOVATELEI NA OSNOVE TELLURIDA KADMIIA, POLUCHENNYKH METODOM IONNOI IMPLANTATSII]

E. S. BALEKA, L. V. GORCHAK, E. V. GILAN, K. D. SUSHKEVICH, and A. G. CHEBAN (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Kishinev, Moldavian SSR) *Geliotekhnika*, no. 3, 1982, p. 3-6. In Russian. refs

Experimental results are presented on the properties of cadmium telluride solar cells manufactured using the ion implantation technique. It is shown that increasing the doping dose and the annealing temperature of the ion doped layers produces an improvement in the power characteristics of such solar cells.

B.J.

A82-39469

TEXTURED-SURFACE SILICON SOLAR CELLS AND THEIR PROPERTIES [KREMNIIEVYE FOTOPREOBRAZOVATELI S TEKSTURIROVANNOI POVERKHNOST'IU I IKH SVOISTVA]

N. M. BORDINA, A. K. ZAITSEVA, E. H. MARASANOVA, and A. A. POCISAN (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR) *Geliotekhnika*, no. 3, 1982, p. 6-11. In Russian.

The design and principles of operation of textured-surface silicon solar cells are described. Theoretical and experimental results are presented on the reflection of light from the textured surface and on the collection of photogenerated charge carriers. The multipyramidal relief of the textured surface is shown to produce double and triple reflection, thereby lowering the reflection coefficient. Moreover, the texturing produces a decrease in the light absorption depth and, hence, an increase in the long-wave sensitivity of the cell and a reduction of the effect of hard radiation on the degradation of the photocurrent.

B.J.

A82-39470

EVAPORATIVE HEAT REMOVAL SYSTEMS FOR SOLAR CELLS [ISPARITEL'NYE SISTEMY TEPLOOTVODA SOLNECHNYKH FOTOLEKTRICHESKIKH PREOBRAZOVATELEI ENERGIU]

M. G. VERDIEV, KH. K. ARIPOV, and V. D. RUMIANTSEV (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR) *Geliotekhnika*, no. 3, 1982, p. 14-18. In Russian. refs

Three variants of an evaporative cooling system are proposed for operation in solar photoelectric generator plants under conditions of concentrated solar illumination. These variants are of simple design and high thermodynamic efficiency, and can be used to cool solar-concentrator systems in fully autonomous plants as well as in large-scale photoelectric plants.

B.J.

A82-39471

CALCULATION OF THE CHARACTERISTICS OF SOLAR POWER PLANTS [RASCHET KHARAKTERISTIK SOLNECHNYKH ENERGETICHESKIKH USTANOVOK]

S. A. AZIMOV, R. IU. AKBAROV, and I. I. PIRMATOV (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR) *Geliotekhnika*, no. 3, 1982, p. 26-32. In Russian.

A general scheme is developed for calculating the shading of heliostats in solar power plants, with reference both to solar furnaces and to tower systems. Results are presented on the relationship between the filling of the middle of a concentrator and the time of year and time of day under clear-sky conditions, and to the relationship between the light energy power incident on circles in focal planes 30 and 40 cm in diameter and the turn angle of the heliostat.

B.J.

A82-39472

OPTICAL CHARACTERISTICS OF SELECTIVE COATINGS FOR SOLAR THERMAL COLLECTORS [OPTICHESKIE KHARAKTERISTIKI SELEKTIVNYKH POKRYTII TEPLOVYKH KOLLEKTOROV SOLNECHNOGO IZLUCHENIIA]

M. M. KOLTUN and I. P. GAVRILOVA (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR) *Geliotekhnika*, no. 3, 1982, p. 35-39. In Russian. refs

Three techniques for obtaining selective coatings for solar thermal collectors are described: (1) vacuum deposition of alternating dielectric and transparent metallic films; (2) electrochemical deposition of black layers; and (3) the simultaneous vacuum evaporation of dielectric and metal to produce cermet films. It is shown that these techniques can produce coatings with values of α sub c/ϵ greater than 30. In addition, it is shown experimentally that electrochemical and cermet coatings have a better selectivity of optical properties and make it possible to attain significantly higher values of α sub c/ϵ (at greater coating thicknesses) than the dielectric-metal coatings.

B.J.

A82-39577* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THERMODYNAMIC LIMITS TO THE CONVERSION OF BLACKBODY RADIATION BY QUANTUM SYSTEMS

A. M. BUONCRISTIANI, B. T. SMITH (Christopher Newport College, Newport News, VA), and C. E. BYVIK (NASA, Langley Research Center, Hampton, VA) *Journal of Applied Physics*, vol. 53, Aug. 1982, p. 5382-5386. refs

(Contract NSG-1514)

Using general thermodynamic arguments, we analyze the conversion of the energy contained in the radiation from a blackbody to useful work by a quantum system. We show that the energy available for conversion is bounded above by the change in free energy in the incident and reradiated fields and that this free energy change depends upon the temperature of the receiving device. Universal efficiency curves giving the ultimate thermodynamic conversion efficiency of the quantum system are presented in terms of the blackbody temperature and the temperature and threshold energy of the quantum system. Application of these results is made to a variety of systems including biological photosynthetic, photovoltaic, and photoelectrochemical systems.

(Author)

A82-39599* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ON THE CAUSE OF THE FLAT-SPOT PHENOMENON OBSERVED IN SILICON SOLAR CELLS AT LOW TEMPERATURES AND LOW INTENSITIES

V. G. WEIZER and J. D. BRODER (NASA, Lewis Research Center, Cleveland, OH) *Journal of Applied Physics*, vol. 53, Aug. 1982, p. 5926-5930. refs

A model is presented that explains the 'flat-spot' power-loss phenomenon observed in silicon solar cells operating under deep space (low temperature, low intensity) conditions. Evidence is presented suggesting that the effect is due to localized metallurgical interactions between the silicon substrate and the contact metallization. These reactions are shown to result in localized regions in which the PN junction is destroyed and replaced with a metal-semiconductor-like interface. The effects of thermal treatment, crystallographic orientation, junction depth, and metallization are presented along with a method of preventing the effect through the suppression of vacancy formation at the free surface of the contact metallization. Preliminary data indicating the effectiveness of a TiN diffusion barrier in preventing the effect are also given.

(Author)

02 SOLAR ENERGY

A82-39605

DETERMINATION OF OPTIMUM LOAD FOR A SOLAR CELL

L. S. KOTHARI, P. C. MATHUR, A. KAPOOR, P. SAXENA, and R. P. SHARMA (Delhi, University, Delhi, India) *Journal of Applied Physics*, vol. 53, Aug. 1982, p. 5982-5984. Research supported by the Council of Scientific and Industrial Research. refs

An expression for load for maximum power transfer from a real solar cell, having resistive and current leakage losses, has been obtained using Lagrange's method of undetermined multipliers for solving the transcendental current-voltage relationship. The theoretical results are compared with the experimental measurements of the optimum load for p-n junction solar cells for various illumination levels. (Author)

A82-39844

FORMATION, GROWTH, AND STABILITY OF THE CDS/CUINSE2 INTERFACE

L. L. KAZMERSKI, O. JAMJOUR, P. J. IRELAND (Solar Energy Research Institute, Golden, CO), R. A. MICKELSEN, and W. S. CHEN (Boeing Aerospace Co., Seattle, WA) *Journal of Vacuum Science and Technology*, vol. 21, July-Aug. 1982, p. 486-490. refs

A82-39847

STUDIES ON SILICON-BASED CDS AND ZNS HYBRID SYSTEMS FOR THE UTILITY OF THESE FILMS IN SOLAR CELLS

F. ABOU-ELFOTOUH and A. S. ABDELHALIM (Riyadh, University, Riyadh, Saudi Arabia) *Journal of Vacuum Science and Technology*, vol. 21, July-Aug. 1982, p. 681-683. refs

The influence of preparation conditions and postdeposition-annealing on the properties of CdS and $(Zn(x)Cd(1-x))S$ films and consequently on the performance of their heterojunctions with Si was investigated. Polycrystalline and epitaxial films of CdS and mixtures of CdS and ZnS were prepared on the surface of Si substrate either by electron beam evaporation in an ultrahigh vacuum system or by RF sputtering. Epitaxial growth of the films was established by electron beam evaporation under high vacuum on the substrates at a deposition temperature above 350 C. The values obtained for the electrical resistivity, electron mobility, carrier concentration, and grain size were 15 ohm cm, 80 sq cm/V-sec, 8×10 to the 16th per cu cm, and 2200 A, respectively. These are in the range of values required for efficient solar cell heterojunctions. The effect of sulfur diffusion into Si on the cell performance is discussed. C.D.

A82-40317

DEVELOPMENT OF SOLAR-ARRAY SIMULATORS WITH IMPROVED CHARACTERISTICS [RAZRABOTKA IMITATOROV SOLNECHNYKH BATAREI S ULUCHSHENNYMI KHARAKTERISTIKAMI]

A. A. GRITSANCHUK (Kievskii Tekhnologicheskii Institut Legkoi Promyshlennosti, Kiev, Ukrainian SSR) *Tekhnicheskaja Elektrodinamika*, May-June 1982, p. 15-18. In Russian.

An analysis is presented of solar-array simulators with improved energetic and dynamic characteristics. A simulator with a discrete-continuous voltage regulator is examined, and expressions for determining the optimal number of transistors in this voltage regulator are presented. B.J.

A82-40341

THICKNESS DEPENDENCE OF THE REFLECTION COEFFICIENT FROM THIN SEMICONDUCTOR FILMS AND MEASUREMENTS OF THE CONDUCTIVITY. B. DIVON AND F. S. BARNES [COLORADO, UNIVERSITY, BOULDER, CO]

Solar Cells, vol. 6, July 1982, p. 125-132. refs

Two approaches to measuring the resistivity of thin films of semiconductors deposited onto metal plates are compared. The results of these approaches show that the microwave reflection coefficient varies with the cube of the film thickness. This is experimentally corroborated by measurements previously reported in the literature. The cubic dependence on film thickness of the reflection coefficients from thin semiconductor films in the millimeter wavelength region is demonstrated, as is the cubic dependence

on thickness of the Q values of Fabry-Perot interferometers.

C.R.

A82-40342

THE SENSITIVITY OF CALCULATED SHORT-CIRCUIT CURRENTS TO SELECTED IRRADIANCE DISTRIBUTIONS AND SOLAR CELL SPECTRAL RESPONSES

J. S. HARTMAN, M. A. LIND, and D. A. CHAUDIERE (Battelle Pacific Northwest Laboratory, Richland, WA) *Solar Cells*, vol. 6, July 1982, p. 133-148. refs
(Contract DE-AC06-76RL-01830)

Calculations of normalized differences in solar cell short-circuit currents are reported for a variety of solar cell materials and illumination sources. All results were referenced to the cell response under a standard air mass 1.5 irradiance distribution. Each solar cell and source combination was evaluated for two candidate source normalization procedures. The first is a photon flux normalization technique in the 300-1100 nm wavelength region and the second is an energy flux normalization procedure over the 300-2500 nm wavelength band. Practical laboratory approximations of these techniques can be implemented with a good silicon detector and a black detector respectively. Results are reported for 15 different solar cells and six illumination sources (two alternative solar spectra and four artificial sources). The results clearly indicate the importance of carefully selecting the illumination source and the source normalization procedure for the specific solar cell to be evaluated. (Author)

A82-40343

OPTIMUM COST COMPUTATION IN PHOTOVOLTAIC SYSTEMS WITH CONCENTRATORS

G. C. JAIN and S. KUMARI (National Physical Laboratory of India, New Delhi, India) *Solar Cells*, vol. 6, July 1982, p. 149-155. refs

It is shown how the economics of photovoltaic systems with concentrators is complicated because of several competing factors, among them the lower cost of solar cells due to the smaller area required at higher concentrations, the increased cost of the optical system, and the reduced cell efficiency at elevated temperatures resulting from concentration. Taking these factors into consideration, the cost of a photovoltaic system is optimized with respect to the concentration ratio for given values of cell cost, a fixed cost of the optical system per unit concentration, and various values of effective thermal conductance (that is, various cooling systems). The optimum concentration ratio is shown to decrease as the cost of the cells decreases. With an increase in the thermal conductance, the ratio increases for a given cell cost per square meter. The cost of energy from photovoltaic systems with concentrators is computed for the optimized concentration ratio. It is found that for a given cooling system (that is, a given thermal conductance), the cost of energy in US dollars per kilowatt hour decreases with decreasing cell cost and tends to approach a value determined by the cost of the optical system. C.R.

A82-40344

DETERMINATION OF THE MINORITY CARRIER LIFETIME IN THE BASE OF A BACK-SURFACE FIELD SOLAR CELL BY FORWARD CURRENT-INDUCED VOLTAGE DECAY AND PHOTOVOLTAGE DECAY METHODS

R. MURALIDHARAN, S. C. JAIN (Solid State Physics Laboratory, Delhi, India), and U. JAIN (Birla Institute of Technology and Science, Pilani, India) *Solar Cells*, vol. 6, July 1982, p. 157-176. refs

A82-40345

AN EVALUATION OF VARIOUS CONFIGURATIONS FOR PHOTO-ELECTROCHEMICAL PHOTOVOLTAIC SOLAR CELLS

B. PARKINSON (Solar Energy Research Institute, Golden, CO) *Solar Cells*, vol. 6, July 1982, p. 177-189. refs

Various configurations for photoelectrochemical photovoltaic solar cells are reviewed and evaluated. Both flat-plate cells and cells which operate with moderate light concentration are examined. Several novel systems where the electrolyte plays a role in the concentration of light are proposed. (Author)

A82-40347

ANALYSIS OF DISPERSION IN THE MEASURED CAPACITANCE OF CDS/CU₂S SOLAR CELLS

W. W. ANDERSON (Lockheed Electro Optics Laboratory, Palo Alto, CA) *Solar Cells*, vol. 6, July 1982, p. 197-201. (Contract XW-0-9296)

A82-41081

OPTICAL FIBER SENSOR FOR TRACKING LINE-FOCUS SOLAR COLLECTORS

J. J. WICZER (Sandia National Laboratory, Albuquerque, NM) *Applied Optics*, vol. 21, Aug. 1, 1982, p. 2703-2707. refs (Contract DE-AC04-76DP-00789)

Currently there is a need to provide an alignment monitor feedback signal to the tracking mechanism of line-focus trough-type concentrating solar collectors. We report here on the novel use of an optical fiber as a distributed integrating sensor to generate such a signal. Experiments have shown that 3.0 m of optical fiber exposed to concentrated sunlight equal to approximately 40 suns in intensity will generate 1 microamp of signal current in a silicon photodiode. These data were measured in an experimental line-focus solar collector using solar flux conditions common to this type of collector. (Author)

A82-41194

CURRENT MECHANISM OF TUNNEL MIS SOLAR CELLS

O. M. NIELSEN (Danmarks Tekniske Højskole, Lyngby, Denmark) *IEE Proceedings, Part I - Solid-State and Electron Devices*, vol. 129, pt. 1, no. 4, Aug. 1982, p. 153-156. refs

Dark current/voltage characteristics have been examined as a function of temperature for two structures of Al-p Si MIS solar cells. The solar cells have been prepared with interfacial oxide thickness ranging from 10 Å to 20 Å. The results show that for oxide thicknesses of 10 Å the diode saturation current behaves as a majority-carrier current, highly dependent on the effective metal-semiconductor barrier height and the oxide tunnel exponent whereas for oxide thicknesses of 20 Å, the diode saturation current behaves as a minority-carrier current highly dependent on the minority-carrier lifetime. (Author)

A82-41231#

STATISTICAL ANALYSIS OF CHARACTERISTICS OF THIN FILM POLYCRYSTALLINE SOLAR CELLS - INFLUENCE OF FLUCTUATION IN LOCAL CHARACTERISTICS ON OUTPUT CHARACTERISTICS

H. KOBAYASHI, Y. OGAWA, and T. KUROBE Hokkaido University, Faculty of Engineering, Bulletin, July 1982, p. 1-11. In Japanese, with abstract in English.

A82-41270#

A FINITE ELEMENT METHOD TO DETERMINE STEADY-STATE TEMPERATURE DISTRIBUTION OF SOLAR COLLECTOR PANELS WITH OPTIMAL MASS FLOW RATE

R. N. SINHA (Bharat Heavy Electricals, Ltd., New Delhi, India) *Institution of Engineers (India), Journal, Mechanical Engineering Division*, vol. 62, Mar. 1982, p. 169-172. refs

A82-41323

PHOTOREDUCTION OF METHYL VIOLOGEN IN AQUEOUS NEUTRAL SOLUTION WITHOUT ADDITIVES

T. W. EBBESEN, G. LEVEY, and L. K. PATTERSON (Notre Dame, University, Notre Dame, IN) *Nature*, vol. 298, Aug. 5, 1982, p. 545-547. Research supported by the U.S. Department of Energy. refs

The direct photoreduction of methyl viologen (paraquat) in aqueous solution to the reduced species radical cation MV(2+)Cl(-)2 was examined to study its effectiveness as a herbicide and in solar photochemical energy conversion devices. Dissolved crystalline cations were found to vary in absorption spectrum with added Cl(-), and excitation with a nitrogen laser at 377 nm indicated the presence of a transient species absorbing below 400 nm. The oxidation of Cl ions by a photolysis-excited state of the MV(2+) is shown to have a quantum yield of 0.2 at 337 nm, using

anthracene as a reference. A parallel pathway to normal toxic oxidation of the substance on plants is suggested, involving the photoproduction of the radical Cl(2-), which reacts with thymine, uracil, guanine, histidine, tyrosine, tryptophan, cysteine, and ascorbic acid. The observed properties are suggested to be useful in the photoreduction and oxidation of water. M.S.K.

A82-41576

PLASMA NITRIDE AR COATINGS FOR SILICON SOLAR CELLS

F. W. SEXTON (Sandia National Laboratory, Albuquerque, NM) *Solar Energy Materials*, vol. 7, July-Aug. 1982, p. 1-14. Research supported by the U.S. Department of Energy. refs

The criteria for the design of antireflection coatings for silicon solar cells are presented and used as a basis for optimizing plasma-assisted CVD nitride films. The effects of dispersion and absorption in the refractive index of silicon and plasma nitride are included through the use of a computer code which models the AR coating and optimizes its thickness under specified conditions. The influence of cell performance and its application on design of AR coatings is considered, along with nonuniformities in film thickness. The deposition conditions which give good uniformity are presented. (Author)

A82-41578

INVESTIGATION ON PHOTOELECTROCHEMICAL CELLS BASED UPON SILICON/METHANOL INTERFACES. I - N-TYPE SI

P. BRONDEEL, M. MADOU, and W. P. GOMES (Gent Rijksuniversiteit, Ghent, Belgium) *Solar Energy Materials*, vol. 7, July-Aug. 1982, p. 23-32. refs

The photoelectrochemical behaviour of n-type Si in methanol with either ferrocene, N, N, N-prime, N-prime-tetramethylphenylenediamine (TMPD) or tetraethylammonium iodide as the electroactive substance was studied by impedance and open-circuit potential measurements and by cyclic voltammetry. The flat-band potential of n-Si was found to be independent of the redox potential in solution, but to be dependent on pH. The open-circuit potential of n-Si in darkness was equal to the equilibrium potential. Under illumination, open-circuit voltages exceeding 0.6 V were reached. From cyclic voltammetry, the reactivity of ferrocene and TMPD with respect to holes was found to be considerably higher than that of iodide. An important fact for photoelectrochemical solar cells is that, with the former two reducing agents, the photocorrosion of the n-Si electrode could effectively be suppressed. (Author)

A82-41579

INVESTIGATION ON PHOTOELECTROCHEMICAL CELLS BASED UPON SILICON/METHANOL INTERFACES. II - P-TYPE SI

M. MADOU, P. BRONDEEL, W. P. GOMES, P. HANSELAER, and F. CARDON (Gent, Rijksuniversiteit, Ghent, Belgium) *Solar Energy Materials*, vol. 7, July-Aug. 1982, p. 33-42. refs

The p-Si/methanol interface in the presence of redox couples was studied by means of impedance, open-circuit photovoltage and cyclic-voltammetric measurements. Evidence was found for the occurrence of an inversion layer underneath the Si surface under certain circumstances, and for the chemical and electrochemical formation of an oxide layer. A strong influence of thermal and chemical pretreatment of the surface upon the interfacial properties was found. Cyclic-voltammetric results yielded additional information on the mechanism of electrochemical and photoelectrochemical reactions which were studied also on n-Si in methanol. (Author)

02 SOLAR ENERGY

A82-41580

SPECTRAL SELECTIVITY OF A THERMALLY OXIDIZED STAINLESS STEEL

E. VALKONEN and B. KARLSSON (Uppsala, Universitet, Uppsala, Sweden) Solar Energy Materials, vol. 7, July-Aug. 1982, p. 43-50. refs

Ferritic stainless steel has been oxidized at 600 to 900 C for the purpose of preparing selective surfaces. The surface oxide has been analysed by X-ray, ESCA and AES. The solar optical parameters have been studied by spectral reflectance measurements. They show typically $\alpha(s) = 0.85-0.90$ and $\epsilon(373) = 0.10-0.20$ combined with good thermal stability and corrosion resistance. The discrepancies between spectral reflectance of the oxidized steels and oxidized Fe and Cr surfaces are explained by a rough oxide surface and dilute oxide-metal interface. (Author)

A82-41583

PREDICTION OF REFLECTANCE OF METAL CARBON SOLAR ABSORBING FILMS FOR THEIR ENHANCEMENT BY ANNEALING

D. R. MCKENZIE, R. C. MCPHEDRAN, and L. M. BRIGGS (Sydney, University, Sydney, Australia) Solar Energy Materials, vol. 7, July-Aug. 1982, p. 75-84. Research supported by the University of Sydney. refs

A82-41584

REACTIVE DC SPUTTERING OF CADMIUM SULPHIDE FILMS

R. J. MCINTYRE (Commonwealth Scientific and Industrial Research Organization, Div. of Mineral Chemistry, Port Melbourne, Victoria, Australia) Solar Energy Materials, vol. 7, July-Aug. 1982, p. 85-99. refs

Cadmium sulphide (CdS) films have been produced on glass substrates by reactive dc sputtering from a cadmium cathode in an atmosphere of argon and hydrogen sulphide (H₂S). The influence of some of the operating variables on the deposition rate, uniformity and resistivity of the films, and on the characteristics of the discharge, was studied. (Author)

A82-41585

DEGASSING OF HYDROGENATED METAL-CARBON SELECTIVE SURFACES FOR EVACUATED COLLECTORS

G. L. HARDING (Sydney, University, Sydney, Australia) and B. WINDOW (Argonne National Laboratory, Argonne, IL) Solar Energy Materials, vol. 7, July-Aug. 1982, p. 101-111. Research supported by the Argonne National Laboratory and University of Sydney. refs

Gas evolution at elevated temperature from an all-glass collector containing a sputtered metal-carbon selective surface has been investigated. Water vapor degasses almost exclusively from the glass, while H₂ and CO are evolved from the selective surface which contains large amounts of hydrogen and oxygen bonded to the carbon. Thermodynamic measurement of gas evolution rates from the selective surface show that the bulk of volatile materials can be degassed at temperatures not less than 480 C. These results are discussed in relation to the bakeout and evacuation of evacuated collectors. (Author)

A82-41586

EVACUATION AND DETERIORATION OF ALL-GLASS TUBULAR SOLAR THERMAL COLLECTORS

G. L. HARDING and T. T. MOON (Sydney, University, Sydney, Australia) Solar Energy Materials, vol. 7, July-Aug. 1982, p. 113-122. Research supported by the University of Sydney. refs

A82-41587

A SPUTTERED COPPER-CARBON SELECTIVE ABSORBING SURFACE FOR EVACUATED COLLECTORS

G. L. HARDING (Sydney, University, Sydney, Australia) Solar Energy Materials, vol. 7, July-Aug. 1982, p. 123-128. Research supported by the University of Sydney. refs

A82-41695#

A STUDY OF INFLATABLE REFLECTING MEMBRANES [ETUDE DE MEMBRANES REFLECHISSANTES GONFLABLES]

C. FAYARD Aix-Marseille III, Universite, Docteur Ingenieur Thesis, 1980. 191 p. In French. refs

A numerical model for the formation of a surface of revolution using an aluminized membrane fastened and sealed at the edges between two spaces at different pressures, is developed, and results of experimental verification are presented. The model comprises the characterization of elastic deformations, assuming that in overpressure conditions other factors, such as heating and gravity, could be neglected. An account was made of the path of reflected luminous rays from both a point source and from the sun, and examples of spherical dome-shaped reflectors which were manufactured are described. Applications as solar heat devices for studying materials at 1000-2000 C in weightless conditions during Spacelab flights, and as ground-based solar furnaces, are cited. M.S.K.

A82-41864#

DATA ACQUISITION AT A RESIDENTIAL PHOTOVOLTAIC SYSTEM

J. M. MCINTYRE and G. N. MILLER (Oak Ridge National Laboratory, Oak Ridge, TN) In: International Instrumentation Symposium, 28th, Las Vegas, NV, May 3-6, 1982, Proceedings. Part 2. Research Triangle Park, NC, Instrument Society of America, 1982, p. 823-832.

(Contract W-7405-ENG-26)

A description is presented of the techniques employed for data collection and analysis in the study of a small residential photovoltaic (PV) system. A model home of approximately 139 sq m incorporated a PV array on the south-facing roof. The PV system was designed to interface directly to the local utility system through an inverter which converted the direct current output of the array to 60 Hz alternating current. Electric power could flow either from the utility lines into the house or vice versa. The solar panel consisted of 120 modules installed in a 5 x 24 array. Attention is given to initial problems, the conduction of a systems analysis, the data collection method, the equipment used in the data acquisition system, aspects of data collection, the encountered problems, and the results of the data acquisition project. It was found that the data acquisition system employed was effective for computer-compatible data collection. G.R.

A82-41923

THEORETICAL ANALYSIS OF AMMONIA-WATER ABSORPTION CYCLES FOR REFRIGERATION AND SPACE CONDITIONING SYSTEMS

S. C. KAUSHIK and S. C. BHARDWAJ (Indian Institute of Technology, New Delhi, India) International Journal of Energy Research, vol. 6, July-Sept. 1982, p. 205-225. refs

A numerical model for the performance of an ammonia-water absorption cycle in solar air conditioning, refrigeration, and heat pump systems are presented. The configurations comprise a solar driven generator, a rectifier, condenser, evaporator, absorber, preheater, and a subcooler. Cooling modes involve supplying heat to the evaporator from the space to be cooled and transferring the heat to the ambient environment by way of the rectifier, absorber, and condenser. In a heat pump, the same equipment is used with the heat being dispersed into the space to be heated. Block diagrams are provided of the basic absorption cycle and a model is constructed from heat and mass balance equations and the equations of state for a NH₃-H₂O cycle system. System simulation then consists of the simultaneous solution of a set of algebraic nonlinear equations and using the Newton-Raphson method to iterate for implicit solutions in each operational mode. M.S.K.

A82-41924

SOLAR ENERGY STORAGE USING SURFACTANT MICELLES

R. C. SRIVASTAVA, P. R. MARWADI, P. K. LATHA, and S. B. BHISE (Birla Institute of Technology and Science, Pilani, India) *International Journal of Energy Research*, vol. 6, July-Sept. 1982, p. 247-251. Research supported by the Ministry of Industrial Development. refs

The results of experiments designed to test the soluble reduced form of thionine dye as a suitable solar energy storage agent inside the hydrophobic core of surfactant micelles are discussed. Aqueous solutions of thionine, methylene blue, cetyl pyridinium bromide, sodium lauryl sulphate, iron salts, and iron were employed as samples of anionic, cationic, and nonionic surfactants. The solutions were exposed to light until the dye disappeared, and then added drop-by-drop to surfactant solutions. The resultant solutions were placed in one cell compartment while an aqueous solution with Fe(2+) and Fe(3+) ions were placed in another, with the compartments being furnished with platinum electrodes connected using a saturated KCl-agar bridge. Data was gathered on the short circuit current, maximum power, and internal resistance encountered. Results indicate that dye-surfactant systems are viable candidates for solar energy storage for later conversion to electrical power. M.S.K.

A82-41925

LATENT HEAT STORAGE FOR SOLAR ENERGY SYSTEMS - TRANSIENT SIMULATION OF REFRIGERANT STORAGE

S. C. KAUSHIK (Queensland University, Brisbane, Australia; Indian Institute of Technology, New Delhi, India) *International Journal of Energy Research*, vol. 6, July-Sept. 1982, p. 253-269. refs

This paper presents a brief review of the available latent heat storage systems for solar energy utilization. A new concept of latent heat storage of solar energy via the refrigerant-absorbent mass storage in absorption cycle heat pump systems used for solar space heating/cooling has been proposed and assessed thermodynamically. A computer modeling and numerical simulation study shows that the concept of refrigerant storage is fundamentally sound, technically feasible and yields the following advantages over other storage methods: (1) the storage capacity per unit volume is high as the latent heat of vaporization of the refrigerant is high; (2) the heat loss from the storage to the surroundings is minimum as the storage temperature is near the ambient; (3) prolonged energy storage is possible with no degradation in system performance and hence suitable for combined solar heating and air conditioning. The effects of operating parameters on the energy storage concentration and storage efficiency have been studied in detail. (Author)

A82-41926

PERFORMANCE OF A CYLINDRICAL PARABOLIC TROUGH USING A FIN RECEIVER - LIMB DARKENING EFFECTS

R. N. SINGH and A. K. SINGHAL (Indian Institute of Technology, New Delhi, India) *International Journal of Energy Research*, vol. 6, July-Sept. 1982, p. 271-282. Research supported by the Council of Scientific and Industrial Research. refs

A82-42016

ORGANIC DYES IN PMMA IN A PLANAR LUMINESCENT SOLAR COLLECTOR - A PERFORMANCE EVALUATION

J. M. DRAKE, J. SANSREGRET, W. R. L. THOMAS (Exxon Research and Engineering Co., Linden, NJ), and M. L. LESIECKI (Universidad de Puerto Rico, Rio Piedras, PR) *Applied Optics*, vol. 21, Aug. 15, 1982, p. 2945-2952. Research supported by the Exxon Research and Engineering Co. refs

The performance of organic dyes in PMMA has been evaluated in a three-layer planar luminescent solar concentrator. The single plate and combined three-plate efficiencies have been measured for a number of dyes, and results of one typical combination are reported here. A detailed characterization of the spectroscopic properties of the dye molecules as well as the device dependent and device independent parameters of the plates allow comparison between measured and predicted efficiency. Our results

demonstrate the presence of a significant positive synergism for the multilayer device. (Author)

A82-42092

HEAT PIPES IN SOLAR COLLECTORS

R. BAIRAMOV (Nauchno-Proizvodstvennoe Ob'edinenie Solntse, Ashkhabad, Turkmen SSR) and K. TOILIEV (Turkmenkii Gosudarstvennyi Universitet, Ashkhabad, Turkmen SSR) In: *Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference*, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 47-54. refs

The diode property of heat pipes is evaluated for use in solar collectors. Model experiments show that the effect of heat pipes in solar collectors is most pronounced during the nighttime, when solar radiation is zero, due to a significant reduction in the heat loss from the transparent cover surface of the collector compared to that for conventional collectors. For a solar collector with a glass cover area of one square meter during the summer season when the maximum water temperature is 60 C and the discharge is 85 l/sq m/day, the water temperature in the accumulator tank of the solar collector with a heat pipe is 10-11 C higher than in the solar collector lacking a heat pipe. In addition, the design of a solar house with passive systems in which heat pipes serve as the heat eliminating mechanism is discussed N.B.

A82-42133

A DEFORMABLE BODY VARIABLE CONDUCTANCE HEAT PIPE

C. C. ROBERTS, JR. In: *Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference*, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 703-708.

Variable thermal conductance can be achieved in a heat pipe by controlling liquid flow. A simple heat pipe design is presented that varies thermal conductance by entrapment of liquid in a deformable section. A prototype was constructed and tested. Heat transfer was varied from 0 to 20 watts. Thermal conductance was proportional to various deformation settings and repeatability was maintained within plus or minus one watt. Applications of this device in the thermal control environment from solar storage are suggested. (Author)

A82-42260

SILICON SOLAR CELLS WITH A DIELECTRIC-SEMICONDUCTOR STRUCTURE AND SCHOTTKY CONTACTS

B. I. GILMAN, M. B. ZAKS, V. V. KASATKIN, I. V. SKOKOV, and A. P. TRETIAKOV (*Geliotekhnika*, no. 5, 1981, p. 3-9.) *Applied Solar Energy*, vol. 17, no. 5, 1981, p. 1-7. Translation. refs

A82-42262

PLANE FOCINES WITH MULTIPLE REFLECTION AS SOLAR RADIATION CONCENTRATORS

V. A. GRILIKHES and O. F. ZAITSEV (*Geliotekhnika*, no. 5, 1981, p. 22-30.) *Applied Solar Energy*, vol. 17, no. 5, 1981, p. 22-30. Translation. refs

The optical, energy, and geometric characteristics of plane focines with multiple reflection are analyzed and compared with the corresponding characteristics of parabolic cylinder focines. In particular, attention is given to the relative dimensions of the focine faces as a function of the concentration ratio and the sensitivity of the overall concentrating capacity to inaccuracy of orientation toward the radiation source. In general, the analysis shows that planar focines with multiple reflection may provide the required concentration ratio for photovoltaic power plants, while being of acceptable size and having satisfactory operating characteristics as well as some advantages over parabolic cylindrical focines, in particular during system construction or deployment in space. V.L.

02 SOLAR ENERGY

A82-42263

TOWER-TYPE SOLAR POWERPLANTS - POSSIBILITIES OF USING FOCUSING REFLECTORS

D. I. TEPLIAKOV and R. R. APARISI (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR) (Geliotekhnika, no. 5, 1981, p. 36-42.) Applied Solar Energy, vol. 17, no. 5, 1981, p. 37-43. Translation. refs

A82-42264

ON THE TRANSFER FUNCTION OF A PLANE HELIOSTAT FOR A SOLAR POWERPLANT

V. M. DUBILOVICH and A. G. KOSTIUKOVSKII (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Belorussian SSR) (Geliotekhnika, no. 5, 1981, p. 43-48.) Applied Solar Energy, vol. 17, no. 5, 1981, p. 44-50. Translation. refs

A82-42265

ON THE NATURE OF THE TEMPERATURE DISTRIBUTION IN A SOLAR FREON GENERATOR OF THE 'HOTBOX' TYPE

N. A. SHCHETININA and S. Z. ZHADAN (Odesskii Tekhnologicheskii Institut Pishchevoi i Kholodil'noi Promyshlennosti, Odessa, Ukrainian SSR) (Geliotekhnika, no. 5, 1981, p. 49-55.) Applied Solar Energy, vol. 17, no. 5, 1981, p. 51-58. Translation.

Vertical temperature distribution in a solar freon generator of the hotbox type is investigated theoretically and experimentally. It is shown that vertical temperature distribution in a direct-boiling solar generator, adequately filled with cooling agent, comprises a heating segment where the surface temperature gradually rises, and a boiling segment where the surface temperature is constant. The ratio of the heating and boiling areas is largely determined by the type of cooling agent, boiling point, and operation mode (heating or cooling). V.L.

A82-42266

SI SOLAR CELLS ON EPITAXIAL STRUCTURES

M. M. KOLTUN, V. V. ARSEININ, and B. M. ABDURAKHMANOV (Akademiia Nauk Uzbekskoi SSR, Institut Elektroniki, Tashkent, Uzbek SSR) (Geliotekhnika, no. 5, 1981, p. 87-91.) Applied Solar Energy, vol. 17, no. 5, 1981, p. 92-96. Translation.

With a view toward decreasing the overall cost of solar cells, the possibility of using inexpensive autoepitaxial silicon structures instead of single-crystal silicon is investigated. Solar cells with efficiencies up to 8.5% have been obtained on the basis of P-P+ and N-N+ epitaxial structures on silicon substrates heavily doped with boron or phosphorus. By applying a transparent coating, the cell efficiency may be increased up to 11%. It is concluded that the structures studied are suitable for use in solar cell technology. V.L.

A82-42343

SOLAR GENERATOR PERFORMANCE WITH LOAD MATCHING TO WATER ELECTROLYSIS

K. FREUDENBERG (Muenchen, Universitaet, Munich, West Germany) Applied Physics A - Solids and Surfaces, vol. A 28, Aug. 1982, p. 205-209. refs

A 7 W generator, based on monocrystalline silicon solar cells, was directly wired to an electronic load, simulating the current-voltage characteristic of an advanced water electrolyzer. System performance was monitored from January 15 to July 7, 1980. Measurements included current and voltage at the load and at the point of maximum power output, global irradiance and ambient temperature. Solar generator efficiency ranged from 7.5% to 11.5%. A large spread of + or - 1% in instantaneous generator efficiency was observed at identical values of global irradiance and ambient temperature. The dependence of the average generator efficiency on global irradiance and ambient temperature is given by a simple relation to an accuracy of + or - 0.2%. Load matching was optimized for high global irradiance at high ambient temperature. Averaged over the half year, period losses by nonideal load matching amounted to only 8.9%. Assuming an ideal current efficiency of the simulated water electrolyzer, the overall efficiency of hydrogen production was 8.0%. (Author)

A82-42550

SOLAR ENERGY DEVELOPMENT AND APPLICATION IN JAPAN - AN OUTSIDERS ASSESSMENT

E. KNOPP (Technoservice AB, Malmo, Sweden) International Journal of Ambient Energy, vol. 3, Apr. 1982, p. 101-107. Research supported by the Swedish Board for Building Research.

The Sunshine Project was initiated in Japan in 1974 in order to develop energy resources to meet future needs. The solar program consists of three categories; solar home construction, the construction and operation of a 1000 kWe capacity solar thermal power generation plant, and the development of a photovoltaic system with a cost per watt reduced to 1/100 of the present cost. Low interest loans to promote the use of solar systems have resulted in the installation of one million solar collectors. Solar water heaters produced have a 2 sq m collection area and a 200 liters water storage capacity, and an evacuated tube collector with an efficiency of 64% has been developed. Work is being devoted to the production of a 50 times concentrating tracking circular Fresnel-type photovoltaic device, and a solar driven cooling system with a 5.35 kW capacity, which operates with a highly efficient freon vapor expander, has been developed. The problem of collected heat storage is being tested and assessed. R.K.R.

A82-42587

EFFICIENT CADMIUM SULPHIDE ON SILICON SOLAR CELLS

R. R. ARYA, P. M. SARRO, and J. J. LOFERSKI (Brown University, Providence, RI) Applied Physics Letters, vol. 41, Aug. 15, 1982, p. 355-357. Research supported by the U.S. Department of Energy and NSF. refs

Heterojunction solar cells of the p-Si/CdS type, fabricated by single source evaporation of CdS over silicon at low temperatures (approximately 175 C), are described. The cells exhibit solar power conversion efficiencies of up to 11%. Regarding spectral response, it is shown that on the long wavelength side, the cell responds as a conventional p-n homojunction Si cell, whereas on the short wavelength side there is a sharp cutoff at the absorption edge of CdS. The cells are considered stable; no significant degradation in the photovoltaic parameters is observed under normal room-ambient conditions for one month after fabrication. The cells demonstrate that even though there is a large lattice mismatch between silicon and CdS, efficient solar cells can be produced by evaporating highly conducting transparent CdS over the silicon. C.R.

A82-42594

STEADY STATE MODEL OF AN ILLUMINATED LIQUID-JUNCTION SOLAR CELL

W. E. PINSON (Infrared Photo, Ltd., Ottawa, Canada) Applied Physics Letters, vol. 41, Aug. 15, 1982, p. 382-384. refs

It is proposed that the position of the semiconductor band edges relative to the electrolyte redox potential at an illuminated semiconductor-electrolyte interface is determined by the minority photocurrent at the interface and its interaction with the density of states distribution of the redox couple, rather than by a flatband potential or by Fermi level pinning. The model is demonstrated for a solar illuminated Au/n-GaAs(0.6)P(0.4) photoanode in contact with electrolytes having redox potentials differing by 0.8 V. (Author)

A82-42751

HOLOGRAPHIC SOLAR CONCENTRATOR

J. E. LUDMAN (Photics, Inc., Westford, MA) Applied Optics, vol. 21, Sept. 1, 1982, p. 3057, 3058. refs

Problems associated with holographic solar collection are examined with particular reference to the collection system architecture and the wavelength tolerance problem. A simple system using a novel hologram design is proposed which effectively addresses these problems. The proposed system will effectively (about 70%) concentrate (4:1) the visible spectrum (wavelength factor of 2) over a 100-degree daily angular variation and for an annual 45-degree variation, which is adequate for a solar collection system. V.L.

A82-42788

THERMAL EMITTANCE OF FILMS OF NICKEL AND STAINLESS STEEL

B. WINDOW and G. L. HARDING (Sydney, University, Sydney, Australia) Optical Society of America, Journal, vol. 72, Sept. 1982, p. 1281-1283. Research supported by the University of Sydney. refs

The emittance and electrical resistance of smooth films (200 nm) of nickel and Type 316 stainless steel sputtered onto glass tubes have been measured in the temperature range 60-440 C. For nickel, there is general agreement with both data in the literature and calculations based on Drude theory, although some discrepancies do occur. For the stainless-steel film, large differences are observed which are attributed to interference-layer effects associated with the finite thickness of the film. V.L.

A82-43020

DEPLETION LAYER STUDIES AND CARRIER PHOTOGENERATION IN DOPED MERCYANINE PHOTOVOLTAIC CELLS

G. A. CHAMBERLAIN (Shell Research, Ltd., Thornton Research Centre, Chester, England) Journal of Applied Physics, vol. 53, Sept. 1982, p. 6262-6269. refs

The capacitance and photocurrent of Al/Cl₂-doped mercyanine/Au thin film photovoltaic cells have been studied as a function of applied voltage bias. The capacitance data indicated that a Schottky barrier had formed between the Al and organic dye. The barrier width, built-in potential, and carrier concentration were 23 nm, 1.05 V, and 10 to the 18th/cu cm, respectively. Photocurrent measurements at different excitation wavelengths strongly suggest that carrier photogeneration is a bulk phenomenon. Combining these observations with a study of the effects of doping with molecular chlorine, it is proposed that carriers are generated by electron transfer from a thermalized exciton to a dopant site. The dopant is thought to be absorbed in the dye layer as the acceptor half of a weak charge transfer complex. A quantum yield of 11.2% at 632.8 nm based on light absorbed by a 30-nm thick mercyanine film was measured for the chlorine-doped cell.

(Author)

A82-43023

SPACE-CHARGE LIMITED CONDUCTION IN N/⁺/NN/⁺/AMORPHOUS HYDROGENATED SILICON FILMS

E. BHATTACHARYA, S. GUHA, K. V. KRISHNA, and D. R. BAPAT (Tata Institute of Fundamental Research, Bombay, India) Journal of Applied Physics, vol. 53, Sept. 1982, p. 6285-6288. Research supported by the Tata Institute of Fundamental Research. refs

A82-43026

OPTICAL CONSTANTS AND SPECTRAL SELECTIVITY OF STAINLESS STEEL AND ITS OXIDES

B. KARLSSON and C. G. RIBBING (Uppsala Universitet, Uppsala, Sweden) Journal of Applied Physics, vol. 53, Sept. 1982, p. 6340-6346. Research supported by the Styrelsen for Teknisk Utveckling. refs

The optical properties of stainless steel and some of the natural oxides which are easily formed on steel surfaces are investigated in order to evaluate the possibilities of using stainless steel in solar collectors. Results show that the metallurgical phase is a more important parameter for the reflectance behavior than the precise content of the alloying elements. The austenitic steels have a higher reflectance than the ferritic and martensitic, although their integrated solar reflectance of 68% is considered to low for solar reflectors. The optical constants of the free oxides Cr₂O₃ and Fe₂O₃ are determined by combined transmission and reflectance measurements. The resulting optical properties for the metal-oxide tandem are then calculated by conventional optical matrix methods. It is found that a ferritic steel base is optimal due to its lower reflectance and it is determined that Fe₂O₃ gives better selectivity than Cr₂O₃ due to its lower interference minimum and maximum. N.B.

A82-43049

EFFICIENCY OF LIGHT-ENERGY CONVERSION IN PHOTOVOLTAIC CELLS AND WATER CLEAVAGE SYSTEMS

M. H. DUNG and J. J. KOZAK (Notre Dame, University, Notre Dame, IN) Journal of Chemical Physics, vol. 77, Sept. 15, 1982, p. 3246-3257. Research supported by the U.S. Department of Energy. refs

Recently, considerable emphasis has been placed on the problem of identifying and then estimating the importance of various (thermodynamic and kinetic) factors which influence the efficiency of conversion of solar energy into storable chemical or electrochemical energy. The present investigation is concerned with an analysis of the efficiency of solar energy conversion processes using the general ideas of finite-time thermodynamics as developed in earlier studies. A comparative study is initiated of two important classes of light-energy conversion devices, including the photogalvanic cell and the cyclic water cleavage system. It is argued that, despite obvious differences in the experimental design and operation of these two systems, there are a number of (photochemical, electrochemical, and mathematical) features common to both systems which can be exploited in a comparative study. G.R.

A82-43063#

PERFORMANCE OF A MATRIX AIR HEATER

M. S. SODHA, N. K. BANSAL (Indian Institute of Technology, New Delhi, India), D. SINGH, and S. S. BHARADWAJ Journal of Energy, vol. 6, Sept.-Oct. 1982, p. 334-339. refs

This communication presents a study of a porous flat plate solar air heater. An earlier theory used to analyze such a system has been modified by using: (1) appropriate boundary conditions and also (2) by considering the realistic case of different air and matrix temperatures. Numerical calculations have been performed to bring out the difference between the earlier theory and the present theory. The results of the present theory are found to be in excellent agreement with the measurements of an experiment. The yearly performance of the system has also been evaluated for Delhi-type climates. (Author)

A82-43069

THEORETICAL ANALYSIS OF THE PERFORMANCE OF A CONICAL SOLAR CONCENTRATOR

M. F. EL-REFAIE (Cairo University, Cairo, Egypt) Applied Energy, vol. 12, Sept. 1982, p. 37-51. refs

This paper describes a study of the conical solar energy concentrator with tubular axial absorber. The concentrated power is evaluated, in a dimensionless form, as a function of the mirror surface quality and the absorber-to-aperture diameter ratio. The irradiated length of the absorber is determined and the axial concentration distribution along its surface is expressed mathematically. An integrated, or average, concentration ratio is used to measure the concentrating power of the reflector-absorber assembly. In addition to the mirror reflectivity, the performance is shown to be influenced by three parameters - the apex angle, the diameter ratio and the truncation ratio. The effects of these parameters on the concentrated power, the concentration profile and the reflector-surface area are investigated. (Author)

A82-43077

SOLAR POWER PLANTS - STATE OF THE ART AND PROSPECTS FROM THE INTERNATIONAL POINT OF VIEW [SONNENKRAFTWERKE - ENTWICKLUNGSSTAND UND ZUKUNFTSAUSSICHTEN AUS INTERNATIONALER SICHT]

G. FANINGER (Oesterreichische Gesellschaft fuer Sonnenenergie und Weltraumfragen GmbH, Vienna, Austria) In: Small power plants; Seminar on Small Power Plants - Technology and Cost Effectiveness, Technische Universitaet Wien, Vienna, Austria, January 15, 16, 1981, Reports. Vienna, Technische Universitaet Wien, 1981, p. 52-87. In German.

Solar-thermal and photovoltaic systems are discussed. The possibilities for solar production of electricity is compared with those for alternative energy sources: running water, wind, waves, and heat gradients in oceans. Solar ponds are briefly discussed.

02 SOLAR ENERGY

The components of solar-thermal power plants are treated, including concentrators, refractors, collectors, and heliostats. The state of international cooperation and goal-setting is examined along with ways of optimizing solar-thermal systems. The tower and farm concepts of such systems are evaluated. For photovoltaic systems, the state of the art in solar cells, the structure of solar generators, cost factors, and system tests are discussed. The possible contributions of energy satellites are noted. C.D.

A82-43078 EXPERIENCES WITH THE AUSTRIAN 10-KW SOLAR POWER PLANT [ERFAHRUNGEN MIT DEM OESTERREICHISCHEN 10-KW-SONNENKRAFTWERK]

H. KLEINRATH (Wien, Technische Universitaet, Vienna, Austria) In: Small power plants; Seminar on Small Power Plants - Technology and Cost Effectiveness, Technische Universitaet Wien, Vienna, Austria, January 15, 16, 1981, Reports. Vienna, Technische Universitaet Wien, 1981, p. 88-96. In German.

Aspects of solar power plants in the range 10-100 kW are discussed in the light of the Austrian experience. The thermal cycle is reviewed, and the overall design of the small solar units is discussed, including the collectors, converters, and characteristic values. Temperature-enthalpy and temperature-entropy diagrams are shown. C.D.

A82-43103#

SAFETY IN THE CONTROL SYSTEM FOR A HELIOSTAT FIELD OF A SOLAR CENTRAL TOWER POWER PLANT [SUR LA SECURITE D'UN SYSTEME DE COMMANDE POUR LE CHAMP D'HELIOSTATS D'UNE CENTRALE SOLAIRE A TOUR]

F. RIVERA MARTINEZ Toulouse III, Universite, Docteur-Ingenieur Thesis, 1981. 146 p. In French. refs

The development of a three-level microprocessor based control strategy for a heliostat field for a solar thermal power plant is presented, with particular emphasis on safety procedures through self-surveillance capability in the control electronics. The control system is decentralized, organized in three hierarchical levels, and interconnected in a series of data buses. The microprocessor system is based on the INTEL 8085 chip as the interface between the central computer and individual heliostats. Each heliostat is treated as a separate system and can be isolated during malfunction, with the total program goal designed to maintain the temperature at the central receiver as close as possible to an optimum operational flux. The subsystem chips were all designed to be continuously self-checking, and a routine was devised for the additional total system self-checking. The interaction between the subsystem checking procedures and the overall system surveillance is discussed. M.S.K.

A82-43125

BONDING SOLAR-SELECTIVE ABSORBER FOILS TO GLASS RECEIVER TUBES FOR USE IN EVACUATED TUBULAR COLLECTORS - PRELIMINARY STUDIES

D. P. GRIMMER and J. G. AVERY (Los Alamos National Laboratory, Los Alamos, NM) Solar Energy, vol. 29, no. 2, 1982, p. 121-124. Research supported by the U.S. Department of Energy. refs

A82-43127

AN EXPERIMENTAL STUDY OF THE CO₂-CH₄ REFORMING-METHANATION CYCLE AS A MECHANISM FOR CONVERTING AND TRANSPORTING SOLAR ENERGY

J. H. MCCRARY, G. E. MCCRARY (New Mexico State University, Las Cruces, NM), T. A. CHUBB, J. J. NEMECEK, and D. E. SIMMONS (U.S. Navy, Naval Research Laboratory, Washington, DC) Solar Energy, vol. 29, no. 2, 1982, p. 141-151. Research supported by the U.S. Department of Energy. 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. A number of receiver elements (chemical reactors) have been tested in the laboratory in an effort to optimize the catalyst parameters and the catalyst-reactor configuration. These tests led to the design and fabrication of both prototype and full scale production model Solchem receivers

which were operated successfully at the White Sands Solar Furnace. The development of energy delivery methanation reactors is proceeding along with the design of both laboratory and field-model closed-loop Solchem systems. (Author)

A82-43128

ELECTROCHEMICAL SOLAR CELLS

A. HELLER (Bell Telephone Laboratories, Inc., Murray Hill, NJ) (International Union of Pure and Applied Chemistry, Congress, 28th, Vancouver, British Columbia, Canada, Aug. 16-22, 1981.) Solar Energy, vol. 29, no. 2, 1982, p. 153-162. refs

Semiconductor liquid junction solar cells reach 12 per cent solar to electrical and similar solar to chemical (hydrogen) conversion efficiency when made with single crystal semiconductors; they retain 2/3 of this efficiency when made with thin, chemically formed, polycrystalline semiconductor films. The principle on which the most efficient cells are based is the neutralization ('passivation') of damaging states, that result from weak chemical bonds at surfaces and at grain boundaries, by chemisorption of strongly bound species. The solar conversion efficiencies of cells made with chemically vapor deposited p-InP films on graphite are increased by factors between 6 and 500 upon diffusion of chemisorbed silver ions into the grain boundaries, and the efficiencies of cells made with similar films of n-GaAs, by factors between 3-4, upon diffusion of ruthenium ions. (Author)

A82-43130

INVESTIGATION OF POLYCRYSTALLINE SILICON BACK SURFACE FIELD SOLAR CELLS

W. A. ORR (IBM Corp., General Technology Div., Hopewell Junction, NY) and M. ARIENZO (IBM Thomas J. Watson Research Center, Yorktown Heights, NY) IEEE Transactions on Electron Devices, vol. ED-29, Aug. 1982, p. 1151-1155. refs

Solar cells fabricated from 'bicyrstalline' silicon wafers with respective orientations of (111) and (100) have been investigated using the scanning spectral response technique. Application of an aluminum back surface field (BSF) increases the photocurrent at long wavelengths even in the intergranular region. Variation in photocurrent enhancement with grain orientation and aluminum alloy time is discussed. At long alloying times, evidences of gettering have been observed. (Author)

A82-43266*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A MODEL FOR PROTON-IRRADIATED GAAS SOLAR CELLS

J. W. WILSON, G. H. WALKER, R. A. OUTLAW (NASA, Langley Research Center, Hampton, VA), and L. V. STOCK (Old Dominion University, Norfolk, VA) Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, San Diego, CA, Sept. 27-30, 1982, Paper. 3 p. refs

A simple model for proton radiation damage in GaAs heteroface solar cells is developed. The model includes the effects of spatial nonuniformity of low energy proton damage. Agreement between the model and experimental proton damage data for GaAs heteroface solar cells is satisfactory. An extension of the model to include angular isotropy, as is appropriate for protons in space, is shown to result in significantly less cell damage than for normal proton incidence. (Author)

A82-43267*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

ON THE VALIDITY OF EQUIVALENT ELECTRON FLUENCE FOR GAAS SOLAR CELLS

J. W. WILSON, G. H. WALKER (NASA, Langley Research Center, Hampton, VA), and J. J. STITH (Virginia State College, Petersburg, VA) Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, San Diego, CA, Sept. 27-30, 1982, Paper. 3 p. refs

A simple model for particulate radiation damage in shallow-junction heteroface GaAs solar cells is used to evaluate the equivalent electron fluence concept especially in the sense of additivity of electron and proton exposure. It is found that spatial dependent factors for low-energy proton exposure results in a

dose dependent equivalent fluence ratio so that additivity within the equivalent fluence concept is generally not possible.

(Author)

A82-43301

INTERNATIONAL SOLAR FORUM, 3RD, HAMBURG, WEST GERMANY, JUNE 24-27, 1980, PLENARY LECTURES [INTERNATIONALES SONNENFORUM, 3RD, HAMBURG, WEST GERMANY, JUNE 24-27, 1980, PLENARVORTRAEGE]

Duesseldorf, VDI-Verlag, 1981. 129 p. In German and English.

Progress and potential in solar energy are discussed. The topics considered include energy research and development in the BRD; raw materials cycles and energy use, anthropogenic loading and limits of the carrying capacity; basic issues of energy policy with special regard for renewable energy and its promotion by states of the BRD; the solar technology market; the role of conservation and renewable energies in meeting future energy demand; a Common Market demonstration project for promoting the use of solar energy; possibilities and limitations for the use of solar energy in Central Europe. C.D.

A82-43306

COMMON MARKET MEASURES TO PROMOTE THE USE OF SOLAR ENERGY - THE DEMONSTRATION PROJECT [EG-MASSNAHMEN ZUR FOERDERUNG DER NUTZUNG VON SONNENENERGIE - DAS DEMONSTRATIONSPROGRAMM]

W. KAUT (Commission of the European Communities, Brussels, Belgium) In: International Solar Forum, 3rd, Hamburg, West Germany, June 24-27, 1980, Plenary Lectures. Duesseldorf, VDI-Verlag, 1981, p. 87-99. In German.

A series of solar technical projects being conducted under the auspices of the Common Market is discussed. The history and legal foundations of this demonstration project, previous proposal requests and their results, and the experiences to date and present status of the project are assessed. Twenty-six projects proposals are being funded; the only German one concerns solar heating of swimming pools. The economic and administrative aspects of these projects are detailed. Problems of the project are discussed, including the allocation of funds between older and newer aspects and financial constraints. C.D.

A82-43307

SOLAR ENERGY USE IN CENTRAL EUROPE - POSSIBILITIES AND LIMITATIONS [NUTZUNG DER SONNENENERGIE IN MITTELEUROPA - MOEGLICHKEITEN UND GRENZEN]

H. HOERSTER (International Solar Energy Society, Aachen, West Germany) In: International Solar Forum, 3rd, Hamburg, West Germany, June 24-27, 1980, Plenary Lectures. Duesseldorf, VDI-Verlag, 1981, p. 100-125. In German. refs

Various solar energy technologies are evaluated and compared. The climatological facts for different areas of Central Europe are summarized, and the main potential practical uses of solar energy in that area are stated. The possibilities and limitations of four types of solar technologies that may be realized within the next ten years are quantitatively assessed, including solar warm water systems for washing and heating, the passive use of solar energy in buildings, heat pumping systems, and a combination of the above. The economic aspects of solar technology are briefly discussed. C.D.

A82-43334#

OPERATION AND PERFORMANCE OF THE SOLAR STEAM SYSTEM AT THE JOHNSON & JOHNSON PLANT IN SHERMAN, TEXAS

D. F. BRINK and S. B. YOUNGBLOOD (Acurex Corp., Mountain View, CA) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, Aug. 1982, p. 139-145. refs (Contract DE-AC03-77CS-31713)

A solar system that produces 174 C (345 F) steam is in operation at the Johnson and Johnson manufacturing plant in Sherman, Texas. The system uses parabolic trough collectors to heat pressurized water which then flashes to steam in a flash boiler; this steam is fed into the plant steam main for use in several

manufacturing processes. The facility's performance has been monitored continuously since it began operation in January 1980. The collector field typically has delivered energy to the flash boiler at an average daily efficiency of 30 to 40 percent, with an hourly average efficiency ranging from 38 to 42 percent at peak insolation periods. The daily and hourly values for energy collected and steam generated on a clear day in September are presented, as well as a monthly summary for the first 13 months of operation.

(Author)

A82-43336#

A REGIONAL COMPARISON OF SOLAR, HEAT PUMP, AND SOLAR-HEAT PUMP SYSTEMS

B. E. MANTON and J. W. MITCHELL (Wisconsin, University, Madison, WI) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, Aug. 1982, p. 158-164. Research supported by the U.S. Department of Energy. refs

A comparative study of the thermal and economic performance of the parallel and series solar heat pump systems, stand alone solar and stand alone heat pump systems for residential space and domestic hot water heating for the U.S. using FCHART 4.0 is presented. Results show that the parallel solar heat pump system yields the greatest energy savings in the south. Very low cost collectors (50-150 dollars/sq m) are required for a series solar heat pump system in order for it to compete economically with the better of the parallel or solar systems. Conventional oil or gas furnaces need to have a seasonal efficiency of at least 70-85% in order to save as much primary energy as the best primary system in the northeast. In addition, the implications of these results for current or proposed federal tax credit measures are discussed. N.B.

A82-43338#

TRANSIENT SIMULATION OF ABSORPTION MACHINES

D. K. ANAND, R. W. ALLEN, and B. KUMAR (Maryland, University, College Park, MD) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, Aug. 1982, p. 197-203. refs

This paper presents a model for a water-cooled Lithium-Bromide/water absorption chiller and predicts its transient response both during the start-up phase and during the shutoff period. The simulation model incorporates such influencing factors as the thermodynamic properties of the working fluid, the absorbent, the heat-transfer configuration of different components of the chiller and related physical data. The time constants of different components are controlled by a set of key parameters that have been identified in this study. The results show a variable but at times significant amount of time delay before the chiller capacity gets close to its steady-state value. The model is intended to provide an insight into the mechanism of build-up to steady-state performance. By recognizing the significant factors contributing to transient degradation, steps can be taken to reduce such degradation. The evaluation of the residual capacity in the shut-off period will yield more realistic estimates of chiller COP for a chiller satisfying dynamic space cooling load. (Author)

A82-43340#

THE SOLAR TRANSMITTANCE OF SOME CONVECTION SUPPRESSION DEVICES FOR SOLAR ENERGY APPLICATIONS - AN EXPERIMENTAL STUDY

J. G. SYMONS (Commonwealth Scientific and Industrial Research Organization, Div. of Energy Technology, Highett, Victoria, Australia) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, Aug. 1982, p. 251-256. Research supported by the National Energy Research, Development and Demonstration Council of Australia. refs

The solar transmittance of seven convection suppression devices (CDSs), including a honeycomb and various slit geometries made from FEP Teflon film and a tubular glass honeycomb, is measured as a function of both angle of incidence and azimuth angle using a large integrating sphere test facility. Results show that all FEP Teflon CDSs tested have solar transmittances not less than 0.94 for angles of incidence up to 45 degrees, while the solar transmittance is not less than 0.87 for the glass tubular

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CSD over the same range. Empirical solar transmittance correlation equations are derived, based on a simple CSD solar transmittance model, and are found to match the measured performance of the CSDs to within 2%. In addition, the transmittance, reflectance, and absorptance of each CSD are determined for diffuse radiation. N.B.

A82-43341#

A SIMPLE FORMULA FOR CALCULATING THE OPTIMAL FREQUENCY FOR CLEANING CONCENTRATING SOLAR COLLECTORS

K. D. BERGERON (Sandia National Laboratory, Albuquerque, NM) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, Aug. 1982, p. 270, 271. Research supported by the U.S. Department of Energy. refs

A82-43463

USE OF FISH-EYE LENS IN SOLAR ENERGY ASSESSMENT

T. M. ELGARF (Washington, University, Seattle, WA) In: American Society of Photogrammetry and American Congress on Surveying and Mapping, Fall Technical Meeting, San Francisco, CA, September 9-11, 1981 and Honolulu, HI, September 14-16, 1981, ASP Technical Papers. Falls Church, VA, American Society of Photogrammetry, 1981, p. 448-453.

This paper concerns the use of fish-eye lens photography in solar energy assessment. Determining the locations and orientation of solar collectors and potential solar easement concerns can be based upon the data collected by use of this method. A mathematical model, a method of photography and representation (mapping) methods have been introduced and discussed and a practical investigation has been carried out. The preliminary results are encouraging and improvement can be expected with further research. (Author)

A82-43594

WIND- AND SUN-POWERED TRANSMITTERS

G. H. MILLARD (British Broadcasting Corp., Research Dept., Tadworth, Surrey, England) IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews, vol. 129, pt. A, no. 7, Sept. 1982, p. 532-534. refs

One consideration which affects the application of wind and solar power to broadcasting in Northwest Europe is that such a high-reliability service must be designed for the worst of variable sun and wind conditions. In the United Kingdom, the combination of solar and wind power is appropriate, because the least windy month, August, has ample sunshine. Two stations using a combination of solar and wind power operate there at latitudes of 50 deg 40 min N and 56 deg 22 min N. One is designed to provide 780 W in peak sunlight and 150 W at a wind speed of 7 m/s with typical power consumption of 2.6 kWh/d. A lead-acid battery is employed with a capacity of 990 Ah. The other has four solar panels with a maximum output of 125 W and a wind turbine with a rated output of 500 W at a wind speed of 15 m/s. The two systems operate separately with batteries having capacities of 237 Ah and 186 Ah and continuous loads of 8 W each. A.B.

A82-43723#

AN EXPERIMENTAL STUDY OF A NEW SOLAR STILL - THE WIPING SPHERICAL STILL [ETUDE EXPERIMENTALE D'UN NOUVEAU DISTILLATEUR SOLAIRE - LE DISTILLATEUR SPHERIQUE A BALAYAGE]

A. MAKKI Lyon, Institut National des Sciences Appliquees and Lyon I, Universite, Docteur-Ingenieur Thesis, 1981. 171 p. In French. refs

Theoretical and experimental results of the functioning of a spherical solar water distiller which includes a curved, turning glass wiper are presented. A review of past and present solar still apparatus is presented, along with an analytical examination of insolation characteristics. Numerical models are constructed of the performance of solar stills, noting the enhanced gain with less materials available by using spherically shaped plexiglass for the transparent upper surface. Attachment of a curved glass wiper,

which extends from the top center of the dome to the collector tray and is made to revolve around the dome's inner surface by either an electric motor, or a wind-powered shaft, or by means of a motor driven by solar cells, is shown to keep the transparency higher and thus augment the efficiency of the still to 14 percent better performance than with a flat plate solar still. M.S.K.

A82-43943

ANALYSIS OF EFFICIENCY LIMITATIONS IN HIGH-LOW EMITTER BACK SURFACE FIELD SILICON SOLAR CELLS

L. PRAT and L. CASTANER (Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Barcelona, Spain) Electronics Letters, vol. 18, Sept. 2, 1982, p. 789, 790. refs

Analytical and numerical models have been used to analyse the electrical behavior of HLE-BSF n(+)-p-p(+) silicon solar cells. It is shown that this structure should have lower open-circuit voltage values than the simple HLE solar cell due to the recombination current in the p(+) region. Back surface passivation is proposed as a means to improve the open-circuit voltage that can be as high as 650 mV. (Author)

A82-44080

THE ESTABLISHMENT OF RADIATION REGIMES IN TUBULAR COLLECTORS [FORMIROVANIE RADIATIONNYKH REZHIMOV TRUBCHATYKH KOLLEKTOROV]

CH. A. AMANOV (Nauchno-Proizvodstvennoe Ob'edinenie Solntse, Turkmen SSR) Akademiia Nauk Turkmenkoi SSR, Izvestiia, Seriya Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk, no. 3, 1982, p. 24-29. In Russian. refs

Methods of calculating the radiant flux density of tubular collectors are developed, showing that solutions are possible for a day, a month, or a season through computer algorithms. Also treated is the effective cross section of a collector in the absence of shading. C.R.

A82-44081

PHOTOVOLTAIC CONVERTERS BASED ON VARIZONE GA/1-X/AL/X/SB P-N STRUCTURES [FOTOELEKTROPREOBRAZOVATELI NA OSNOVE VARIZONNYKH GA/1-X/AL/X/SB P-N-STUKTUR]

K. ATADZHIKOV, A. BERKELIEV, and N. NAZAROV (Akademiia Nauk Turkmenkoi SSR, Fiziko-Khimicheskii Institut, Ashkhabad, Turkmen SSR) Akademiia Nauk Turkmenkoi SSR, Izvestiia, Seriya Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk, no. 3, 1982, p. 83-86. In Russian. refs

The production of varizone (where the chemical composition, the forbidden zone width, and other important parameters vary continuously) Ga(2-x)Al(x)Sb p-n structures with a forbidden zone width gradient from 50 to 400 eV/cm is discussed. The results of an investigation carried out with a view to creating photovoltaic converters are presented. The method of repeated isothermal mixing of the solution-melt is used for creating varizone structures in which the width of the forbidden zone increases in the direction of growth and the gradient of the width has a large magnitude. C.R.

A82-44155

INVESTIGATION OF SOLAR CELLS CONTAINING GAAS-ALGAAS HETEROJUNCTIONS AT HIGH LEVELS OF OPTICAL EXCITATION

ZH. I. ALFEROV, KH. K. ARIPOV, B. V. EGOROV, N. S. KOROLEVA, V. R. LARIONOV, T. A. NULLER, V. D. RUMIANTSEV, and O. M. FEDOROVA (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR) (Zhurnal Tekhnicheskoi Fiziki, vol. 51, Dec. 1981, p. 2550-2553.) Soviet Physics - Technical Physics, vol. 26, Dec. 1981, p. 1506-1508. Translation. refs

The results of investigations of solar cells (SC) employing an nGaAs-pGaAs-pAl(x)Ga(1-x)As structure 30 microns thick at high illumination densities are presented. The specimen fabrication and measurement methods are described. Pulsed excitation of the specimens to eliminate uncontrolled thermal effects was first done, and the region of linearity of the short-circuit current of the SC

was determined with increase in excitation level. Then the dependence of the no-load voltage on the current density was taken by varying the illumination at a fixed temperature. From the results, a series of functions for current densities was constructed. The highest efficiency of 21.6 percent per illuminated surface was obtained for a solar radiation concentration coefficient of 130. The SC retain an efficiency of about 17 percent up to a coefficient of about 1000. The possibility of increasing the unit power of SC by increasing their diameter to 17 mm is shown. C.D.

A82-44183**INP AND CDS PHOTOANODES IN CONCENTRATED AQUEOUS IODIDE ELECTROLYTES**

L. F. SCHNEEMEYER and B. MILLER (Bell Telephone Laboratories, Inc., Murray Hill, NJ) (Electrochemical Society, Meeting, Denver, CO, Oct. 11-16, 1981.) Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 1977-1981. refs

Conditions for the efficient photo-oxidation of iodide for both n-CdS and n-InP are demonstrated by theoretical collection properties in rotating ring-disk electrode configurations. A specific I-CdS surface interaction promoting hole transfer kinetics is evidenced by open-circuit potential shifts of illuminated disks with iodide concentration and nearly quantitative disk iodine production at low iodide concentrations. For n-InP, however, high concentrations of Ca^{2+} and control of hydrogen ion levels are both needed to maintain a thin, charge conducting semiconductor-oxide film and adequate kinetics for solution iodide oxidation. Acidified concentrated iodide is the first electrolyte with an n-InP photoanode to handle solar current densities. (Author)

A82-44184**PHOTOELECTROCHEMISTRY OF N- AND P-TYPE SILICON IN ACETONITRILE**

H. J. BYKER, V. E. WOOD, and A. E. AUSTIN (Battelle Columbus Laboratories, Columbus, OH) (Electrochemical Society, Meeting, Hollywood, FL, Oct. 5-10, 1980.) Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 1982-1987. refs
(Contract XP-9-8002-2)

The use of silicon electrodes in electrochemical photovoltaic cells for the conversion of light to electricity has been investigated. The effect of surface condition on electrochemical characteristics has been studied, and a photoelectrochemical corrosion reaction between n-silicon electrodes and chloride or fluoroborate ion in acetonitrile was observed. Corrosion currents occurred at potentials positive of about +0.2V vs. Ag/Ag(+) for a freely corroding, illuminated electrode. From impedance measurements the flatband potential of n-silicon in acetonitrile was determined to be -0.23V vs. Ag/Ag(+) in the absence of redox couples. Thus the corrosion potential is within the bandgap of n-silicon under these conditions. Electrochemical characterization of p-silicon electrodes with several redox species showed a lack of useful photovoltages. Unprotected or unmodified n- and p-silicon electrodes have proven to be poor choices for electrochemical photovoltaic cells in acetonitrile.

(Author)

A82-44187**PHOTOELECTROCHEMICAL BEHAVIOR OF P-TYPE SI SINGLE CRYSTALS IN LIQUID AMMONIA AND IN LIQUID AMMONIATE OF SODIUM IODIDE**

G. VAN AMERONGEN, D. GUYOMARD, M. HERLEM (CNRS, Laboratoire de Chimie Analytique des Milieux Reactionnels, Paris, France), R. HEINDL (CNRS, Laboratoire d'Etudes des Matériaux par des Techniques Avancées, Meudon, Hauts-de-Seine, France), and J.-L. SCULFORT (CNRS, Laboratoire d'Electrochimie Interfaciale, Meudon, Hauts-de-Seine, France) Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 1998-2003. Direction des Recherches, Etudes et Techniques refs
(Contract DRET-79-1210)

The characteristics of the junctions formed between p-type Si single crystals and liquid ammonia at low temperature and liquid ammoniate of sodium iodide at room temperature are determined. In the former case, at 233 K, the flatband potential $V(\text{FB})$ is plus 0.8 plus or minus 0.1 V, and $E(\text{G})$ is 1.2 plus or minus 0.1 eV. In

the latter case, at 293 K, the $V(\text{FB})$ value is plus 0.9 plus or minus 0.3 V. The photogeneration of solvated electrons is possible. O.C.

A82-44188**THE PREPARATION OF TiO₂ ELECTRODES WITH MINIMUM MOTT-SCHOTTKY FREQUENCY DISPERSION**

H. O. FINKLEA (Virginia Polytechnic Institute and State University, Blacksburg, VA) Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 2003-2008. refs

A TiO₂ electrode preparation procedure is described which yields Mott-Schottky plots in 0.5M H₂SO₄ that are linear and exhibit slopes and intercepts nearly independent of applied frequency from 105 Hz to 50 KHz. On the basis of Mott-Schottky intercepts and photocurrent onset potentials, the flatband potential voltage is found to be -0.23 + or - 0.09V. Frequency dispersion increases when the TiO₂ electrodes are soaked in 0.5M H₂SO₄, examined in 1M NaOH, or used to generate photocurrent in 0.5M H₂SO₄. Frequency dispersion's origins and possible remedies are discussed, and the need for Mott-Schottky plots over a range of frequencies is emphasized. O.C.

A82-44190**MORPHOLOGY, PROPERTIES, AND PERFORMANCE OF ELECTRODEPOSITED N-CDSE IN LIQUID JUNCTION SOLAR CELLS**

M. TOMKIEWICZ, I. LING, and W. S. PARSONS (Brooklyn College, Brooklyn, NY) Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 2016-2022. refs
(Contract XS-9-8312-1)

A82-44196**THERMODYNAMIC AND PHOTOELECTROCHEMICAL BEHAVIOR OF THE N-TiO₂ ELECTRODE IN FLUORIDE-CONTAINING SOLUTIONS**

T. HEPEL, M. HEPEL (New York, State University, Buffalo, NY; Krakow, Uniwersytet, Krakow, Poland), and R. A. OSTERYOUNG (New York, State University, Buffalo, NY) (Electrochemical Society, Meeting, Denver, CO, Oct. 11-16, 1981.) Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 2132-2141. Research supported by the Solar Energy Research Institute and U.S. Navy. refs

The current-voltage characteristics of n-TiO₂ semiconductor electrodes were determined in fluoride-containing solutions under illumination and in the dark, and found to exhibit electrochemical behavior similar to that reported for other media. Increased solubility of the TiO₂ is found to occur over a narrow range of solution pH values near 3.2. A photoetching process is recommended for the n-TiO₂ surface's preparation for solar energy conversion applications. The doping profile in the space charge layer which forms during photoetching is more effective in splitting the electron hole pair created in a working electrochemical solar cell. On the evidence of chronovoltamperometric and coulometric studies of the reactions taking place at electrode potentials negative of the flatband potential, it is concluded that only the first step of the TiO₂ reduction to lower oxides is reversible. O.C.

A82-44197**INTERFACIAL CHEMISTRY AT P-GAP PHOTOELECTRODES**

D. S. GINLEY and M. B. CHAMBERLAIN (Sandia National Laboratory, Albuquerque, NM) Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 2141-2145. refs
(Contract DE-AC04-76DP-00789)

P-GaP photoelectrodes are of interest as cathodes in photosynthetic photoelectrochemical devices. The nature of the surface appears crucial to the efficient utilization of this material. It is shown how an oxide surface layer is present even in the reductive environment at the surface, that this layer appears to be necessary for efficient interfacial charge transport, and that high solution oxygen concentrations increase the stability of this layer and consequently the electrode. Aging experiments with chemical and surface analyses are included that support these results. (Author)

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A82-44226#

AN ANALYSIS OF THE INSERTION OF NONMARGINAL SOLAR-ELECTRICITY PRODUCTION INTO THE GRID UNDER OPTIMIZED MANAGEMENT [ANALYSE DE L'INSERTION D'UNE PRODUCTION ELECTRO-SOLAIRE NON MARGINALE DANS UN RESEAU SOUS GESTION OPTIMALE]

J. M. SZARVAS Toulouse III, Universite, Docteur-Ingenieur Thesis, 1981. 106 p. In French. refs

Optimal management strategies are presented for the introduction of solar central tower power plant electricity into a grid which includes hydroelectric power plants. Limiting conditions on the study included the grid as being isolated node and the strategy being concerned only with the lifetime of the equipment. Consideration is given to management of a solar-electric plant with varying levels of storage capability. A numerical model is formulated for the hydro-solar hybrid system in terms of coupled subsystems. A volumetric model is then defined for a maximum decrease in the amount of combustible fuels burned in thermal power plants in the same grid. The problem is solved by means of a reduced gradient method, and the control algorithm is provided. The optimization horizon is demonstrated as a function of characteristics of electricity demand. A weekly cycle of alternating peak and lull demand hours is found to be optimal as the time step, and seasonal heat storage is determined to be infeasible.

M.S.K.

A82-44229#

DECOMPOSITION AND CONTROL OF COMPLEX SYSTEMS - APPLICATION TO THE ANALYSIS AND CONTROL OF INDUSTRIAL AND ECONOMIC SYSTEMS /ENERGY PRODUCTION/ WITH LIMITED SUPPLIES [DECOMPOSITION ET COMMANDE DE SYSTEMES COMPLEXES - APPLICATION A L'ANALYSE ET LA COMMANDE DE SYSTEMES INDUSTRIELS ET ECONOMIQUES /PRODUCTION D'ENERGIE/, AVEC STOCKS BORNES]

M. DE COLIGNY Toulouse III, Universite, Docteur d'Etat Thesis, 1981. 205 p. refs

Optimized control strategies are developed for industrial installations where many variables of energy supply and storage are involved, with a particular focus on characteristics of a solar central tower power plant. It is shown that optimal regulation resides in controlling all disturbances which occur in a limited domain of the entire system, using robust control schemes. Choosing a command is then dependent on defining precise operational limits as constraints on the machines' performances. Attention is given to the development of variational principles used for the elements of the command logic. Particular consideration is given to a limited supply in storage in spatial and temporal terms. Commands for alterations in functions are then available on-line, and discontinuities are not a feature of the control system. The strategy is applied to the case of a field of heliostats and a central tower thermal receiver showing that management is possible on the basis of a sliding horizon.

M.S.K.

A82-44301

SOLAR ENGINEERING - 1981; PROCEEDINGS OF THE THIRD ANNUAL CONFERENCE ON SYSTEMS SIMULATION, ECONOMIC ANALYSIS/SOLAR HEATING AND COOLING OPERATIONAL RESULTS, RENO, NV, APRIL 27-MAY 1, 1981

R. L. REID, (ED.) (Tennessee, University, Knoxville, TN), L. M. MURPHY (Solar Energy Research Institute, Golden, CO), and D. S. WARD (Colorado State University, Fort Collins, CO) Conference sponsored by the American Society of Mechanical Engineers and U.S. Department of Energy. New York, American Society of Mechanical Engineers, 1981. 777 p. \$40

Progress made toward the commercialization of solar energy technologies as of 1981 is assessed, and attention is given to the future uses and impacts of solar energy. Attention is given to the results of several years of monitoring and modifying solar heating and cooling on residential and commercial structures. Solar system simulation and analysis methods are reviewed, covering the performance and operations of passive and active systems,

thermosyphon systems, heat pumps and phase change systems. Simulations of system components are discussed, as are means to validate existing computer simulation codes, particularly the TRNSYS program. Control systems and logic for collector systems are explored, including analyses of building loads and climates, and numerical models of the economics of solar heating systems are presented. Performance simulations and economic analyses are also outlined for wind and photovoltaic systems, and for industrial solar heating systems. Finally, fundamental studies of corrosion, steam flow, wind loading, and scaling in solar systems are described.

M.S.K.

A82-44302#

PERFORMANCE COMPARISON OF SOLAR SPACE HEATING SYSTEMS OF SELECTED ACTIVE SITES IN THE NATIONAL SOLAR DATA NETWORK

P. W. KENDALL and H. O. HOLTE (Vitro Laboratories, Silver Spring, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 1-14. refs

The purpose of this paper is to present the most recent composite performance results for selected active solar space heating commercial sites in the National Solar Data Network. Results presented have been developed on the basis of analysis of instrumented sites monitored through the 1979-1980 heating season. Sites analyzed in depth include four representative major types of active solar heating systems. A great quantity of individual measurements have been collected and reduced, providing a large reservoir of data for operational and comparative analysis. Parameters and performance indices presented include overall system delivered loads, solar fraction of load, solar saving ratio, coefficient of performance, energy collected and stored, and various subsystem efficiencies. The comparison of these factors has allowed evaluation of the relative performance of various system designs. A matrix of performance indices is presented for comparison of the representative solar heating installations.

(Author)

A82-44303#

EXPERIENCES IN SOLAR COOLING SYSTEMS

D. S. WARD (ENTEC Products Corp., Fort Collins, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 15-27. refs

The results of performance evaluations for nine solar cooling systems are presented, and reasons for low or high net energy balances are discussed. Six of the nine systems are noted to have performed unfavorably compared to standard cooling systems due to thermal storage losses, excessive system electrical demands, inappropriate control strategies, poor system-to-load matching, and poor chiller performance. A reduction in heat losses in one residential unit increased the total system efficiency by 2.5%, while eliminating heat losses to the building interior increased the efficiency by 3.3%. The best system incorporated a lithium bromide absorption chiller and a Rankine cycle compression unit for a commercial application. Improvements in the cooling tower and fan configurations to increase the solar cooling system efficiency are indicated. Best performances are expected to occur in climates inducing high annual cooling loads.

M.S.K.

A82-44304#

THE CONTINUING PERFORMANCE OF THE USAF ACADEMY RETROFIT SOLAR HOUSE

K. A. CORNELIUS and J. D. BENSON (U.S. Air Force Academy, Colorado Springs, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 28-35. refs

Performance results of the installation of energy conservation and flat plate collector retrofits to a U.S. Air Force standard serviceman's house are reported. Solar collectors were emplaced on the roof and in the back yard, and a 2500 gal underground thermal storage tank was included in the system. Urea formaldehyde foam was injected into the wall and blown into the attic, while three-inch thick fiberglass batts were added between floor joists over the crawl space. The heating load decreased 30% after the installation of insulation. The collector ground array was tested for effectiveness at different inclination angles, which were found to have a negligible impact on system performance. Collection efficiencies increased significantly with the use of tubular flat plate collectors. The solar fraction of the heating load increased to 60%, maximum, with the tubular collectors. It is noted that the system performance was highest when the building was inhabited. M.S.K.

A82-44305#

PERFORMANCE OF SOLAR ENERGY HOT WATER SYSTEMS

M. A. CRAMER, K. D. EVANS, J. M. ROSEBUSCH, and R. A. WEINSTEIN (Vitro Laboratories, Silver Spring, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 43-52.

The results of performance comparisons of four solar hot water/building heat installations of the National Solar Data Network are presented. The sites were monitored by various sensors and data were processed remotely at a central location. Statistics are presented for seasonal hot water demand, solar fraction, fuel saved, supply and delivery temperatures, auxiliary fuel required, and costs, in addition to specifications of passive, active, or hybrid configuration. Lowest collector efficiencies were experienced during the summer months (7%), rising to 58% in winter conditions. System efficiencies ranged from 21-41%, with the highest value occurring at the site with passive components. Constant circulation of heating fluid in a large building was found to lower the system efficiency. One solar system, in a warm climate, with thermosiphon collector and storage, is suggested to satisfy 100% of the system load if proper pipe insulation is implemented M.S.K.

A82-44306#

LONG-TERM PERFORMANCE TRENDS FOR TEN SOLAR SYSTEMS MONITORED BY THE NATIONAL SOLAR DATA NETWORK

L. DOAK and C. GERVASIO (Vitro Laboratories, Silver Spring, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 53-57. refs (Contract DE-AC01-79CS-30027)

Performance of ten solar sites in the National Solar Data Network (NSDN) are plotted over periods of two to three years. Performance trends for collector array, and the energy collection and storage subsystems are presented. Comparisons are made between performance trends for air and liquid collectors, and between active and passive systems. The report also offers observations on causes for trends over several years of operation. (Author)

A82-44307#

PERFORMANCE OF A SOLAR AUGMENTED HEAT PUMP

A. F. G. BEDINGER, J. J. TOMLINSIN, R. L. REID, and D. J. CHAFFIN (Tennessee, University, Knoxville, TN) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 58-67. Tennessee Valley Authority (Contract TVA-TV-42885A)

Performance results from a test house equipped with a parallel solar augmented heat pump system with off-peak storage and a utility interconnection back-up, are presented. The collector array consisted of 12 air heating flat plates with a 9 l/sec flow. Thermal storage was consigned to a 260 cu ft crushed limestone pebble bed, with an 8.8 kW heat pump used to draw heat from storage during off-peak hours and a 15 kW electrical resistance heater used to charge the pebble bed. Monitoring and data recording were carried out on all energy inputs and outputs of the systems, and a modified TRNSYS program was employed to model the system performance. The data indicate that although the system offered the possibility of reducing the utility capacity, the addition of the solar system did not significantly augment the performance of the heat-pump system, at least in terms of the cost of supplementary electricity. M.S.K.

A82-44308#

DEVELOPMENT AND IMPROVEMENT OF LIQUID SYSTEMS FOR SOLAR SPACE HEATING AND COOLING - CSU SOLAR HOUSE I

G. O. G. LOF, W. S. DUFF, and C. E. HANCOCK (Colorado State University, Fort Collins, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 68-80. Research supported by the U.S. Department of Energy. refs

Quantitative results of a six year study of three residential structures equipped with solar flat plate collector heating and cooling systems, in addition to storage and gas or electric back-up, are reported. The systems were modified yearly to increase the systems' efficiency and also define effective means of integrating commercially available solar equipment into retrofit housing. Comparisons of efficiencies of four different collector types showed that an evacuated tube system performed best, at 49-62% in the heating mode and 48-58% in the cooling mode. Reduction of the heat loss from storage was found to produce a maximum of 75% of the cooling load using an evacuated tube system. Use of electric back-up was determined to be acceptable from a utility standpoint, because the solar equipment furnished the heating during peak generation hours, while back-up heat was required only during the night. M.S.K.

A82-44309#

COMMERCIAL SOLAR WATER HEATING SYSTEMS OPERATIONAL TEST

G. R. GUINN, B. J. NOVELL, and L. HUMMER (Alabama, University, Huntsville, AL) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 81-91.

The features, systems, and instrumentation of the Alabama Solar Energy Center, which is monitoring the long term performance of six commercially available flat plate collector systems, are described. The flat plates are installed in parallel on the same sloping south-facing roof, and all are fed a constant 3.79 l/min flow water. The systems are outfitted with either silicone, oil, drain-back or glycol freeze protection measures. Monitoring proceeds on the total insolation, cumulative electrical operating energy requirements, the necessary auxiliary electricity to heat hot water coils, the cumulative heat delivered to the water, the cumulative hot water delivered to the load, and solar energy

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delivered to an auxiliary water system. It has been found that parasitic electrical use is a significant factor in solar system economics. Water heaters from the same manufacturer have been determined to vary 25% in heat loss, but performance is best using a single tank. M.S.K.

A82-44310# EVALUATION OF FIVE SOLAR DOMESTIC WATER HEATING SYSTEMS

S. R. SWANSON and R. F. BOEHM (Utah, University, Salt Lake City, UT) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 92-98. Research supported by the Utah Power and Light Co. refs

Five solar domestic water heaters were tested over a period of two years. Four of the systems are similar and utilize an experimental dual preheat tank arrangement with external heat exchanger. The fifth system uses a single tank with in-tank heat exchanger. Measurements were made of useful energy delivered to storage, hot water used, and electrical energy used for pumps and auxiliary heating. The results indicated that overall performance was lower than had been expected. Short term diagnostic tests were run, and a number of factors were determined to have a negative effect on system performance. These were low collector tilt angle, high pumping energy, mismatch of flows in heat exchanger, high thermal mass external to the storage tank, and a possible decrease in collector performance. (Author)

A82-44311# SOLAR DOMESTIC WATER HEATING PERFORMANCE TEST PROGRAM - INTERIM REPORT

R. H. AURIS (Philadelphia Electric Co., Commercial Operations Dept., Philadelphia, PA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 99-103.

Performance results from utility-installed or monitored flat plate collector systems on 13 residences are reported. The systems comprised either drain-down, i.e., emptying the water-working fluid into a reservoir in response to thermistor sensing of sufficiently low temperatures, or water/glycol mixture as freeze protection measures. Installation errors committed by commercial solar contractors employed by the utility customers are outlined, indicating the uncertainty involved in obtaining a quality installation. Most system failures occurred with the drain-down systems, which also featured the highest system efficiencies. Redundancy in the control systems is suggested to offer significant improvements in system efficiency. The systems provided an average of 40% of the annual hot water needs, and the development of low cost materials, better system designs, low cost financing, and increased tax credits are concluded to be methods of making the systems cost effective. M.S.K.

A82-44312# PARTIAL RESULTS SUMMARY FOR SOLAR DOMESTIC HOT WATER MONITORING IN PENNSYLVANIA

W. K. AUNGST (Pennsylvania State University, Middletown, PA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 104-111.

Installation procedures, monitoring practices, and results of performance evaluations of 50 HUD-sponsored residential solar flat plate collector systems studied in the field are summarized. The systems consisted of antifreeze, drain-down, and air freeze protection schemes, featured either one- or two-tank thermal storage, and were either roof- or ground-mounted. Residents kept daily records of water flow, temperature, kWh, and elapsed time. The HUD program goals were that one-half of the household daily

water needs would be heated by the solar system. An average of 34.5% of the hot water energy was found, although a coefficient of performance of 1.40 was also found, compared to 0.78 and 0.82 for nonsolar water heaters. An average of 9% rate of return on investment was calculated for the solar systems, noting that system efficiencies ranged from 7-79.8%, and the rates of return ranged from 1-22.4%. M.S.K.

A82-44313# DEVELOPMENT OF A DAY-BY-DAY SIMULATION OF SOLAR SYSTEMS

W. S. DUFF, G. J. FAVARD, and K. R. DEN BRAVEN (Colorado State University, Fort Collins, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 112-121. Research supported by the Solar Energy Research Institute. refs

Features of the DAYSIM computer program, used to provide accurate daily and long-term performance simulations of solar heating, cooling, and hot water systems are presented and compared in practice with predictions made with the TRNSYS program. DAYSIM employs six to eight time steps per day, with insolation, ambient temperature, and loads input as cosine waves, thus reducing computing time. Numerical modeling of the collector, heat exchanger, piping, pumps, storage, controls, pressure relief valve, domestic hot water demand, space heating and cooling demand, and environmental data is discussed. The comparisons were made for a water-glycol mixture heat carrying fluid system in Madison, Ft. Worth, and Washington weather conditions. The DAYSIM model provided better insolation estimates, whereas better load models are recommended for each program, as well as inclusion of air system capability. M.S.K.

A82-44314# THE MEASURED PERFORMANCE OF AN AIR THERMOSYPHON SYSTEM

L. S. MARSHALL, P. J. BURNS, and C. B. WINN (Colorado State University, Fort Collins, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 122-129. refs

(Contract EG-79-S-02-4519)

Results of performance tests of a solar thermosyphon test cell are reported. The test cell comprised a structure on a concrete slab with fiberglass insulated walls. The north wall consisted of a styrofoam-insulated gravel-filled box, while the south wall featured double glazing over metal solar collectors. The ceiling was ducted to provide air flow from the south collector to the rock storage, and an air channel was built into the floor. A numerical model was developed of the expected performance of the cell, using an Euler technique to solve the transient energy and momentum equations. The temperature was monitored at various points of the structure and flow visualization studies were made with titanium tetrachloride. Heat was found to be stored in the upper portion of the rock box, which because of its size also inhibited circulation. Thermal comfort was determined to be available due to warm surfaces, rather than warm air. M.S.K.

A82-44315#

A SEQUENTIAL FILTER USED FOR PARAMETER ESTIMATION IN A PASSIVE SOLAR SYSTEM

C. B. WINN and D. V. PRYOR (Colorado State University, Fort Collins, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 130-134.
(Contract DE-AC02-80CS-30259)

The use of a sequential least squares filter for estimating passive solar system parameters is presented as it applies to certain types of systems. The method given is used to identify a particular existing system, and the results are given. A discussion is also included on a comparison of various sampling rates used by the filter, with a view toward selecting a 'reasonable' sampling rate.
(Author)

A82-44317#

AN INVESTIGATION OF HORIZONTAL STORAGE TANKS FOR SOLAR HOT WATER SYSTEMS

M. F. YOUNG (California, University, Irvine, CA) and J. W. BAUGHN (California, University, Davis, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 159-167.
refs

The thermal behavior of a horizontal storage tank for possible use in a solar domestic hot water system has been investigated analytically and experimentally. The purpose of the present work is to compare a simple analytical model to the measured temperature stratification in this horizontal tank. The experimental results demonstrated that axial temperature gradients were negligible compared to vertical temperature gradients. Severe mixing of the tank occurred when loads were removed unless a diffuser manifold was placed on the make-up water inlet. The analytical model used was one-dimensional (vertical) with some degree of mixing at the inlet and outlet boundaries. The temperatures at the top of the tank were predicted fairly well, but the temperatures at the bottom deviated somewhat from the predictions. It appears that some additional interior mixing not included in the present model occurs.
(Author)

A82-44318#

COMPARISON OF SOME RESULTS OF PROGRAM SHOW WITH OTHER SOLAR HOT WATER COMPUTER PROGRAMS

M. F. YOUNG (California, University, Irvine, CA) and J. W. BAUGHN (California, University, Davis, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 168-174. Research supported by the California Energy Resource and Development Commission. refs

Subroutines and the driver program for the simulation code SHOW (solar hot water) for solar thermosiphon systems are discussed, and simulations are compared with predictions by the F-CHART and TRNSYS codes. SHOW has the driver program MAIN, which defines the system control logic for choosing the appropriate system subroutine for analysis. Ten subroutines are described, which account for the solar system physical parameters, the weather data, the manufacturer-supplied system specifications, mass flow rates, pumped systems, total transformed radiation, load use profiles, stratification in storage, an electric water heater, and economic analyses. The three programs are employed to analyze a thermosiphon installation in Sacramento with two storage tanks. TRNSYS and SHOW were in agreement and lower than F-CHART for annual predictions, although significantly more computer time was necessary to make TRNSYS converge. M.S.K.

A82-44319#

A RELIABLE METHOD FOR RATING SOLAR COLLECTORS

G. O. G. LOF, D. JONES, and L. E. SHAW (Solaron Corp., Englewood, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 216-225. refs

Features of a solar flat plate collector system rating scheme which can be used by either technical or nontechnically trained persons are described and compared with other rating systems. Performance curves from the ASHRAE 93-77 technique are taken as the basic indicator of collector heat delivery capability, and can be combined with data on the type of climate, heating demand the collector serves, and the solar fraction of the load. The rating method comparisons covered calculations of heat delivery, for space heating applications, for four different collectors supplying four different load fractions in five locations. F-Chart simulations were run for the test, considering commercially available systems. Useful heat from the collectors varied with location, as did relative performance. The ARI rating system was found to be useless as a performance predictor, and recommendations are provided for an adequate rating system. M.S.K.

A82-44320#

DESIGN AND CONTROL TRADEOFFS FOR ROCKBINS IN PASSIVELY SOLAR HEATED HOUSES WITH HIGH SOLAR FRACTIONS

G. VERED and A. V. SEBALD (California, University, La Jolla, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 226-238. refs
(Contract DE-AC04-79AL-10891)

Performance of active and passive rockbins are compared in Albuquerque NM, Santa Maria CA and Madison WI. The basic house is assumed to contain both Trombe wall and direct gain. The latter are assumed to be optimally sized and controlled for each weather zone. It is demonstrated that rockbins can be used to advantage in reduction of the early morning auxiliary energy consumption peak common to passive houses with night setback thermostats. The paper also analyzes performance sensitivity to rockbin configuration (active, radiant slab top down charge, radiant slab bottom up charge), and to control strategies for charging and discharging. Effects of fan energy are included. New results on the thermal conductivity of passive rockbeds are outlined. These results are shown to be crucial to understanding the role of rockbins in passive houses.
(Author)

A82-44321#

OPTIMUM OPERATING CONDITIONS OF ABSORPTION REFRIGERATION SYSTEMS FOR FLAT PLATE COLLECTOR TEMPERATURES

G. S. KOCHHAR and S. SATCUNANATHAN (University of the West Indies, St. Augustine, Trinidad and Tobago) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 260-267. refs

This paper presents an evaluation of the performance of absorption refrigeration cycles with a view to determining optimum conditions for use with flat plate solar collectors. Equations for the thermodynamic performance analysis of the NH₃-H₂O systems are formulated and solved for various combinations of temperatures of the heat interacting components of the system using available equilibrium thermodynamic property equations. Equilibrium thermodynamic property equations for the H₂O - LiBr pair are developed and used to extend the performance analysis to the H₂O - LiBr absorption cycle. It is shown that the COP increases sharply initially with generator temperature, reaches a peak value and levels off thereafter. COP also increases with lowering of

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condensing/absorption temperatures, the increases being significant for generation temperatures below about 80 C, which is well within the effective operational range of flat plate solar collectors. Results are also presented for the overall COP's of systems driven off flat plate collectors which show that the overall COP reaches an optimum value for a particular generator temperature. (Author)

A82-44322#

THE IMPLEMENTATION OF AN ANALYTICAL VERIFICATION TECHNIQUE ON THREE BUILDING ENERGY ANALYSIS CODES - SUNCAT 2.4, DOE 2.1, AND DEROB III

D. WORTMAN, B. ODOHERTY, and R. JUDKOFF (Solar Energy Research Institute, Golden, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 268-276. Research supported by the U.S. Department of Energy. refs

An analytical verification technique for building energy analysis codes has been developed. For this technique, building models are developed that can be both solved analytically and modeled using the analysis codes. The output of the codes is then compared with the analytical solutions. In this way, the accuracy of selected mechanisms in the codes can be verified. The procedure consists of several tests and was run on SUNCAT 2.4, DOE 2.1, and DEROB III. The results are presented and analyzed. (Author)

A82-44323#

ASSESSMENT OF AIR SOLAR SYSTEM PERFORMANCE WITH ALTERNATE METHODS OF ANALYSIS

S. L. TAYLOR (Vitro Laboratories, Silver Spring, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 277-289.

As an alternative to using detailed measurements to determine the energy losses of an active air solar system, the solar space heating contribution of solar systems may be evaluated using the building as the control volume for the analysis. The method can also assess solar performance using a minimum of instrumentation. A second method, used by some designers, for active solar system performance is presented which used modified degree day design. It uses only the active space heating system as the control volume for the analysis. Discrepancies in the results suggest that space heating designers consider all heating energy flows into the building and not just the active space heating system. (Author)

A82-44324#

HOURLY USE PROFILES FOR SOLAR DOMESTIC HOT WATER HEATERS IN THE NATIONAL SOLAR DATA NETWORK

E. J. BARVIR, L. G. DOAK, R. E. WATERMAN, and C. GERVASIO (Vitro Laboratories, Silver Spring, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 319-324. refs

(Contract DE-AC01-79CS-30027)

Daily hot water rates of consumption and the Hourly Profiles of Daily Hot Water Consumption for single and multiple family dwellings are provided in this paper. These new statistics obtained from the National Solar Data Network (NSDN) are significantly different from the statistics currently being used in TRNSYS, SOLCOST and F-Chart. The NSDN statistics suggest that both the daily demand and hourly use profiles used in performance models should be revised. (Author)

A82-44325#

IMPLEMENTATION OF AN AMBIENT TEMPERATURE OBSERVER-PREDICTOR /ATOP/

N. L. WEAVER (Regional Systems Services Group, Inc., Englewood, CO) and W. S. DUFF (Colorado State University, Fort Collins, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 325-329. Research supported by the U.S. Department of Energy. refs

Test results of the performance of an algorithm which incorporates ambient temperature predictions into control decisions for off-peak energy storage in a solar heated and cooled house are reported. The collectors functioned in a drain-down mode and auxiliary heat was furnished by electric resistance heating. Storage was implemented with 1360 ceramic blocks capable of storing up to 200 kWth. Details of the ATOP algorithm are presented, noting the basis in Luenberger observer theory (1964, 1966) for a linear dynamic system with a state equation. The gain vector in the algorithm was chosen to assure stability, with ambient temperature modeled as generated by a harmonic oscillator with a natural period of 24 hr. Results are provided for a 15-day test period, showing a prediction error of 3.0 C. Energy demand to charge the storage in off-peak hours was reduced from 18.8 kW to 3.0 kW by use of ATOP in the system controller logic. M.S.K.

A82-44326*# Ford Aerospace and Communications Corp., Newport Beach, Calif.

CONTROL SYSTEM DEVELOPMENT FOR AN ORGANIC RANKINE CYCLE ENGINE

F. M. BERGTHOLD, JR., D. G. FULTON, and H. J. HASKINS (Ford Aerospace and Communications Corp., Aeronutronic Div., Newport Beach, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 330-336. (Contract JPL-955115)

The development of a control logic to govern the toluene throttle valve and verify the stability of the speed control approach for multiple engines connected to a 1 MWe point focus solar generator installation for distributed applications is presented. The toluene is pumped by booster and main feed pumps through a regenerator to the parabolic focus receiver, with the flow rate controlled by a valve to remain at critical level of 4.1 MPa. The valve changes the inlet pressure at the turbine nozzle block. Each concentrator would produce 76 kWth and 20 kWe. Dynamic variables in the logic account for insolation variation, fluid temperature, ac grid voltage, the thermal dynamics of the regenerator, and variations in the head supplied by the feed pump. Separate analyses are presented for the turbine shaft speed and toluene loop dynamics. The resulting logic is considered preliminary and suitable only in full insolation conditions. Extension of the model to nonlinear perturbations is indicated. M.S.K.

A82-44327#

ANALYSIS, SIMULATION AND DIAGNOSIS OF SOLAR ENERGY CONTROL SYSTEM ANOMALIES

R. E. WATERMAN (Vitro Laboratories, Silver Spring, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 337-344. refs

(Contract DE-AL01-79CS-30027)

This paper examines control system anomalies and attempts to quantify the resultant system performance characteristics and economic consequences. The study methods employed to investigate and diagnose controller malfunctions involve a blend of mathematical modelling and analysis of long term data from three solar homes in the National Solar Data Network. The diagnostic methods and results of this study should be of immediate

practical value to designers, installers and owners concerned with obtaining maximum performance from their solar energy systems.

(Author)

A82-44328#

SIMPLIFIED METHODOLOGY FOR CHOOSING CONTROLLER SET-POINTS

J. M. ALCONTE and R. W. HERMAN (Science Applications, Inc., Alternate Energy Systems Div., Albuquerque, NM) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 345-347.

The selection of controller Delta T set-points for solar energy systems must be made carefully to assure that unnecessary cycling of pump or fan motors does not occur, and that a maximum amount of the available solar energy is collected. The analysis described in this paper shows how set-points can be chosen based on the efficiency curve for the collector.

(Author)

A82-44329#

A TRNSYS MICROPROCESSOR CONTROLLER

L. P. PIESENS, W. A. BECKMAN, and J. W. MITCHELL (Wisconsin, University, Madison, WI) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 348-357. refs

A truth table approach is employed to model the operation of a microprocessor controller for a solar energy system. Using the simulation code TRNSYS, a parameter is added to stop iteration procedures which potentially could become endless as the program seeks a solution to a set of governing equations at the same time as a pump or switch is turned off, thus creating a stable mode of iteration. The simulation of control logic also includes comparisons between input signals in order to arrive at a choice of output control signals. Temperatures are the normal input signals, and additional input may be mass flow rate, insolation, and night setbacks. Techniques for identifying typographical errors in the control logic are explored, as are the effects of the time step size chosen. Results are presented of simulations of month-long operation of a solar system and primary loop control strategies.

M.S.K.

A82-44330#

EXPERIMENTAL VALIDATION OF DYNAMIC CONTROL MODELS

P. R. HERCZFELD, R. FISCHL, G. VARDAKAS (Drexel University, Philadelphia, PA), and R. L. T. WOLFSON (Middlebury College, Middlebury, VT) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 358-366. refs
(Contract DE-AS02-77C5-34512; DE-AC03-86CS-30218)

One of the problems encountered in the control of solar heating and cooling systems is pump cycling. The purpose of this paper is to present results of an experimental study designed to validate the dynamic distributed parameter model used in investigating this problem and the more general problem of liquid flow control in solar collector loops. The validation experiments were performed at the Middlebury College facility. They consisted of first measuring the thermal time constants and transit times of the solar collector loop components. These time constants together with other system parameters and measured climatic data were used to predict the controller performance via the computer simulation model developed by the authors. The results of this simulation were compared to those obtained experimentally. The three experiments analyzed showed that the computer simulation was able to predict the controller performance well within the accuracy of the measured data.

(Author)

A82-44331#

COMPUTER SIMULATION FOR EVALUATING CONTROL STRATEGIES

S. J. SOKOLOWSKI, M. J. FISHER (U.S. Army, Fort Monmouth, NJ), P. R. HERCZFELD, R. FISCHL (Drexel University, Philadelphia, PA), and R. WOLFSON (Middlebury College, Middlebury, VT) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 367-376. refs

(Contract DE-AS02-77C5-34512; DE-AC03-86CS-30318)

The main objective of this paper is to present a computer simulation code which accurately simulates the operation of solar energy systems under different control strategies such as either the on/off controller or the proportional flow controller. The salient feature of this simulation code is its accuracy, since it continually updates a set of samples of the solution of the partial differential equation which represents the dynamic behavior of the solar system components. This approach avoids the simulation errors introduced by such methods as the finite differencing scheme which seem to influence the simulation results. The accuracy of the computer simulation has been tested against both analytic expressions for the solar energy system performance and against experimental data. As an example of the utility of this simulation code, a comparison between the performance of on/off and proportional flow controls for different pump functions is given

(Author)

A82-44332#

ON ELIMINATING PEAK LOAD AUXILIARY ENERGY CONSUMPTION IN PASSIVE SOLAR RESIDENCES DURING WINTER

A. V. SEBALD (California, University, La Jolla, CA) and D. MUNOZ (Tijuana, Instituto Tecnológico Regional, Tijuana, Mexico) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 377-388. refs

(Contract DE-AC04-79AL-10891)

Simulation analyses from Albuquerque, NM and Madison, WI are used to investigate control strategies for passively heated buildings with an eye to minimizing the implementation of auxiliary power, i.e., electrical resistance heating, during peak load periods. The basic structure examined was a single family dwelling incorporating direct gain and Trombe wall elements in the system. Linear programming algorithms were employed to calculate optimized storage strategies, and included weather conditions such as sunny, cloudy, warm, and cold. Consideration was given to assuring sufficient stored energy for operation during blackout periods. It was found that substantial amounts of auxiliary power can be required even in a well-designed passive solar house, although if the sun shines during the heating season no back-up is necessary. Faulty weather predictions were found to potentially waste half of the stored energy.

M.S.K.

A82-44333#

DATA DEPENDENT SYSTEMS APPROACH TO SOLAR ENERGY SIMULATION INPUTS

S. M. PANDIT (Michigan Technological University, Houghton, MI) and K. P. RAJURKAR In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 389-398. refs

The paper proposes and illustrates an application of a recently developed methodology called Data Dependent Systems (DDS) to modeling and analysis of solar insolation data. Such an approach is shown to be capable of combining the advantages of deterministic as well as stochastic models. Illustrative DDS models for Madison, Wisconsin data provide a comprehensive quantitative analysis of all the dynamic patterns, including some very minute ones. The model characteristics reveal the relation of these patterns

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to the direct and diffuse insolation as well as constant and variable weather dynamics. Major dynamic patterns are successfully reproduced in the data simulated with the help of only a few parameters and a random number generator. The relation of the dynamic patterns with a physical model is developed to show that a more realistic estimate of the extinction coefficient is obtained from the DDS models. (Author)

A82-44334#

A COMPARISON OF RADIANT INTERCHANGE ALGORITHMS
J. A. CARROLL (California, University, La Jolla, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 399-407. refs
(Contract DE-AC02-80CS-30260-A000)

The comparison of radiant energy exchange algorithms made by Walton (1980) is extended to include the MRT network method developed by Carroll (1980). The various methods are described and geometry-related errors are identified. Other errors common to most of the methods are then analyzed. The effect of these radiant interchange errors on simulation results is described. Tables are included which show the magnitude of the errors associated with each method in a variety of test cases. C.R.

A82-44335#

THE ECONOMIC FEASIBILITY OF FLAT-PLATE SOLAR HOT WATER SYSTEMS - RETROFIT APPLICATIONS FOR VIRGINIA PUBLIC BUILDINGS

R. R. SOMERS, II, A. C. PRITCHARD, M. R. SEXTON (Virginia, University, Charlottesville, VA), M. C. HOFFMAN (Syska and Hennessy, Inc., Washington, DC), and L. S. FLETCHER (Texas A & M University, College Station, TX) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 431-438. refs

A82-44336#

THERMAL AND ECONOMIC ASSESSMENT OF HOT SIDE SENSIBLE HEAT AND COLD SIDE PHASE CHANGE STORAGE COMBINATION FOR ABSORPTION SOLAR COOLING SYSTEM
M. K. CHOI and J. H. MOREHOUSE (Science Applications, Inc., Solar Technology Div., McLean, VA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 439-448. refs
(Contract XI-0-9083-1)

A82-44337#

A GENERALIZED ANALYSIS OF SOLAR SPACE HEATING IN THE UNITED STATES

J. A. CLARK (Michigan, University, Ann Arbor, MI) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 449-457. refs

A life-cycle model is developed for solar space heating within the United States that is based on the solar design data from the Los Alamos Scientific Laboratory. The model consists of an analytical relationship among five dimensionless parameters that include all pertinent technical, climatological, solar, operating and economic factors that influence the performance of a Solar Space Heating System. An important optimum condition presented is the 'Breakeven' metered cost of conventional fuel at which the cost of the solar system is equal to that of a conventional heating system. The effect of Federal (1980) and State (1979) income tax credits on these costs is determined. A parameter that includes

both solar availability and solar system utilization is derived and plotted on a map of the U.S. This parameter shows the most favorable present locations for solar space heating application to be in the Central and Mountain States. The data employed are related to the rehabilitated solar data recently made available by the National Climatic Center (SOLMET). (Author)

A82-44338#

ECONOMICS OF SOLAR ENERGY - SHORT TERM COSTING

H. KLEE (Central Florida, University, Orlando, FL) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 458-464. refs

A method of short-term costing analysis for solar water heating systems is presented as a basis for homeowner investment decisions. The payback period is neglected because of the possibility that the house will be sold before the period elapses, and return on investment (ROI) is employed as the critical factor. A cash flow analysis is developed for annualized ROI over a 20 yr system lifetime, taking into account items such as initial cost, first year utility saving, first year maintenance, inflation rate, and the utility escalation rate. Weight is also given to a 30% federal tax credit and to the cash flow for the purchaser of a home already equipped with a solar system. The added value to the home is modeled numerically, and the annual ROI is projected over the lifetime of the system. Scenarios are presented which cover the ranges from no additional value with the solar system installed to the solar system being worth more than the purchase price. M.S.K.

A82-44339#

AN ECONOMIC COMPARISON OF ACTIVE SOLAR ENERGY AND CONVENTIONAL FUELS FOR WATER AND SPACE HEATING

J. G. SHINGLETON (Mueller Associates, Inc., Baltimore, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 465-474. Research supported by the U.S. Department of Energy.

This paper describes in simple terms the economic considerations involved in the decision to buy a solar energy system. In addition, a realistic evaluation is presented of the current cost-effectiveness of solar water and space heating systems in all regions of the country and under various economic conditions based on the best available information. A reference long-term economic scenario and several typical systems were used as the basis for the analyses. The sensitivity of the results to differences from the reference case is described. The paper summarizes a series of reports produced for the U.S. Department of Energy. All results are not provided for each application type against each type of conventional fuel. However, sufficient results are presented to obtain an understanding of the extent to which solar water and space heating applications compete with conventional fuels. (Author)

A82-44341#

A COMPARISON OF FUEL SAVINGS IN THE RESIDENTIAL AND COMMERCIAL SECTORS GENERATED BY THE INSTALLATION OF SOLAR HEATING AND COOLING SYSTEMS UNDER THREE TAX CREDIT SCENARIOS

R. MODEN (U.S. Department of Energy, Washington, DC) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 485-494. refs

This paper presents an analysis of expected energy savings between 1977 and 1980, under three different solar tax credit scenarios. The results were obtained through the Solar Heating

and Cooling of Buildings (SHACOB) Commercialization model, originally developed in 1977 by Arthur D. Little, Inc. This simulation provides projected savings of conventional fuels through the installation of solar heating and cooling systems on buildings in the residential and commercial sectors. The three scenarios analyzed considered the tax credits contained in the Windfall Profits Tax of April 1980, The National Tax Act of November 1978, and a case where no tax credit is in effect. (Author)

A82-44342#

SIMULATION AND ECONOMIC ANALYSIS OF A LIQUID-BASED SOLAR SYSTEM WITH A DIRECT-CONTACT LIQUID-LIQUID HEAT EXCHANGER, IN COMPARISON TO A SYSTEM WITH A CONVENTIONAL HEAT EXCHANGER

P. BROTHERS and S. KARAKI (Colorado State University, Fort Collins, CO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 503-508.

A82-44344#

OPERATING A DISTRIBUTED PHOTOVOLTAIC POWER GENERATION SYSTEM AT A RESIDENTIAL SITE

T. F. HALPIN, R. FISCHL, and P. R. HERCZFELD (Drexel University, Philadelphia, PA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 523-531. Research supported by the Middle Atlantic Committee on Power Engineering Education. refs

This paper presents both a method and an inexpensive experiment for designing a photovoltaic electric power generating system located at a residential or commercial user's site which complements the utility's electric supply and is designed to be cost-effective for the utility as well as the user. The Integrated-Solar-Utility Electric (ISUE) energy system consists of a solar cell array, battery storage, and a load management strategy. The design is based on probabilistic performance indices which measure the probability of solar energy utilization and the probability of using utility power during peak periods. Experimental data on the effect of solar cell array size and energy management strategies on these performance indices have been obtained using an inexpensive ISUE simulator which has been installed at a residence. The results give the tradeoffs required in the design and the operating problem encountered when installing such a photovoltaic ISUE system. (Author)

A82-44346#

BUFFER THERMAL ENERGY STORAGE FOR A SOLAR THERMAL POWERED 1-MWE ELECTRICAL PLANT

R. E. POLZIEN (Ford Aerospace and Communications Corp., Aeronutronic Div., Newport Beach, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 541-548. refs

This paper reports the results of a DOE-funded study for application of a latent heat Thermal Energy Buffer Storage (TEBS) Subsystem to the Small Community Solar Thermal Power Experiment (SCSE). The SCSE is a 1-MWe solar thermal electric plant under development at FACC consisting of multiple paraboloidal concentrators with an organic Rankine cycle power conversion unit mounted at the focus of each concentrator. Objective of the TEBS is to minimize plant shutdowns during intermittent cloud coverage thereby improving life expectancy of major subsystems. An SCSE plant performance model is used with time varying insolation to show that 70 to 80 percent of the potential engine shutdowns may be averted with the TEBS system. Parametric variation of engine life dependency on start/stop cycles

shows the potential for a 4 percent reduction in levelized bus bar energy cost (BBEC) using TEBS. (Author)

A82-44347#

ECONOMIC ANALYSIS OF A DISH-RANKINE SOLAR THERMAL POWER SYSTEM

R. L. PONS and R. E. IRWIN (Ford Aerospace and Communications Corp., Aeronutronic Div., Newport Beach, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 549-556. refs

This paper presents an analysis of the performance and cost of a first-generation dish-Rankine solar thermal power system for small community and industrial applications. The system is of the point-focusing distributed receiver type, with distributed generation and employs multiple paraboloidal concentrators with organic Rankine cycle power conversion systems at the focus of each dish. Projected life-cycle energy costs for a fully developed and mass-produced system are shown to be competitive with costs projected in the near future for electricity generated by more conventional means. It is shown that (1) the method of rating plant power output has a minor influence on life-cycle energy cost, (2) optimum dish size is greater than 12m, (3) energy cost is virtually independent of plant size above 1 MWe and (4) dish spacing and geometric arrangement can be optimized of reduce energy cost. (Author)

A82-44349#

RESULTS OF ASHRAE 95 THERMAL TESTING OF 32 RESIDENTIAL SOLAR WATER HEATING SYSTEMS

G. T. CHINERY and F. C. WESSLING, JR. (Tennessee Valley Authority, Chattanooga, TN) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 581-588. refs

The results of ASHRAE 95 thermal testing for 32 residential solar water heating systems that were submitted for TVA's Nashville 10,000 Residential Solar Water Heating Project are presented with system descriptions and a review of the test methodology. The tested systems included drain back, drain down, closed loop and air designs and utilized water, glycol/water mixtures, silicone oil and air heat transfer fluids. Systems tested included one and two tank designs with individual tank sizes ranging from 0.15 cu m (40 gal) to 0.45 cu m (120 gal). Collectors comprised of selective and nonselective surfaces had array areas ranging from 3.40 sq m (36.6 sq ft) to 9.65 sq m (103.8 sq ft). The system energy multipliers ranged from 0.96 to 3.6 and calculated fractional energy savings ranged from 17 percent to 78 percent. Experimental validation of the test method is underway. (Author)

A82-44351#

COOLING PERFORMANCE DATA AND ANALYSIS FOR THREE PASSIVE/HYBRID HOMES IN DAVIS, CALIFORNIA

S. MAHAJAN, C. NEWCOMB, M. SHEA, D. WOODFORD, E. HODAPP, and W. ARMES (California State University, Sacramento, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 616-625.

The houses were monitored continuously over a three- to four-week period during the summer of 1979. Hourly data on air temperature, globe temperature, thermal mass temperatures, and ambient air temperature are collected (using up to 18 sensors) and recorded on a strip chart. The strip chart data are then transferred to magnetic tapes for digital analysis. Thermal performance simulations for all three houses are made using the CALPAS-1 and SEA-1 computer codes. The air and thermal mass temperatures measured experimentally and the auxiliary cooling

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energy used are compared with the computer code predictions. The results of the comparisons are presented and discussed in detail. C.R.

A82-44352#

MEASUREMENT OF THE HEAT TRANSFER RATE FOR THERMAL ENERGY STORAGE MASSES IN DIRECT GAIN PASSIVE SOLAR HEATING SYSTEMS

S. F. FAUNCE (Delaware, University, Newark, DE) and R. K. RICKERT (West Chester State College, West Chester, PA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 626-631. refs

A way of measuring the heat transferred, as well as the amount of thermal energy stored in thermal mass used in a passive solar heating system, is described. A thermal flux meter measures the rate of heat transfer, and the data are recorded on a strip-chart recorder. This gives a time relationship for the solar energy absorbed and discharged by the mass. Integration of the area under the curve yields experimental data, which are related to the storage efficiency of the mass. The measurements are made using different orientations of the irradiated surface, which consists of different materials, such as brick, concrete, and phase change materials (Na₂SO₄-10H₂O). Measurements for various mass composites made during December and January at Newark, Delaware (lat., 39.5 deg N), give values of heat transfer for absorption of the solar irradiated surface from 63 to 101 W/sq m for horizontally oriented masses and 158 to 212 W/sq m for the same masses in a vertical position. The discharge heat transfer rates due to convection are from 13 to 25 W/sq m for horizontal surfaces and 47 to 85 W/sq m for vertical surfaces. C.R.

A82-44353#

THERMAL ANALYSIS OF A SOLAR ADVANCED WATER/STEAM RECEIVER

L. T. YEH (Babcock and Wilcox Co., Fossil Power Generation Div., Barberton, OH) and M. WIENER In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 632-641. Research supported by the Sandia National Laboratory refs (Contract AT(29-1)-789)

The Department of Energy and Sandia Laboratories have sponsored the development of a conceptual design for a 100 MWe solar advanced Water/steam receiver that is cost-effective and will perform within a practical and reliable power generation system. The design requirements and the basic features of a novel receiver are described. This paper presents the methods used to estimate the receiver's thermal losses and predict its thermal efficiency. The receiver under consideration is external with screen tubes using a forced recirculation system. Thermal efficiency of the receiver at the design point is estimated at 89.3%. Effects due to changing conditions, such as ambient temperature and wind speed, and changes of solar incident power are presented. Also, calculations compute the maximum tube metal temperature and the safety factor which is the ratio of maximum allowable heat flux to the actual heat flux absorbed. (Author)

A82-44354*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE APPLICATION OF SIMULATION MODELING TO THE COST AND PERFORMANCE RANKING OF SOLAR THERMAL POWER PLANTS

L. S. ROSENBERG, W. R. REVERE, and M. K. SELCUK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 642-653. Research sponsored by the U.S. Department of Energy and NASA. refs

A computer simulation code was employed to evaluate several generic types of solar power systems (up to 10 MWe). Details of the simulation methodology, and the solar plant concepts are given along with cost and performance results. The Solar Energy Simulation computer code (SESII) was used, which optimizes the size of the collector field and energy storage subsystem for given engine-generator and energy-transport characteristics. Nine plant types were examined which employed combinations of different technology options, such as: distributed or central receivers with one- or two-axis tracking or no tracking; point- or line-focusing concentrator; central or distributed power conversion; Rankin, Brayton, or Stirling thermodynamic cycles; and thermal or electrical storage. Optimal cost curves were plotted as a function of levelized busbar energy cost and annualized plant capacity. Point-focusing distributed receiver systems were found to be most efficient (17-26 percent). A.B.

A82-44355*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HEAT ENGINE DEVELOPMENT FOR SOLAR THERMAL POWER SYSTEMS

H. Q. PHAM and L. D. JAFFE (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 654-659. Research sponsored by the U.S. Department of Energy and NASA. refs

The technical status of three heat engines (Stirling, high-temperature Brayton, and Combined cycle) for use in solar thermal power systems is presented. Performance goals necessary to develop a system competitive with conventional power requirements include an external heated engine output less than 40 kW, and efficiency power conversion subsystem at least 40% at rated output, and a half-power efficiency of at least 37%. Results show that the Stirling engine can offer a 39% efficiency with 100 hours of life, and a 20% efficiency with 10,000 hours of life, but problems with seals and heater heads exist. With a demonstrated efficiency near 31% at 1500 F and a minimum lifetime of 100,000 hours, the Brayton engine does not offer sufficient engine lifetime, efficiency, and maintenance for solar thermal power systems. Examination of the Rankine bottoming cycle of the Combined cycle engine reveals a 30 year lifetime, but a low efficiency. Additional development of engines for solar use is primarily in the areas of components to provide a long lifetime, high reliability, and low maintenance (no more than \$0.001/kW-hr). R.K.R.

A82-44356#

OPTIMIZING THE PERFORMANCE OF A SOLAR LIQUID PISTON PUMP

C. L. MURPHY (McGill University, Montreal, Canada) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 660-666. Research supported by the Natural Sciences and Engineering Research Council. refs

The 0.1-m solar liquid piston pump (SLPP) model is shown to exhibit stable operation over a wide range of conditions, provided

the heat input (at $T = 85\text{ C}$) and the heat rejected (at $T = 22\text{ C}$) are maintained above the critical values for stalling. Under these conditions, the pumps operation is affected primarily by the heating coil position and the geometries of the inlet and outlet water tubes. It is found that the optimum output power of the model SLPP is 4.5 W at a pumping heat of 2 m, a mass flow rate of 0.23 kg/s, and an overall efficiency of 1%. It is noted that further optimization of the model would at best only marginally increase the output power and efficiency. It is thought that larger mass flow rates can be obtained by increasing the cross sectional area of the working tube and/or staging a number of pumps in parallel. It is possible to increase the pump head by staging a number of pumps in series. C.R.

A82-44358#**DESIGN AND ECONOMIC ANALYSIS FOR SOLAR PROCESS HEAT**

G. V. MIGNON, L. CAMPOY, F. LUTTMANN, and R. FAZZOLARE (Arizona, University, Tucson, AZ) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 688-695. Research sponsored by the Arizona Solar Energy Research Commission. refs

A general methodology for the analysis of solar industrial process heat design is described. In the analysis a number of factors must be considered such as climate, plant location and environment, displaced fuel, process demand and schedule, equipment and component alternatives, and system cost. The system parameters are optimized for an assumed set of economic conditions. The results of the analysis are: technical and economic feasibility indicators, collector field design, thermal storage size, pumping and heat exchanger requirements. (Author)

A82-44359#**CALCIUM CARBONATE SCALING IN SOLAR COLLECTORS**

I. SINGH, C. F. CHENG (ECA, Inc., Woodridge, IL), and R. M. WOLOSEWICZ (Argonne National Laboratory, Argonne, IL) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 708-711. Research supported by the U.S. Department of Energy.

Water samples collected from five U.S. Department of Energy-sponsored solar-energy systems and eight water samples of varying degrees of hardness were assessed for tendency to form calcium carbonate scale on solar collector surfaces. A two-step approach is recommended for estimating scaling potential based on water analysis: (1) calculate the Palin Index, and (2) if the index shows a potential for scaling, confirm this result by using the method developed at Argonne National Laboratory based on the Caldwell-Lawrence approach. Water treatments for preventing scaling also are discussed. (Author)

A82-44360#**CORROSION PROBLEMS ASSOCIATED WITH SOLAR FLUID AND COMPONENTS**

C. F. CHENG, C. P. CHEN (ECA, Inc., Woodridge, IL), and R. M. WOLOSEWICZ (Argonne National Laboratory, Argonne, IL) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 728-738. Research supported by the U.S. Department of Energy.

Corrosion and materials problems encountered at three commercial solar demonstration sites are discussed, including analyses of failed outer/inner glass cover plates, absorber panels/tubes, collector outlet tubes, interconnecting hoses, heat exchangers, and storage tanks. In addition, preliminary results are reported of laboratory tests on the corrosion of carbon steel,

copper, and aluminum in inhibited propylene-glycol solutions at temperatures typical of stagnant-full conditions (352 F). (Author)

A82-44361#**COMPUTER SIMULATION OF A PASSIVE SOLAR ASSISTED HEAT PUMP**

D. KINLOCH, J. TICHY (Rensselaer Polytechnic Institute, Troy, NY), and N. HINSEY In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 739-745. refs

A computer simulation of the Passive Solar Assisted Heat Pump (PSAHP) concept is presented. An outdoor heat exchanger of a conventional air-to-air heat pump, enclosed in an attached passive solar greenhouse, comprise the system, which is evaluated by an hour-by-hour simulation using weather data for the Albany, NY area. It is found that electric consumption can be reduced by 24% with a 10 year payback period. The PSAHP may be beneficial for homes already equipped with a heat pump with the installation of a solar retrofit. Graphs include those illustrating energy demand, storage volume effects on temperature, and payback period. R.K.R.

A82-44362#**THERMAL PERFORMANCE OF LOW-COST RETROFITTED SOLAR SPACE HEATING SYSTEMS**

J. SLOTE (Midland Energy Institute, Kansas City, MO) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 746-754. Research supported by the Department of Urban Affairs of Kansas City. refs

The thermal performance of 10 similar, low-cost, shop-built, south-wall, active air solar space-heating systems is evaluated for 10 days of the 1979-80 heating season. The design of the systems, built by Comprehensive Employment and Training Act (CETA) workers as a part of the Kansas City Solar Utilization/Economic Development and Employment (SUEDE) Project, is outlined. In addition, the equipment and procedures used to monitor the system are detailed, and several practical problems encountered in monitoring are discussed. Performance data are correlated to the designs of the individual systems, with the consistent features of the more successful systems receiving special attention. (Author)

A82-44363#**RELIABILITY ASSESSMENT OF SOLAR DOMESTIC HOT WATER SYSTEMS**

P. Y. WANG and R. M. WOLOSEWICZ (Argonne National Laboratory, Argonne, IL) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 755-761. Research supported by the U.S. Department of Energy. refs

This paper presents reliability and mean-time-between-failure studies of six generic solar domestic hot water systems. Failure rate data for system components were obtained from product literature or from consumer product industries. Reliability block diagrams are employed for the analyses, and exponential distribution functions are assumed for individual components. Since some components do not operate continuously, a duty-cycle factor is developed and defined as the ratio of operating time to total mission time. To accommodate systems experiencing different duty cycles, an averaged duty cycle is introduced to estimate mean lives. Large variations in system reliability and mean life were found and result from wide failure-rate bands for some of the components. (Author)

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A82-44364#

VALIDATION OF REMOTELY SENSED DATA FROM A LARGE NETWORK OF SOLAR HEATING AND COOLING INSTALLATIONS

C. J. KELLY, JR. (Vitro Laboratories, Silver Spring, MD) In: Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 762-769.

Methods of validating data from a network of solar heating and cooling installations are presented, as divided into two phases: data screening and performance validation. Screening involves determining that data are reasonable in magnitude, rate of change, and relationship to other sensor outputs. Daily screening is performed in three steps: transmission error checks, data reasonableness screening, and scan level data inspection. The data are then validated on a monthly basis at four levels: mode and level logic screening, flow diagram energy balance, sensor comparisons, and actual versus calculated energy flow comparisons. An extension of these processes is performed in order to validate data on a seasonal or annual level. It is found that this validation process ensures a .2 probability that an error will go undetected in one month and allows data validity determination with a high degree of confidence. Printout data and energy flow diagrams are included. R.K.R.

A82-44390

PERCOLATION-TYPE BEHAVIOR IN BLACK CHROME SELECTIVE SOLAR FILMS

G. ZAJAC (Houston, University, Houston, TX; Argonne National Laboratory, Argonne, IL) and A. IGNATIEV (Houston, University, Houston, TX) Applied Physics Letters, vol. 41, Sept. 1, 1982, p. 435-437. Research supported by the U.S. Department of Energy and University of Houston. refs

The optical constants (n and k) and dc resistivity have been measured for black chrome particulate solar absorbing coatings for the purpose of defining the applicability of various inhomogeneous medium theories in the description of the black chrome optical response. It has been shown that percolation-type behavior does exist in the films and hence of the various theories, only those exhibiting percolation at the 0.3 packing fraction value determined for the black chrome films are applicable. The two valid approaches are an effective medium theory first proposed by Bruggeman and a modified Garnett theory which includes a particle shape distribution. (Author)

A82-44466

DETERMINATION OF LIFETIME AND DIFFUSION LENGTH IN SILICON SOLAR CELLS BY SELF-BIASED /PHOTOVOLTAGE/ CAPACITANCE MEASUREMENTS

P. SWARUP and V. K. JAIN (Solid State Physics Laboratory, Delhi, India) IEEE Electron Device Letters, vol. EDL-3, Sept. 1982, p. 259-261. refs

Many methods have been developed for the measurement of the diffusion length and lifetime of minority carriers in p-n junction solar cells. This paper presents a new technique for the measurement of these parameters, based on capacitance measurements in forward-bias condition at room and liquid air temperatures. In this experiment the solar cell was not biased by an external dc source, but was forward-biased by its own photovoltage generated by illumination. The results give 135 micron diffusion length and 5.2 microsec lifetime of the minority carriers in a n(+)-p Si-solar cell. (Author)

A82-44746#

MULTIPURPOSE COMMUNICATION SATELLITE SOLAR ARRAY

J. L. BASTARD and R. LAGET (Societe Nationale Industrielle Aerospatiale, Cannes, France) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 7 p. (IAF PAPER 82-402)

The construction and operation of the solar array for the Multipurpose Communication Satellite is described. Employing high efficiency cells with a back surface reflector, the solar array consists of two wings with four panels each. The favorable 21.4 W/kg power mass ratio makes this system fully adapted to telecommunications missions. Primary power ranging from 1.3 to 1.5 kW is to be provided over the expected orbital lifetime of seven years. During the transfer orbit, the array is designed to be partially deployed and to provide a minimum average power of 400 W. Features of the mechanical design of the array, such as the hold-down mechanisms, linkage and the centrifugal brake are discussed. A.B.

A82-44747#

COMPACT SPS - POWER DELIVERY

M. POSPISIL and L. POSPISILOVA (Ceskoslovenska Akademie Ved, Astronomicky Ustav, Ondrejov, Czechoslovakia) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 6 p. refs (IAF PAPER 82-403)

The power deliverable by a compact solar Space Power Station (SPS) is a function of its outer surface shape. Methods of fitting the power delivery curve of such a system to different patterns of daily power demand are considered that involve the appropriate choice of the number of satellites, their maximal power, height to width ratio and the shift of longitude with respect to the receiving station. Changes in the daily delivery curve can be made by altering the longitudes and orientations of the satellites. Certain limitations to the choice of parameters exist, such as: the height to width ratio should be near 1.2, and the sum of longitude and orientation changes will probably not be greater than 50 deg. The optimization of the peak to average power ratio is also discussed. A.B.

A82-44750*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPONENT TECHNOLOGY FOR SPACE POWER SYSTEMS

R. C. FINKE (NASA, Lewis Research Center, Cleveland, OH) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 10 p. refs (IAF PAPER 82-408)

Progress made by NASA toward implementation of equipment for the conversion, management, and distribution of voltage power in space applications are reviewed. Work has been carried forward on components such as bipolar transistors, deep impurity semiconductors, conductors, dielectrics, magnetic devices, and rotary power transfer. Specific programs for the high voltage systems have included research on lightweight, low-cost conductors featuring graphite fibers containing electron donor materials for wires and cables with reduced mass and the conductivity of copper. Attention has also been given p-n junction technology for high-speed, high-current, high-voltage materials and diamond-like dielectric films which are hard, have high dielectric strength, and can operate up to 300 C. A transistor has been fabricated with a voltage of 1200 V at 100 A, with a gain of 10 and a 0.5 microsec rise/fall time. A 25 kW transformer has also been built which performs at 20 kHz with an efficiency of 99.2%. M.S.K.

A82-44787* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOVOLTAIC MODULE RELIABILITY IMPROVEMENT THROUGH APPLICATION TESTING AND FAILURE ANALYSIS

L. N. DUMAS and A. SHUMKA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 228-234. Research sponsored by the U.S. Department of Energy and NASA. refs

During the first four years of the U.S. Department of Energy (DOE) National Photovoltaic Program, the Jet Propulsion Laboratory Low-Cost Solar Array (LSA) Project purchased about 400 kW of photovoltaic modules for test and experiments. In order to identify, report, and analyze test and operational problems with the Block Procurement modules, a problem/failure reporting and analysis system was implemented by the LSA Project with the main purpose of providing manufacturers with feedback from test and field experience needed for the improvement of product performance and reliability. A description of the more significant types of failures is presented, taking into account interconnects, cracked cells, dielectric breakdown, delamination, and corrosion. Current design practices and reliability evaluations are also discussed. The conducted evaluation indicates that current module designs incorporate damage-resistant and fault-tolerant features which address field failure mechanisms observed to date. G.R.

A82-44788

PERFORMANCE OF EXPERIMENTAL TERRESTRIAL PHOTOVOLTAIC MODULES

S. E. FORMAN (MIT, Lexington, MA) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 235-245. Research sponsored by the U.S. Department of Energy. refs

MIT Lincoln Laboratory (LL) serves as a Field Tests and Applications Center for the U.S. Department of Energy (DOE) in order to evaluate the energy potential of photovoltaic components in various test applications. In this connection, MIT LL has received photovoltaic modules containing silicon cells from various manufacturers for use at its experimental test sites. A summary is presented of the results of an MIT LL program of periodic surveillance, measurements, and inspections at a number of test sites over the 4-year period, 1977-1980. Specific details are given of module failures and failure rates and the electrical and physical degradation of modules due to weathering. While over 11,000 modules have been placed into service, only slightly more than 320 have failed electrically. G.R.

A82-44789* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOVOLTAIC ARRAY RELIABILITY OPTIMIZATION

R. G. ROSS, JR. (California Institute of Technology, Jet Propulsion Laboratory, Solar Photovoltaic Engineering Group, Pasadena, CA) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 246-251. refs

An overview of the photovoltaic array reliability problem is presented, and a high reliability/minimum cost approach to this problem is presented. Design areas covered are cell failure, interconnect fatigue, and electrical insulation breakdown, and three solution strategies are discussed. The first involves controlling component failures in the solar cell (cell cracking, cell interconnects) and at the module level (must be statistically treated). Second, a fault tolerant circuit is designed which reduces array degradation, improves module yield losses, and controls hot-spot heating. Third, cost optimum module replacement strategies are also effective in reducing array degradation. This can be achieved by minimizing the life-cycle energy cost of the photovoltaic system. The integration of these solutions is aimed at reducing the 0.01% failure rate. R.K.R.

A82-44790* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

QUALIFICATION TESTING OF FLAT-PLATE PHOTOVOLTAIC MODULES

A. R. HOFFMAN, J. S. GRIFFITH, and R. G. ROSS, JR. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 252-257. Research sponsored by the U.S. Department of Energy and NASA. refs

The placement of photovoltaic modules in various applications, in climates and locations throughout the world, results in different degrees and combinations of environmental and electrical stress. Early detection of module reliability deficiencies via laboratory testing is necessary for achieving long, satisfactory field service. This overview paper describes qualification testing techniques being used in the US Department of Energy's flat-plate terrestrial photovoltaic development program in terms of their significance, rationale for specified levels and durations, and test results.

(Author)

A82-44791* Clemson Univ., S.C.

ACCELERATED STRESS TESTING OF TERRESTRIAL SOLAR CELLS

J. W. LATHROP, D. C. HAWKINS, J. L. PRINCE, and H. A. WALKER (Clemson University, Clemson, SC) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 258-265. Research sponsored by the U.S. Department of Energy and NASA. refs

The development of an accelerated test schedule for terrestrial solar cells is described. This schedule, based on anticipated failure modes deduced from a consideration of IC failure mechanisms, involves bias-temperature testing, humidity testing (including both 85-85 and pressure cooker stress), and thermal-cycle thermal-shock testing. Results are described for 12 different unencapsulated cell types. Both gradual electrical degradation and sudden catastrophic mechanical change were observed. These effects can be used to discriminate between cell types and technologies relative to their reliability attributes. Consideration is given to identifying laboratory failure modes which might lead to severe degradation in the field through second quadrant operation. Test results indicate that the ability of most cell types to withstand accelerated stress testing depends more on the manufacturer's design, processing, and workmanship than on the particular metallization system. Preliminary tests comparing accelerated test results on encapsulated and unencapsulated cells are described.

(Author)

A82-44792* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INVESTIGATING RELIABILITY ATTRIBUTES OF SILICON PHOTOVOLTAIC CELLS - AN OVERVIEW

E. L. ROYAL (California Institute of Technology, Jet Propulsion Laboratory, Energy Technology Engineering Section, Pasadena, CA) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 266-269. Research sponsored by the U.S. Department of Energy and NASA. refs

Reliability attributes are being developed on a wide variety of advanced single-crystal silicon solar cells. Two separate investigations: cell-contact integrity (metal-to-silicon adherence), and cracked cells identified with fracture-strength-reducing flaws are discussed. In the cell-contact-integrity investigation, analysis of contact pull-strength data shows that cell types made with different metallization technologies, i.e., vacuum, plated, screen-printed and soldered, have appreciably different reliability attributes. In the second investigation, fracture strength was measured using Czochralski wafers and cells taken at various stages of processing and differences were noted. Fracture strength, which is believed to be governed by flaws introduced during wafer sawing, was observed to improve (increase) after chemical polishing and other process steps that tend to remove surface and edge flaws. (Author)

02 SOLAR ENERGY

A82-44793

ENVIRONMENTAL TESTING OF SINGLE-CRYSTAL SILICON SOLAR CELLS WITH SCREEN-PRINTED SILVER CONTACTS

K. FIROR and S. HOGAN (Solar Energy Research Institute, Golden, CO) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 271-275. refs

A82-44794

STABILITY ANALYSIS OF CR-MIS SOLAR CELLS

G. RAJESWARAN, W. A. ANDERSON, M. THAYER (New York, State University, Buffalo, NY), and B. W. LEE (Rutgers University, Piscataway, NJ) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 276-280. refs
(Contract XM-0-9080-1)

The 50 A Cu/30 A Cr/20 A SiOx/Si solar cell structure has been analyzed by Auger, ESCA and ellipsometer measurements. An oxidation-reduction failure mechanism has been proposed for shelf-life degradation, and experimental evidence for such behavior is presented. The effect of this degradation is a decrease in the oxide thickness at the interface bringing about a photovoltaic performance degradation. The performance degradation involves a typical change in V_{oc} from about 0.55 V to 0.52 V with little or no change in J_{sc} or fill factor. The performance of all Cr-MIS devices then stabilizes when a thermodynamic equilibrium is attained. The light-effect degradation is more complex and the rearrangement of bonding in the interface oxide and at the SiOx/Si interface might reduce the rate of degradation. The Cr-MIS solar cell should be designed with an oxide thickness more than the static optimum value to allow for a decrease in oxide thickness to the optimum value. (Author)

A82-44795

STABILITY OF AMORPHOUS SILICON SOLAR CELLS

D. L. STAEBLER (RCA Laboratories, Princeton, NJ) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 281-284. refs

The present situation on the stability of amorphous silicon solar cells is discussed. Impurity diffusion is not expected to be a problem in normal cell operation. Interface contamination degrades Schottky barrier or MIS cells that are exposed to water vapor, but has no influence on p-i-n or n-i-p cells. Optically induced changes in the amorphous silicon have an influence, depending on cell structure and preparation conditions. Preliminary results on approximately 5% efficiency n-i-p cells suggest that the efficiency will degrade by only 20% in 20 years of sunlight. (Author)

A82-44796* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

A TECHNIQUE FOR DETERMINING SOLAR IRRADIANCE DEFICITS

C. C. GONZALEZ and R. G. ROSS, JR. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 285-288. Research sponsored by the U.S. Department of Energy and NASA. refs

An analytic technique which determines the variation of solar irradiance from long term averages is presented. The technique involves computer-assisted data reduction techniques, and was designed to improve system reliability by determining the amount of storage capability required to supplement a baseline system. Variations in time intervals of up to 60 days can be determined, and 10 years of data collection are reviewed. The technique involves first calculating average monthly irradiance values, then examining the average irradiance deviation over time intervals. The calculation procedure is clarified by determining solar energy level probabilities and the long term solar energy deviation (achieved by repeatedly integrating actual irradiance figures). It is found that a 15% increase in collector area and the addition of energy storage or backup are essential contributions to achieving cost-effectiveness. In addition, one to seven no-sun day storage capacities are required to accommodate weather caused deficits.

R.K.R.

A82-44797

RELIABILITY TERMINOLOGY AND FORMULAE FOR PHOTOVOLTAIC POWER SYSTEMS

H. A. LAUFFENBURGER (Solar Energy Research Institute, Golden, CO) and R. T. ANDERSON (Reliability Technology Associates, Lockport, IL) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 289-295. refs

The emergence of photovoltaic (PV) solar energy as a new industry has prompted development of a reliability, availability, and maintainability (RAM) methodology which, when applied, will foster the development of reliable, cost-effective PV electric power systems. The new industry has attracted talent from a variety of disciplines, and different reliability approaches and analytic methods are being investigated. However, because of differences in vocabulary, communication difficulties arise among workers and organizations. A common, uniformly applied reliability language is, therefore, essential. The present investigation is, therefore, concerned with a proposal for a uniform, reliability language for photovoltaic power system technology. The basic concepts extend those for the conventional electric power industry. Adaptations and new concepts are introduced as necessary, to be consistent with PV technology and applications. The language accounts for the unique characteristics of the PV array as well as the variability of the input energy. G.R.

A82-44798

A METHODOLOGY FOR PHOTOVOLTAIC SYSTEM RELIABILITY AND ECONOMIC ANALYSIS

L. H. STEMBER, W. R. HUSS, and M. S. BRIDGMAN (Battelle Columbus Laboratories, Columbus, OH) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 296-303. Research supported by the U.S. Department of Energy. refs

It is pointed out that the operation of large terrestrial photovoltaic (PV) power systems (over 50 peak kilowatts) is a fairly recent event. The present investigation provides a review of the characteristics of current and future PV systems and selects a methodology to allow the system designer to consider system reliability and maintenance parameters early in the design. The goal is to minimize the cost of system output energy over system life. Thus, cost per kW-hour is the objective function which PV system designers should minimize. Attention is given to an integrated reliability, availability, maintainability (RAM) model, which represents failure and repair, and provides the corrective maintenance portion of the yearly maintenance cost. The RAM model and a life-cycle energy cost model are combined to provide the information the designer needs for system optimization. G.R.

A82-44799

RELIABILITY IMPACT OF SOLAR ELECTRIC GENERATION UPON ELECTRIC UTILITY SYSTEMS, J. T. DAY AND W. J. HOBBS [WESTINGHOUSE ELECTRIC CORP., ADVANCED SYSTEMS TECHNOLOGY DIV., PITTSBURGH, PA]

IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 304-307.

The introduction of solar electric systems into an electric utility grid brings new considerations in the assessment of the utility's power supply reliability. This paper summarizes a methodology for estimating the reliability impact of solar electric technologies upon electric utilities for value assessment and planning purposes. Utility expansion and operating impacts are considered. Sample results from photovoltaic analysis show that solar electric plants can increase the reliable load-carrying capability of a utility system. However, the load-carrying capability of the incremental power tends to decrease, particularly at significant capacity penetration levels. Other factors influencing reliability impact are identified.

(Author)

A82-44800

PLANNING, PRICING AND PUBLIC POLICY ISSUES FOR RELIABILITY OF INTERCONNECTED SOLAR ENERGY SYSTEMS

J. W. MILON, B. L. CAPEHART, and C. F. KIKER (Florida, University, Gainesville, FL) IEEE Transactions on Reliability, vol. R-31, Aug. 1982, p. 308-312. refs

A82-44928

PHOTOVOLTAIC SPECIALISTS CONFERENCE, 15TH, KISSIMMEE, FL, MAY 12-15, 1981, CONFERENCE RECORD

Conference sponsored by the Institute of Electrical and Electronics Engineers, New York, Institute of Electrical and Electronics Engineers, Inc., 1981. 1523 p.

MEMBERS, \$75.; NONMEMBERS, \$100

GaAs cells for space applications are considered, taking into account AlGaAs/GaAs high efficiency cascade solar cells, and a thermochemical model of radiation damage and continuous annealing applied to GaAs solar cells. Other topics discussed are related to silicon solar cells for space applications, photovoltaic concentrator receivers and application experiments, photovoltaic concentrator cells, economics and feasibility analysis, space solar cell calibration, low cost technology for space applications, thin film solar cells, low cost processes, and low cost cell and array processes. A description is also presented of subjects in the areas of low cost Si and sheet technology, amorphous silicon solar cells, flat-plate array subsystem and system technology, cadmium sulfide and copper sulfide solar cells, flat-plate array subsystem design and test methods, module failure/degradation mechanism and reliability, measurement techniques for photovoltaic cells and materials, and flat-plate residential and intermediate system applications. G.R.

A82-44929*# National Aeronautics and Space Administration, Washington, D. C.

PHOTOVOLTAIC OUTLOOK FROM THE NASA VIEWPOINT

L. P. RANDOLPH (NASA, Washington, DC) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 10-13. refs

The NASA photovoltaic outlook for space applications focuses on the needs for increasing the specific power (W/kg), establishing radiation damage control, and reducing the specific cost (\$/W). In each of these areas the technology requirements and potential impediments are presented. Technology trends and forecasts are also discussed. (Author)

A82-44930#

PHOTOVOLTAIC OUTLOOK FROM THE DEPARTMENT OF DEFENSE VIEWPOINT

R. R. BARTHELEMY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 14-16. refs

Power system technology advances will be necessary in the areas of intelligence collection and treaty monitoring, strategic force management, and satellite control. Currently, research is being done on laser hardening of the power system, and future research trends will focus on the development of a 25-200 KW spacecraft power system. System needs have been established (40%-80% weight reduction, multithreat survivability, and improved thermal management techniques), and a photovoltaic technology program is currently addressing studies of silicon, gallium arsenide, and multiband gap technologies. The main objectives of the silicon technology investigations are high efficiency, 17% BOL, and maximum EOL power. High efficiencies, demonstrated flight readiness, and lower cost technological approaches are the focuses of the GaAs program. A 22%-25% efficiency with an AlGaAs/GaAs monolithic cell approach is being considered by the multiband gap cell technology studies. R.K.R.

A82-44931

PHOTOVOLTAIC OUTLOOK FROM EUROPEAN COMMUNITY'S VIEWPOINT

W. PALZ (Commission of the European Communities, Directorate General for Research Science and Education, Brussels, Belgium) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 17-20.

An overview of photovoltaic developments is presented, and the three primary future program specifications are to provide scientific and technological guidelines, provide for the economic feasibility of such a program, and establish implementation guidelines. It is concluded that both hard and soft technology approaches should be developed, and a 5 MW panel production in 1982 is predicted. Silicon is the leading material being used, and research and development programs are investigating the use of alternative materials such as CdSe and amorphous silicon. A 1.3 MW pilot is established in Europe, and 18 projects are mentioned, including a program which will soon be established in Sicily. R.K.R.

A82-44932

ALGAAS/GAAS HIGH EFFICIENCY CASCADE SOLAR CELLS

S. M. BEDAIR, J. A. HUTCHBY, M. SIMONS (Research Triangle Institute, Research Triangle Park, NC), J. CHIANG, and J. R. HAUSER (North Carolina State University, Raleigh, NC) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 21-26. refs (Contract F33615-78-C-2077; XM-9-8136-1)

A high efficiency AlGaAs-GaAs multijunction cascade solar cell has been fabricated which uses diffused GaAs and Al(0.35)Ga(0.65)As junctions which are electrically connected by an Al(0.35)Ga(0.65)As tunnel junction. A close match between the currents generated by each cell was achieved by optimizing layer thicknesses and carrier concentrations as well as the depths of both junctions. It was found that the short circuit current density achieved by this structure is equal to one half of the current generated by the best GaAs single-junction solar cell reported. Efficiencies of 15% at AMO and 16.4% at AM1 have been measured on samples not equipped with an anti-reflection coating N.B.

A82-44933* Florida Univ., Gainesville.

STUDY OF RADIATION INDUCED DEEP-LEVEL DEFECTS AND ANNEALING EFFECTS IN THE PROTON IRRADIATED ALGAAS-GAAS SOLAR CELLS

S. S. LI (Florida, University, Gainesville, FL) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 27-32. refs (Contract NSG-1425)

The radiation induced deep-level defects and the recombination parameters in the proton irradiated AlGaAs-GaAs p-n junction solar cells were investigated over a wide range of proton energies (from 50 KeV to 10 MeV) and proton fluences (from 10 to the 10th to 10 to the 13th P/sq cm), using DLTS, I-V, C-V, and SEM-EMIC measurement techniques. The measurements were used to determine the defect and recombination parameters such as defect density and energy level, carrier lifetimes, and the hole diffusion lengths in the GaAs LPE layers. Results show that a good correlation was obtained between the measured defect parameters and the dark recombination current as well as the performance parameters of the solar cells. The most damages to the cell were produced by the 200 KeV protons. In addition, the effects of low temperatures (200 to 400 C) thermal annealing on the deep-level defects and the dark current of the 200 KeV proton irradiated samples were examined. N.B.

02 SOLAR ENERGY

A82-44934* Hughes Research Labs., Malibu, Calif.
ENHANCED ANNEALING OF GAAS SOLAR CELL RADIATION DAMAGE

R. LOO, R. C. KNECHTLI, and G. S. KAMATH (Hughes Research Laboratories, Malibu, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 33-37.

(Contract NAS1-15926)

Solar cells are degraded by radiation damage in space. Investigations have been conducted concerning possibilities for annealing this radiation damage in GaAs solar cells, taking into account the conditions favoring such annealing. It has been found that continuous annealing as well as the combination of injection annealing with thermal annealing can lead to recovery from radiation damage under particularly favorable conditions in GaAs solar cells. The damage caused by both electrons and protons in GaAs solar cells can be substantially reduced by annealing at temperatures as low as 150 C, under appropriate conditions. This possibility makes the GaAs solar cells especially attractive for long space missions, or for missions in severe radiation environments. Attention is given to results concerning periodic thermal annealing, continuous annealing, and injection annealing combined with thermal annealing. G.R.

A82-44935* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A THERMOCHEMICAL MODEL OF RADIATION DAMAGE AND ANNEALING APPLIED TO GAAS SOLAR CELLS

E. J. CONWAY, G. H. WALKER (NASA, Langley Research Center, Hampton, VA), and J. H. HEINBOCKEL (Old Dominion University, Norfolk, VA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 38-44. refs

Calculations of the equilibrium conditions for continuous radiation damage and thermal annealing are reported. The calculations are based on a thermochemical model developed to analyze the incorporation of point imperfections in GaAs, and modified by introducing the radiation to produce native lattice defects rather than high-temperature and arsenic atmospheric pressure. The concentration of a set of defects, including vacancies, divacancies, and impurity vacancy complexes, are calculated as a function of temperature. Minority carrier lifetimes, short circuit current, and efficiency are deduced for a range of equilibrium temperatures. The results indicate that GaAs solar cells could have a mission life which is not greatly limited by radiation damage. (Author)

A82-44936
PULSED LASER ANNEALING OF ION-IMPLANTED SEMICONDUCTING GAAS FOR HOMOJUNCTION SOLAR CELLS

D. H. LOWNDES, J. W. CLELAND, J. FLETCHER, J. NARAYAN, R. D. WESTBROOK, R. F. WOOD, W. H. CHRISTIE, and R. E. EBY (Oak Ridge National Laboratory, Oak Ridge, TN) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 45-51. refs (Contract W-7405-ENG-26; DS-0-9078-1)

The results of a study whose purpose was to evaluate the combination of ion implantation followed by pulsed ruby laser annealing (II/PLA), as a method for shallow p-n junction formation in semiconducting GaAs substrates, are reported. High dose Zn, Mg, Si and Se implants were used. PLA was carried out in air without encapsulation, and with thin sputtered SiO₂ encapsulation layers. The combination of I-V, C-V, SEM, TEM and SIMS measurements that were carried out have important implications for photovoltaic applications including the possibility of forming planar junctions, the choice of implanted ions to obtain high electrical activation, the optimum pulsed laser energy density range, the resultant junction depth and electrical characteristics, and the

presence of laser- and implantation-induced residual defects

(Author)

A82-44937
SHADING ANALYSIS OF A PHOTOVOLTAIC CELL STRING ILLUMINATED BY A PARABOLIC TROUGH CONCENTRATOR

M. W. EDENBURN (Sandia National Laboratory, Albuquerque, NM) and J. R. BURNS (Texas Tech University, Lubbock, TX) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 63-68. Research supported by the U.S. Department of Energy. refs

This paper describes an analysis on the performance of a linear string of cells with diode bypassing; which are illuminated by a horizontal, north-south oriented, parabolic-trough sunlight concentrator; and on which shadows are cast by the ends of the concentrator and by transverse gaps in its reflective surface. A three-part model was used to determine illumination on each cell, calculate the IV curve for each cell, and find the cell string's maximum power. The model was

A82-44938
HEAT PIPE FOR PASSIVE COOLING OF CONCENTRATOR SOLAR CELLS

R. T. BEACH and R. M. WHITE (California, University, Berkeley, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 75-80. Research supported by the Southern California Edison Co.; U.S. Department of Energy refs (Contract DOE-49-2603)

A design is presented for a gravity-dependent copper heat pipe using water or acetone as the working fluid, for passively cooling concentrator solar cells operating up to 1000X. The major sources of the cell-to-ambient temperature drop are the boiling superheat in the evaporator pool and the drop from cooling fins to the ambient air. Heat input to the device is limited by the critical boiling heat flux of the working fluid; spreading the reject heat from the cell through a slightly larger evaporator plate permits the cell heat flux to exceed the critical boiling heat flux. Tests in highly concentrated sunlight agreed well with results of a computer model, especially for acetone. For both water and acetone the cell-to-ambient thermal conductance was about 2 W/sq cm-degrees C. This is an order of magnitude more effective passive cooling than previously reported for extended surfaces whose base area is restricted to the cell area, and extends the possibility of passive cooling to concentrations of 1000 suns. (Author)

A82-44939
DOE/GENERAL ELECTRIC PHOTOVOLTAIC CONCENTRATOR APPLICATION EXPERIMENT

A. KIRPICH (General Electric Co., Advanced Energy Programs Dept., Philadelphia, PA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 81-85.

The design and predicted performance of a Photovoltaic Concentrator Application Experiment (PCEA) to be installed near Orlando, FL are outlined. Three azimuth-tracking turntable arrays, each containing twenty-four 2.1 x 9.2 m elevation-tracking parabolic trough PV concentrators, are employed having actively cooled receivers with Vee-mounted solar cells, which are designed for combined PV generation and thermal energy collection. The system is designed to have a peak PV power rating of 120 kW at 1 kW/sq m insolation and 30 C cooling. For coolant temperatures of 30 C and 80 C, prototype tests yielded a PV efficiency of 10 and 7.6%, peak PV power of 110 and 84 kW, and a thermal efficiency of 50 and 40%. Overall system efficiency is estimated to be 12.7%, considering pump and fan parasitic loads. A.B.

A82-44940

PHOENIX AIRPORT SOLAR PHOTOVOLTAIC CONCENTRATOR PROJECT

C. M. ZITTLE (Motorola, Inc., Government Electronics Div., Scottsdale, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 86-89.

Plans for the construction of a 225 kW solar photovoltaic concentrator at the Phoenix, AZ airport are given. The basic concentrator module for the system uses a 24 inch square acrylic Fresnel lens, focusing energy on a 3-inch diameter, float zone silicon solar cell. Each cell has a peak output of 41.6 W at 1 kW/sq m insolation and 28 C. Modules will be mounted on eighteen 65 foot wide two-axis tracking turntables, and a dc-ac converter will be used for connecting the system to the utility grid. Preliminary tests of the first array indicate that 10 kW (normalized to 1 kW/sq m and 28 C) is produced, for a 2.5 kW loss. The present recurring cost of the system is \$15.96 per watt, but for the production of 400 arrays per year, the recurring cost would be \$6.90 per watt.

A.B.

A82-44941

EXPERIENCE WITH A GRID-INTERACTIVE SOLAR PHOTOVOLTAIC ELECTRIC SYSTEM

S. I. KAPLAN (Oak Ridge National Laboratory, Oak Ridge, TN) and C. M. BENSON (Mississippi County Community College, Blytheville, AR) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 90, 91.

(Contract W-7405-ENG-26)

A water/glycol-cooled solar photovoltaic array used at Mississippi County (Arkansas) Community College is described, and preliminary results from systems checkout are given. The system has a rated output of 240 kW in summer (with 845 W/sq m insolation at 30 C), and delivers 11.5 million BTU of heat output in winter. Excess power is diverted into the local utility power grid. Preliminary tests indicate that single row output is 3300 W with 904 W/sq m insolation, whereas 5.33 kW/row is expected. However, by realigning position sensors for the tracking drives, readjusting the focal position of the receivers, and cleaning reflectors and cell faces, a 60% increase in output should occur.

A.B.

A82-44942* Communications Satellite Corp., Clarksburg, Md. ADVANCES IN HIGH OUTPUT VOLTAGE SILICON SOLAR CELLS

R. A. ARNDT, A. MEULENBERG, J. F. ALLISON (COMSAT Laboratories, Clarksburg, MD), and V. G. WEIZER (NASA, Lewis Research Center, Cleveland, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 92-96. Research sponsored by the Communication Satellite Corp. refs

(Contract NAS3-21227)

Solar cells have been fabricated from 0.1 ohm-cm, p-type silicon by means of a two-step diffusion process of emitter formation in order to delineate the factors limiting V_{oc} in conventionally structured cells with the goal of achieving 700 mV. The cells are 200 microns thick and 2 x 2 cm in area with a planar front surface that has an anti-reflection coating of tantalum oxide, as well as Cr-Au-Ag contact metallization on both sides of the cell. The Cr-Au-Ag is applied over an aluminum diffused layer on the back, while it is applied through small holes in the anti-reflection coating on the front. Results show that the best of these cells exhibits an open-circuit voltage of 654 mV under AMO illumination.

N.B.

A82-44943

PRODUCTION IMPLEMENTATION OF THIN, HIGH EFFICIENCY SILICON SOLAR CELLS

J. FODOR, M. GILLANDERS, and R. OPJORDEN (Spectrolab, Inc., Sylmar, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 97-101. Research supported by the International Telecommunications Satellite Organization.

Data are presented representing processing yields of 62 and 100-micron thick cells, both preproduction and in production line, and beginning-of-life electrical outputs and cell performance after electron, proton, and neutron irradiation testing are discussed. Preproduction and production fabrication of thin cells is described and discussed, as is the production of ultrathin cells and 100 micron thick cells. For the ultrathin cells, the size, weight, resistivity, BSF, BSR, contacts, and contact configuration are indicated. For the irradiation testing, fluence level, voltage, current, and power values are shown.

C.D.

A82-44944* Applied Solar Energy Corp., City of Industry, Calif. THIN FOIL SILICON SOLAR CELLS WITH COPLANAR BACK CONTACTS

F. HO, P. A. ILES (Applied Solar Energy Corp., City of Industry, CA), and C. R. BARAONA (NASA, Lewis Research Center, Cleveland, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 102-106. refs

(Contract NAS3-22228)

To fabricate 50 microns thick, coplanar back contact (CBC) silicon solar cells, wraparound junction design was selected and proved to be effective. The process sequence used, the cell design, and the cell performance are described. CBC cells with low solar absorptance have shown AMO efficiencies to 13%, high cells up to 14%; further improvements are projected with predictable optimization.

(Author)

A82-44945

DEVELOPMENT OF HIGH EFFICIENCY THIN SILICON SOLAR CELLS

G. M. STORTI and J. S. CULIK (Solarex Corp., Rockville, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 107-110. refs

Technology development is described for high efficiency ultra-thin (50 microns) silicon solar cells. Significant improvements in open-circuit voltage and conversion efficiency are achieved by use of screen-printed aluminum paste back surface field (BSF) technology. Over 2000 non-textured ultra-thin cells were fabricated in a one week pilot line effort in which AMO efficiencies averaging 12.5% were achieved. The results demonstrate that the ultra-thin silicon solar cell is at a state of technical readiness for large scale production.

(Author)

A82-44946* Solarex Corp., Rockville, Md.

THE GRIDDED BACK CONTACT AND ITS EFFECT ON SOLAR CELL PERFORMANCE

M. GIULIANO and J. WOHLGEMUTH (Solarex Corp., Rockville, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 111-114

(Contract JPL ORDER LO-727616)

The effect of using gridded back contacts on silicon solar cells made with Al baked surface field (BSF) was experimentally investigated and found to result in a significant increase in conversion efficiency due to higher short-circuit current. An increase of 5 to 8% was noted for thin cells while a smaller increase was observed for standard thickness cells. Several possible explanatory mechanisms are suggested and summarized, including stress relief, incomplete BSF formation, improved back surface recombination velocity, and improved optical reflection off the back silicon-air interface.

C.D.

02 SOLAR ENERGY

A82-44947

SILICON SOLAR CELLS FORMED BY ORIENTATION-DEPENDENT SLICING

P. A. ILES and S. I. SOCLIF (Applied Solar Energy Corp., City of Industry, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 115-119. refs
(Contract XS-9010-1)

Orientation-dependent slicing was investigated as a means to increase the areal yield from good quality ingots. This method produces thin slices, and from these slices, thin cells can be processed. The paper describes the slicing process, and some practical difficulties encountered; the cell design and matrix processing are also discussed. (Author)

A82-44948

SIGNIFICANCE OF LOW-TEMPERATURE PROCESSING IN THE FABRICATION OF SILICON SOLAR CELLS

J. G. FOSSUM and D. S. LEE (Florida, University, Gainesville, FL) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 120-125. U.S. Department of Energy refs
(Contract DOE-28-1161)

A theoretical model that describes the dependence of carrier lifetime on doping density, which is based on the equilibrium solubility of a particular defect in non-degenerately doped silicon, is developed. Comparisons of the model predictions with the longest measured hole and electron lifetimes ever reported for n-type and p-type silicon support the model and imply a possible 'fundamental' defect in silicon. The defect is acceptor-type and is more soluble in n-type than in p-type silicon, which suggests a longer fundamental limit for electron lifetime than for hole lifetime at a given doping density. The prevalent, minimum density of the defect, which defines these limits, occurs at the processing temperature below which the defect is virtually immobile in the silicon lattice. The analysis reveals that this temperature is 300-400 C, and thus emphasizes the significance of low-temperature processing, e.g., annealing, in silicon solar cell fabrication. (Author)

A82-44949

IMPROVED SILICON SOLAR CELLS FOR HIGH CONCENTRATION LEVELS

S. KHEMTHONG, P. A. ILES, and F. HO (Applied Solar Energy Corp., City of Industry, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 126-131. U.S. Department of Energy refs
(Contract DOE-49-2670)

This paper describes work on further improving extrinsic processes to make silicon concentrator cells over 20% efficiency. In addition, the performance at high insolation has been improved above 19%. The results show promise of reasonable costs for such high efficiency cells. (Author)

A82-44950

PROCESS OPTIMIZATION AND PRODUCTION EXPERIENCE OF CONCENTRATOR CELLS

J. KUKULKA, C. KARNOPP, N. TANEJA, and T. BRAWLEY (Applied Solar Energy Corp., City of Industry, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 138-141.

A large project to fabricate silicon concentrator solar cells is described. Over 50,000 cells of 2.27-in. diameter were fabricated with an overall efficiency of better than 13.8% measured at 33 suns and 77 C. Generation capability of the cells is in excess of 500 kW. The fabrication process described optimized performance yet was not prohibitively expensive for large scale production. Bulk resistivity, surface finish, junction formation and contact materials

were selected for high efficiency, durability and reasonably low cost. (Author)

A82-44951

HIGH EFFICIENCY CONCENTRATOR CELLS

K. W. MITCHELL (Solar Energy Research Institute, Golden, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 142-146. refs

Technologies which are being developed in order to provide high efficiency, low cost photovoltaic converters are discussed. Efficiencies above 30% could be achieved at a cost of \$0.15 to \$0.40 per peak watt. Single junction Si and InP concentrator cells are being developed that eliminate front contact obscuration losses with front surface passivating to increase the short-circuit current, and with reduced resistance losses, yielding increased efficiencies at higher solar fluxes. Multijunction converters which employ bonded cascade cells, graded composition cells, and superlattice cells are also being considered. These approaches require that metal-organic source purification, lattice mismatch and its passivation, high voltage planar cells, and thin film single crystal substrates for concentrator cells be explored further. A.B.

A82-44952

PERFORMANCE AND DURABILITY OF ALGAS/GAAS CONCENTRATOR CELLS

P. E. GREGORY, P. G. BORDEN, M. J. LUDOWISE, C. B. COOPER, III, and R. R. SAXENA (Varian Associates, Inc., Palo Alto, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 147-150.

AlGaAs/GaAs solar cells have been fabricated in a pilot production run. Cells were produced by both organometallic vapor phase epitaxy (OM-VPE) and liquid phase epitaxy (LPE). OM-VPE has proven to produce a higher yield of high-efficiency cells than LPE. An aging study has shown that the cells are very durable at elevated temperatures, but that OM-VPE cells are more resistant to AlGaAs corrosion than are LPE cells. (Author)

A82-44953

GAAS SHALLOW-HOMOJUNCTION CONCENTRATOR SOLAR CELLS

G. W. TURNER, J. C. C. FAN, R. L. CHAPMAN, and R. P. GALE (MIT, Lexington, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 151-155. USAF-sponsored research. refs

Concentrator solar cells using the GaAs shallow-homojunction n(+)/p/p(+) structure, without an AlGaAs window layer, have been fabricated for the first time. Although the n(+) top layer of these cells is typically less than 0.1 micron thick, this layer is comparable in sheet resistance to the thicker p(+) GaAs top layer of AlGaAs/GaAs heteroface cells. The shallow-homojunction cells have efficiencies over 20% from 2X to 125X (AM1), even though they employ a simple metallization scheme similar to the one used for nonconcentrator cells. With an optimized contact grid, these high efficiencies should be retained to much higher concentration ratios. (Author)

A82-44954

THE BEHAVIOR OF SILICON CONCENTRATOR SOLAR CELLS BETWEEN 50 AND 500 SUNS

R. W. SANDERSON and C. E. BACKUS (Arizona State University, Tempe, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 156-159. U.S. Department of Energy refs
(Contract DOE-40-1356)

Considerable progress has been made during the past few years in the development of high efficiency, high intensity silicon concentrator solar cells. This paper presents the results of an experimental investigation concerning the performance of silicon concentrator solar cells at intensities ranging between 50 and

500 suns. In addition to presenting electrical performance characteristics including cell efficiency, fill factor, and open-circuit voltage, data concerning the effects of high intensity operation on cell spectral response and temperature coefficients are also presented. Measurements of the linearity of short-circuit vs intensity at high concentration are reported. (Author)

A82-44955

A PASSIVE HEAT PIPE COOLED PHOTOVOLTAIC RECEIVER

K. T. FELDMAN, JR. (Energy Engineering, Inc., Albuquerque, NM), D. D. KENNEY (New Mexico, University, Albuquerque, NM), and M. W. EDENBURN (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 165-172. U.S. Department of Energy (Contract DOE-62-1271)

The design and analysis, fabrication, and testing of a prototype heat pipe exchanger are described, and test results are presented and discussed. The exchanger is a two-phase thermosyphon with a fluid that evaporates when heated by photovoltaic cells and carries the heat to the finned heat exchange surface where it condenses and returns to the cell area by gravity flow. The stress and cost analysis is summarized and the fabrication is briefly described. Both wind tunnel and outdoor testing was done, as well as a deflection test. It was found that the exchanger will operate below the maximum specified evaporator temperature of 140 C if the wind speed is greater than 1 m/sec. The operating temperature of the device is a strong function of wind speed, dropping with increasing wind speed and rising with decreasing speed. The operating temperature was not a strong function of either ambient air temperature, wind direction, or tilt orientation. C.D.

A82-44956

A TECHNIQUE FOR COMPARING PARABOLIC TROUGH PHOTOVOLTAIC PERFORMANCE

T. J. LAMBARSKI, J. A. HIGBIE (BDM Corp., Albuquerque, NM), and G. B. ROGERS (Sandia Corp., Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 183-186.

An analysis was performed to predict the power outputs of 4- and 7-foot aperture linear parabolic troughs. The analysis was part of a trade-off study to reduce the cost of the BDM 47 kW concentrating PV applications experiment (PRDA-35) by using fewer larger aperture collectors. The key feature of the analysis was the use of laser scans of the troughs to provide individual insolation inputs to cell computer models. The analysis, using the Photovoltaic Transient Analysis Program (PV-TAP), led to the selection of the larger trough for the PRDA system. The techniques detailed in this paper can serve as a valuable tool in predicting the output of proposed collector designs. This paper also presents the results of the trade-off and conclusions pertinent to parabolic troughs in general. (Author)

A82-44957* Case Western Reserve Univ., Cleveland, Ohio. FABRICATION OF MULTI-JUNCTION HIGH VOLTAGE CONCENTRATOR SOLAR CELLS BY INTEGRATED CIRCUIT TECHNOLOGY

G. J. VALCO, V. J. KAPOOR (Case Western Reserve University, Cleveland, OH), J. C. EVANS, JR., and A.-T. CHAI (NASA, Lewis Research Center; Case Western Reserve University, Cleveland, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 187-192. NASA-supported research.

Standard integrated circuit technology has been developed for the design and fabrication of planar multijunction (PMJ) solar cell chips. Each 1 cm x 1 cm solar chip consisted of six n(+)/p, back contacted, internally series interconnected unit cells. These high open circuit voltage solar cells were fabricated on 2 ohm-cm, p-type 75 microns thick, silicon substrates. A five photomask level

process employing contact photolithography was used to pattern for boron diffusions, phosphorus diffusions, and contact metallization. Fabricated devices demonstrated an open circuit voltage of 3.6 volts and a short circuit current of 90 mA at 80 AMI suns. An equivalent circuit model of the planar multi-junction solar cell was developed. (Author)

A82-44958

THE FLASH TESTING OF ALGAS/GAAS CONCENTRATOR SOLAR CELLS

P. G. BORDEN, R. A. LARUE, P. E. GREGORY, and R. BOETTCHE (Varian Associates, Inc., Palo Alto, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 193-196. refs

A computer-controlled test system using a pulsed xenon light source has been developed, producing results which correlate well with actual solar tests. The cell is mounted in a simple fixture, and tested automatically. Testing is complete in a minute and accurate to about 3%. Due to the brief duration of the flash (2 msec), no cooling apparatus is required. Also, a large area can be illuminated uniformly. Thus, the method is well suited to production testing of cells. Cost for the entire system is modest and circuitry is simple. Flash testing also shows great promise as a research and diagnostic tool. Temperature, intensity distribution over the cell, and spectral output can be readily varied. A set-up is described for determining the dependence of efficiency on temperature. Also, by altering the distribution of light on the cell with opaque masks, certain defects such as excessive gridline resistance, and solder voids can be discovered. (Author)

A82-44959

FRENCH PUBLIC PHOTOVOLTAIC MARKET STAND-ALONE APPLICATIONS

Y. CHEVALIER (Commisariat a l'Energie Solaire, Paris, France), A. HAENTJENS, and B. MEUNIER (Societe d'Economie et de Mathematiques Appliquees, Montrouge, Hauts-de-Seine, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 201-204.

The existence of a potential French domestic market is important for the future development of the photovoltaic industry. In this paper, professional applications depending on the French Administrations are considered. It is shown that any electric equipment requiring less than 1 KwP could be already powered by photovoltaics, when the grid is not available. The number and type of applications should be increasing in the following years since photovoltaics' costs will be decreasing. Nevertheless, non-technical obstacles should be overstepped. (Author)

A82-44960

COMPARISON OF EUROPEAN REFERENCE SOLAR CELL CALIBRATIONS

F. C. TREBLE (Commission of the European Communities, Brussels, Belgium) and K.-H. KREBS (Commission of the European Communities, Joint Research Centre, Ispra, Italy) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 205-210.

The results of the first two annual round robin exercises organised by the CEC Joint Research Centre, Ispra to compare AM 1.5 sunlight calibrations of reference solar cells by four European agencies are presented and discussed. They are generally encouraging but further work is needed to trace and eliminate the source of some unacceptable systematic discrepancies. Radiometer calibration is the most likely source. (Author)

02 SOLAR ENERGY

A82-44961* Hughes Aircraft Co., Culver City, Calif.
**SIMULATOR SPECTRAL CHARACTERIZATION USING
BALLOON CALIBRATED SOLAR CELLS WITH NARROW BAND
PASS FILTERS**

G. S. GOODELLE, G. R. BROOKS (Hughes Aircraft Co., Culver City, CA), and C. H. SEAMAN (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 211-217. refs

The development and implementation of an instrument for spectral measurement of solar simulators for testing solar cell characteristics is reported. The device was constructed for detecting changes in solar simulator behavior and for comparing simulator spectral irradiance to solar AMO output. It consists of a standard solar cell equipped with a band pass filter narrow enough so that, when flown on a balloon to sufficient altitude along with sufficient numbers of cells, each equipped with filters of different bandpass ratings, the entire spectral response of the standard cell can be determined. Measured short circuit currents from the balloon flights thus produce cell devices which, when exposed to solar simulator light, have a current which does or does not respond as observed under actual AMO conditions. Improvements of the filtered cells in terms of finer bandpass filter tuning and measurement of temperature coefficients are indicated. M.S.K.

A82-44962* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**SLAM EXAMINATION OF SOLAR CELLS AND SOLAR CELL
WELDS**

P. M. STELLA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), C. L. VORRES, and D. E. YUHAS (Sonoscan, Inc., Bensenville, IL) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 218-224. refs
(Contract NAS7-100)

The scanning laser acoustic microscope (SLAM) has been evaluated for non-destructive examination of solar cells and interconnector bonds. Using this technique, it is possible to view through materials in order to reveal regions of discontinuity such as microcracks and voids. Of particular interest is the ability to evaluate, in a unique manner, the bonds produced by parallel gap welding. It is possible to not only determine the area and geometry of the bond between the tab and cell, but also to reveal any microcracks incurred during the welding. By correlating the SLAM results with conventional techniques of weld evaluation a more confident weld parameter optimization can be obtained. (Author)

A82-44963* Spectrolab, Inc., Sylmar, Calif.

**LARGE AREA, LOW COST SPACE SOLAR CELLS WITH
OPTIONAL WRAPAROUND CONTACTS**

D. MICHAELS, N. MENDOZA, and R. WILLIAMS (Spectrolab, Inc., Sylmar, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 225-227. NASA-supported research.

Design parameters for two large area, low cost solar cells are presented, and electron irradiation testing, thermal alpha testing, and cell processing are discussed. The devices are a 2 ohm-cm base resistivity silicon cell with an evaporated aluminum reflector produced in a dielectric wraparound cell, and a 10 ohm-cm silicon cell with the BSF/BSR combination and a conventional contact system. Both cells are 5.9 x 5.9 cm and require 200 micron thick silicon material due to mission weight constraints. Normalized values for open circuit voltage, short circuit current, and maximum power calculations derived from electron radiation testing are given. In addition, thermal alpha testing values of absorptivity and emittance are included. A pilot cell processing run produced cells averaging 14.4% efficiencies at AMO 28 C. Manufacturing for such cells will be on a mechanized process line, and the area of coverslide application technology must be considered in order to achieve cost effective production. R.K.R.

A82-44964* Applied Solar Energy Corp., City of Industry, Calif.
**OPTIMIZATION OF LARGE AREA SOLAR CELLS FOR LOW
COST SPACE APPLICATION**

K. W. MATTHEI, D. K. ZEMMRICH, and M. WEBB (Applied Solar Energy Corp., City of Industry, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 228-232.
(Contract NAS9-16125)

The development of large-area solar cell manufacturing techniques for production of up to 10 kW/month of cells for use on the Shuttle Power Extension Package is detailed. Design goals for the cells were 14% efficiency at 135.3 mW/sq cm AMO illumination for a 10 ohm-cm BSF/reflector cell, or 12.8% for a 2 ohm-cm BSR cell. Use of terrestrial cell technology to produce CVD SiO₂ dielectric insulators for 3-in. ingot cells yielded satisfactory contact integrity. Fused silica coverings with thicknesses of 0.004 in. have allowed exploration of conventional and wraparound cell configurations due to inherent flexibilities of the frosted covers. One production run can now handle 108 3-in. wafers for the wraparound form or 216 in one-sided contact evaporations, with both processes taking 70 mins. Current contact grid designs for space use production permits average efficiencies of 12.8%. M.S.K.

A82-44965*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**ON THE CAUSE OF THE FLAT SPOT PHENOMENON
OBSERVED IN SILICON SOLAR CELLS AT LOW
TEMPERATURES AND LOW INTENSITIES**

V. G. WEIZER and J. D. BRODER (NASA, Lewis Research Center, Cleveland, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 235, 236. refs

The results of an effort to determine the mechanisms involved in the flat spot (FS) effect are given. It is suggested that the FS effect is due to a resistive metal-semiconductor-like (MSL) interface in parallel with the cell PN junction. Regions responsible for the FS effect lie under the front surface metallization in these cells, where the PN junction has been destroyed and replaced with a metal silicide-semiconductor interface. Such structural changes, which appear to be due to the thermally activated dissolution of the silicon, have been induced in cells as a result of isochronal heat treatments at temperatures between 450 C and 560 C. It has been found that a 650 A layer of Ta₂O₅ evaporated over the metallization is sufficient to prevent the underlying silicon from pitting during the subsequent heat treatment, although pitting at the metal silicon ambient interface could still be observed. A.B.

A82-44966

**HIGH EFFICIENCY ALGAS/GAAS SOLAR CELLS WITH HIGH
RESISTANCE TO RADIATION DAMAGE**

S. YOSHIDA, K. MITSUI, T. ODA, and Y. YUKIMOTO (Mitsubishi Electric Corp., Research and Development Laboratory, Itami, Japan) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 239, 240.

A simple but efficient fabrication process for high efficiency shallow junction AlGaAs/GaAs solar cells by using GaAs substrates with low carrier concentration is described. The cells were two by two square centimeters in size with efficiency exceeding 18 percent at AMO and efficiency ratio of 0.85 after irradiation of 10 to the 15th MeV electrons/sq cm. The schematic cross section of a cell is depicted, and the ratio of a final cell performance to initial performance as a function of one MeV electron fluence is shown for junction depths of 0.3, 0.6, and 1.6 micron and for silicon cezils irradiated at the same time. Reduction of junction depth improved the efficiency ratio. The effect of one MeV electron irradiation on the spectral response shows that decreasing junction depth improves the short wavelength region of the response. C.D.

A82-44967

THE SOLAR CELL EQUATION IN THE FRAMEWORK OF REACTION KINETICS

P. T. LANDSBERG and G. TONGE (Southampton, University, Southampton, England) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 241, 242. refs

A derivation of the simple solar cell equation without explicit reference to p-n junction theory or boundary conditions is given in terms of a kinetic model. Two groups of states with transitions are used, focusing on the change in the free energy per particle passing through the load. The transition rates per unit area of exposed surface become current densities divided by electric charge. The model has been applied using various meteorological conditions with more reliable spectra than have been used so far. Optimum band gap and optimum efficiency results are given for clear day, overcast day, and undersea. It is found that optimum gaps and efficiencies are not as sensitive to cloud cover as has been thought. Solar cell fill-factors can be obtained from the theory and they are found to be relatively insensitive to meteorological conditions. Generalization of the model to photochemical energy transfer involving three sets of levels is possible. C.D.

A82-44968

NONLINEAR RESPONSE OF GAAS CONCENTRATOR CELLS TO SOLAR INSOLATION

R. J. CHAFFIN and J. J. WICZER (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 243, 244.

(Contract DE-AC04-76DP-00789)

A nonlinearity in the relationship between short circuit current and the insolation in some GaAlAs/GaAs solar cells which may affect the evaluation of the cells is reported. Small nonlinearities have been observed in the range 1-1000 suns, while large nonlinearities are present at 1/100,000-1/10 suns insolation. Sample approximations in the small deviations case are shown to lead to an error of as much as 3% in the prediction of efficiency of one commercially available cell. Low insolation nonlinearities are due to traps and saturable shunt paths, and can lead to errors of an order of magnitude in predicting the quantum efficiency if account is not properly taken of the bias light intensity in evaluations of sample cells. M.S.K.

A82-44969

ALPHA-SiC:H/ALPHA-Si:H HETEROJUNCTION SOLAR CELL HAVING MORE THAN 7.5% CONVERSION EFFICIENCY

Y. TAWADA, M. KONDO, H. OKAMOTO, and Y. HAMAKAWA (Osaka University, Toyonaka, Japan) In: Photovoltaic Specialist Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 245, 246. refs

A new type of amorphous silicon solar cell having a wide band alpha-SiC:H window has been developed. A p-type hydrogenated amorphous silicon carbide heterojunction was grown on the i-n hydrogenated amorphous silicon by the glow discharge decomposition of SiH₄ (1-X) + CH₄ (X):B₂H₆ gas control system. A typical cell performance is V(OC) of 0.909 volts, J(SC) of 13.45 mA/sq cm, FF of 0.617 and the conversion efficiency of 7.55% under AM-1(100 mW/sq cm) illumination for a 2 mm phi cell.

(Author)

A82-44970

OXIDATION-STABILITY STUDIES OF CUINSE2

L. L. KAZMERSKI, P. J. IRELAND, O. JAMJOUR, S. K. DEB, P. SHELDON (Solar Energy Research Institute, Golden, CO), R. A. MICKELSEN, W. CHEN (Boeing Aerospace Corp., Seattle, WA), and K. BACHMANN (Bell Telephone Laboratories, Inc., Murray Hill, NJ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 247, 248.

The oxidation of p-type single-crystal and thin-film polycrystalline CuInSe₂ is investigated using complementary Auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS) and X-ray photoelectron spectroscopy (XPS). The compositions of the thermally-grown oxides over the 150-300 C temperature range are found to be primarily In₂O₃, with some SeO₂, estimated to be less than 10% by quantitative AES and XPS. The interface between the oxide and CuInSe₂ is examined using AES and SIMS depth-compositional profiling in conjunction with XPS. Cu(x)Se is found to form at the interface. Angular-resolved XPS with an in-situ oxidation process is utilized to evaluate the initial oxidation of this Cu-ternary semiconductor. These studies confirm that Cu(x)Se forms during oxide growth. (Author)

A82-44971

NOVEL AMORPHOUS SEMICONDUCTOR FOR SOLAR CELLS - THE SILICON-TIN ALLOYS SYSTEMS

C. VERIE, J. F. ROCHETTE (CNRS, Laboratoire de Physique du Solide et Energie Solaire, Valbonne, Alpes-Maritimes, France), and J. P. REBOUILLAT (CNRS, Laboratoire Louis Neel, Grenoble, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 251, 252. refs

The properties of a-Si(1-x)Sn(x) alloys have been studied in the range x greater than 0 but less than or equal to 0.12, leading to establish, for the first time, the existence of these new amorphous semiconductors. The a-Si(Sn)-based solar cells might have efficiencies above 10 percent. (Author)

A82-44972

OPTIMIZATION OF PULSED-LASER PROCESSING FOR THE FABRICATION OF SILICON SOLAR CELLS

D. HOONHOUT, F. W. SARIS (Stichting voor Fundamenteel Onderzoek der Materie, Instituut voor Atoom- en Molecuulfysica, Amsterdam, Netherlands), J. MICHEL, C. FAGES, and E. FABRE (Laboratoires d'Electronique et de Physique Appliquees, Limeil-Brevannes, Val-de-Marne, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 253, 254.

Silicon solar cells made by ion-implantation and Q-switched ruby-laser annealing were examined to determine the optimum parameters for implantation and annealing. Rutherford Backscattering (RBS) plus channeling, and Scanning Electron Microscopy (SEM) were used to analyze the structure and composition of the cells, and performance was characterized by electrical measurements and spectral response. The optimum laser energy density is determined in relation to the recrystallization threshold and the surface damage threshold (about 2 J/sq cm). The presence of an appreciable leakage current indicates defects near the junction due to the laser treatment, that can be removed by furnace heating at 450 C for 10 min. A.B.

A82-44973

HIGH RATE GROWTH OF SILICON RIBBON BY LOW ANGLE CRYSTAL GROWTH

H. E. BATES and D. N. JEWETT (Energy Materials Corp., Harvard, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 255, 256. (Contract XS-9-8041-3)

A novel approach to silicon sheet growth has been demonstrated and significant progress has been achieved.

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Continuously grown ribbons of four to five meters have been produced routinely. Growth rates of 30-40 cm/min are typically obtained. Ribbon widths are 20-45 cm and thicknesses vary from 0.3-0.6 mm, with 0.5 mm being typical. Productivity of 70-100/sq cm/min is routinely achieved. Solar cells of 11% AM1 efficiency have been made. (Author)

A82-44974

JUNCTION FORMATION BY SOLID-PHASE EPITAXY - A NOVEL LOW-TEMPERATURE TECHNIQUE FOR EFFICIENT SI SOLAR CELLS

B.-Y. TSAUR, G. W. TURNER, and J. C. C. FAN (MIT, Lexington, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 257, 258. USAF-supported research.

A new low-temperature technique that uses solid-phase epitaxy (SPE) to form p-n junctions for Si solar cells is described. In initial experiments employing this technique at 400-500 C in the fabrication of p/n cells without an AR coating or back-surface field, conversion efficiencies at AM1 of 10.4 and 8.5% have been obtained for cells on single-crystal and large-grained n-Si substrates, respectively. (Author)

A82-44975

ENHANCEMENT OF MINORITY CARRIER DIFFUSION LENGTH IN GRAINS OF CAST SI BY HYDROGEN HEAT TREATMENTS

J. MIMILA-ARROYO, F. DUENAS-SANTOS, and J. L. DEL VALLE (Instituto Politecnico Nacional, Mexico City, Mexico) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 259, 260. Research supported by the Consejo Nacional de Ciencia y Tecnologia of Mexico refs

(Contract UNESCO-MEX/77/014)

Minority carrier diffusion length (mcdl) enhancement in the bulk of grains of cast poly-silicon for solar cells has been produced by hydrogen heat treatments. Measurements made by LBIC method, showed an increase of mcdl in the bulk of grains from a mean value of 53 microns to a mean value of 69 microns, before and after the hydrogen heat treatments, respectively, under white light illumination. A mean increase ratio of 33% in the mcdl was obtained in a reproducible way and it was verified that hydrogen was effectively responsible. This result clearly establishes the hydrogen passivating role in this material (Author)

A82-44976* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

A PHOTOVOLTAIC INDUSTRY OVERVIEW - THE RESULTS OF A SURVEY ON PHOTOVOLTAIC TECHNOLOGY INDUSTRIALIZATION

R. R. FERBER, E. N. COSTOGUE, J. W. THORNHILL, and K. SHIMADA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 261-266. Research supported by the U.S. Department of Energy.

The National Photovoltaics Program of the United States Department of Energy has the objective of bringing photovoltaic power systems to a point where they can supply a significant portion of the United States energy requirements by the year 2000. This is planned to be accomplished through substantial research and technology development activities aimed at achieving major cost reductions and market penetration. This paper presents information derived from a limited survey performed to obtain photovoltaic industry attitudes concerning industrialization, and to determine current industry plans to meet the DOE program goals. Silicon material production, a key photovoltaic manufacturing industry, is highlighted with regards to implementation of technology improvement and silicon material supply outlook. (Author)

A82-44977

LIFETIME AND INFLATION IN PHOTOVOLTAIC SYSTEMS ANALYSIS

M. MARTINEZ and R. MAGAR (Mexico, Universidad Nacional Autonoma, Villa Obregon, Mexico) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 273-277. refs

The effects and interrelation of the array lifetime and inflation rate are obtained by a net present value analysis. Four economic scenarios were studied for diesel vs. PV generators at Rural Mexico. A twenty five-fold increase in the diesel cost increases the array break-even cost by 50 or 100 percent, for none or the proper inflation rate increases the array break-even cost by zero or a factor of 2, for a diesel cost of 4 or 100 cents/lt. A four-fold reduction in the array lifetime produces up to a 60 percent decrease in the array break-even cost. So, the use of the proper inflation rate value is more important than the actual array lifetime for the PV systems economic viability. (Author)

A82-44978

THE ECONOMIC IMPACT OF STATE ORDERED AVOIDED COST RATES FOR PHOTOVOLTAIC GENERATED ELECTRICITY

D. BOTTARO and N. J. WHEATLEY (MIT, Cambridge, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 293-298. refs

Various methods the states have devised to implement federal policy regarding the Public Utility Regulatory Policies Act (PURPA) of 1978, which requires that utilities pay their full 'avoided costs' to small power producers for the energy and capacity provided, are examined. The actions of several states are compared with rates estimated using utility expansion and rate-setting models, and the potential break-even capital costs of a photovoltaic system are estimated using models which calculate photovoltaic worth. The potential for the development of photovoltaics has been increased by the PURPA regulations more from the guarantee of utility purchase of photovoltaic power than from the high buy-back rates paid. The buy-back rate is high partly because of the surprisingly high effective capacity of photovoltaic systems in some locations. A.B.

A82-44980

A 10-UNIT DICHROIC FILTER SPECTRAL SPLITTER MODULE

P. G. BORDEN, P. E. GREGORY, O. E. MOORE, H. VANDER PLAS (Varian Associates, Inc., Palo Alto, CA), and L. W. JAMES In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 311-316. U.S. Department of Energy refs

(Contract DOE-13-0308)

A 10-unit dichroic filter spectral splitter module has been built and tested at better than 20.5% conversion efficiency at 783 W/sq m insolation and a coolant inlet temperature of 35 C. Each unit consists of a f3.8, 8 in. diagonal measure curved-groove Fresnel lens, a dichroic filter with a 1.55-eV cutoff, a silicon low-bandgap cell, and an AlGaAs high-bandgap cell. The module is wired in three parallel strings, two with five AlGaAs cells and one with ten silicon cells. Module design, fabrication and testing, as well as future approaches are discussed. (Author)

A82-44981

2.2 KW ACTIVELY COOLED POINT FOCUSING PHOTOVOLTAIC ARRAY

S. BROADBENT, T. HOWERTON, and J. A. SANDERS (Martin Marietta Aerospace, Bethesda, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 323-328.

An actively cooled photovoltaic array which utilizes a concentrating optical system comprising a parquet of four Fresnel point focusing lenses operating at a power concentration ratio of 33:1 combined into modular units which assemble easily into a

simple single tube structural member mounted on a central pedestal supported by a two axis drive mechanism is described. A primary intent of the design is to produce useful thermal output in the form of hot water within a temperature range from 140 F to 190 F, in addition to the electrical output (Author)

A82-44982
THE DESIGN AND PERFORMANCE OF A POINT-FOCUS CONCENTRATOR MODULE

N. F. SHEPARD, JR. and T. S. CHAN (General Electric Co., Advanced Energy Programs Dept., Philadelphia, PA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 336-341. refs

Design parameters of a passively-cooled point-focus photovoltaic concentrator module for use in remote, stand-alone, or intermediate load center applications are presented. A solar cell mount assembly using a direct-bonded copper-on-aluminum insulator is employed to provide the required electrical isolation with a less than 0.2 C/W thermal resistance between the solar cell junction and the interface with the module baseplate. The cell mount is bolted to the module baseplate at the focus of a Fresnel lens parquet, which is a laminate of 25 individual 170 mm square compression molded acrylic lenses. Thermal analysis reveals that a 1.5 mm thick aluminum plate is the most effective for heat dissipation, and a cell temperature of 53 C for a direct normal insolation of 100 mW/sq cm can be expected. Prototype module test results demonstrate a 12.4% efficiency, and indicate a 6.5 W power increase over a flat-panel module. R.K.R.

A82-44983
PHOTOVOLTAIC CONCENTRATOR TEST RESULTS AND INTERPRETATIONS

H. J. GERWIN (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 342-346. Research supported by the U.S. Department of Energy.

A series of actively- and passively-cooled photovoltaic modules and arrays have been tested at the Sandia Photovoltaic Advanced Systems Test Facility. Four actively-cooled collectors were studied: (1) the Acurex parabolic trough module efficiency is 7.9%, (2) the E-systems module demonstrates a 9.9% efficiency, (3) the General Electric module has an 8.2% efficiency, and (4) the Varian module measures a 14% efficiency. Among the passively-cooled collectors tested is the Martin-Marietta Array, and it is shown that a 10 C difference in cell temperature changes the conversion efficiency from 9.0 to about 9.4%. In addition, the Spectrolab array has been 99.2% reliable and has a measured efficiency of 7.4%. Finally, the Motorola module demonstrates efficiencies of 7.8% and 10.7%. In order to compare collector performances, each design must be optimized. R.K.R.

A82-44984
OPTIMIZATION OF A PHOTOVOLTAIC CONCENTRATING COLLECTOR

A. K. YASUDA and J. I. KULL (Acurex Corp., Alternate Energy Div., Mountain View, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 347-352. refs

Analytical modeling and optimization are summarized for a photovoltaic concentrating collector. The optical modeling characterizes collector performance for a variety of concentrator and receiver tube geometries. Selection of the optimal configuration is based on maximizing optical energy incident on the photovoltaic cells. Results of the study show the best performance to be with a split trough which creates two focal points, and a trough rim angle of 95 deg. For this rim angle, the optimum receiver is V-shaped with an included angle of 44 deg and the receiver tube apex 0.83 in. below the focal point. Another conclusion of this study was the dramatic effect of reflector surface slope error on optical performance. A potential performance increase of 6.9

percent is achievable with an improvement in slope errors over existing troughs. (Author)

A82-44985#
STATUS AND ASSESSMENT OF COLLECTOR COST-REDUCTION EFFORTS

L. M. MAGID (U.S. Department of Energy, Div. of Photovoltaic Energy Systems, Washington, DC) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 353-360. refs

The current status of approaches for reducing the price of photovoltaic collectors, to \$2.80/ peak watt (Wp) and then to \$0.70/Wp (FOB factory module price in 1980 dollars), is discussed. Two baseline technologies, for flat-plate and concentrating collectors, are available which should easily be able to achieve the \$2.80/Wp target and which are making significant progress toward the \$0.70/Wp target. Two concerns regarding flat-plate collectors are the need for accelerated testing to establish the desired 20-year system lifetime, and the need for lower cost slicing techniques for use with the Advanced Czochralski, HEM, and SEMIX ingot growing technologies. The quoted costs are found to be within the grasp of the concentrating collector industry, providing an adequate sales volume exists for the 100-1000 megawatt plants that would be needed to achieve these goals. In this regard, the lack of significant commercialization of concentrator systems is a concern. A.B.

A82-44986* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

OVERVIEW - FLAT-PLATE TECHNOLOGY

W. T. CALLAGHAN (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 361-366. Research sponsored by the U.S. Department of Energy and NASA.

Progress and continuing plans for the joint NASA/DoE program at the JPL to develop the technologies and industrial processes necessary for mass production of low-cost solar arrays (LSA) which produce electricity from solar cells at a cost of less than \$0.70/W are reviewed. Attention is given to plans for a demonstration Si refinement plant capable of yielding 1000 MT/yr, and to a CVD process with chlorosilane, which will yield material at a cost of \$21/kg. Ingot and shaped-sheet technologies, using either Czochralski growth and film fed growth methods have yielded AM1 15% efficient cells in an automated process. Encapsulation procedures have been lowered to \$14/sq m, and robotics have permitted assembled cell production at a rate of 10 sec/cell. Standards are being defined for module safety features. It is noted that construction of a pilot Si purification plant is essential to achieving the 1986 \$0.70/W cost goals. M.S.K.

A82-44987
DETERMINATION AND THERMODYNAMICS OF THE MAXIMUM EFFICIENCY PHOTOVOLTAIC DEVICE

H. PAUWELS and A. DE VOS (Gent, Rijksuniversiteit, Ghent, Belgium) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 377-382. refs

The efficiency of the most general semiconductor photovoltaic structure for solar energy conversion is maximized with respect to its structural parameters. The maximum efficiency structure appears to be a tandem cell with an infinite number of diodes, which have bandgaps that decrease monotonically from + infinity to 0, and which are selectively black bodies. The thermodynamics of this structure are analysed and the relation of the photovoltaic energy conversion with the Carnot efficiency and the Landsberg efficiency is determined. (Author)

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A82-44988

A THEORETICAL ANALYSIS OF THE OPTIMUM NUMBER OF UNITS IN MULTIGAP MULTIJUNCTION SYSTEM UNDER VARIOUS OPERATING CONDITIONS

J. E. PARROTT and A. M. BAIRD (University of Wales Institute of Science and Technology, Cardiff, Wales) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 383-386. refs

Starting from the photon Boltzmann equation, general expressions have been obtained describing the performance of a stacked solar cell system. The efficiency is then calculated for optimum values of the energy gap and terminal voltage of each cell. Where there is complete electroluminescent coupling between cells and no non-radiative recombination the highest efficiency is obtained for an infinite number of cells infinitesimally spaced in energy gap. If these conditions no longer hold then the spacing of the cells only becomes infinitesimal for vanishingly small energy gap. When the cells are electrically in series there is a finite optimum number of cells for which the efficiency is a maximum.

(Author)

A82-44989

CHARACTERISTICS AND PERFORMANCE OF SILICON SOLAR CELLS BETWEEN LOW AND HIGH LEVEL INJECTION

M. A. WOLF and M. WOLF (Pennsylvania, University, Philadelphia, PA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 387-393. refs

The operation of silicon solar cells utilizing high-low junctions has been studied for injection levels between the validity ranges of normal low-level and high-level injection approximations. The effects of primary influence on the I-V characteristic and their dependence on cell design were investigated in detail. These effects are: ohmic voltage drops, voltages resulting from non-equilibrium carrier distribution fields, and voltages generated across the high-low junction, and current variations due to minority carrier lifetime changes. Several quantitative evaluations of cell structures are compared to illustrate the combined effects of different illumination intensities and cell structures.

(Author)

A82-44990

A MODEL FOR THE BACK-SURFACE-FIELD SOLAR CELL UNDER CONCENTRATED SUNLIGHT

B. L. GRUNG (Honeywell Corporate Technology Center, Bloomington, MN) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 394-399. Research supported by Honeywell, Inc. refs

A physical model is presented for the back-surface-field (BSF) solar cell under concentrated sunlight. The model combines the instructive aspects of a completely analytical approach with the accuracy of a numerical technique. The analytical techniques include dividing the cell into space-charge and quasi-neutral regions, and then using the Fletcher (1957) boundary conditions for the two-space-charge regions and the ambipolar approach for the lightly-doped base region. This approach leads to a nonlinear two-point boundary value problem which is best solved using numerical techniques such as the shooting method. Specific results are given for both the p(+)/n(+/-) and the n(+)/pp(+/-) solar cells, assuming a base resistivity of 10 ohm-cm and a concentration ratio in the range from 0.1 to 1000 suns (AM1). The calculated results indicate that the p(+)/n(+/-) solar cell has a higher efficiency than the n(+)/pp(+/-) solar cell.

(Author)

A82-44991

MODELING SOLAR CELLS CONTAINING HEAVILY DOPED REGIONS

M. S. LUNDSTROM, R. J. SCHWARTZ, and J. L. GRAY (Purdue University, West Lafayette, IN) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 400-405. U.S. Department of Energy refs (Contract DOE-13-2304)

Techniques for modeling solar cells that contain regions of heavy impurity doping are discussed in this paper. Complications caused by bandgap narrowing, changes in the densities-of-states, and Fermi-Dirac statistics are considered, and it is shown that these effects can be modeled in a simple, but rigorous manner by formulating the transport equations in a Boltzmann-like form. Two parameters, the effective bandgap shrinkage and the effective asymmetry factor, account for the above-mentioned heavy doping effects. The relationship of these parameters to the band structure of the semiconductor is discussed. Finally, the use of these equations in numerical and analytical analysis of silicon solar cells is discussed and related to previous work.

(Author)

A82-44994

STRATEGIES FOR THE ANALYSIS OF THE EFFECTS OF GRAIN BOUNDARIES ON THE PERFORMANCE OF POLYSILICON SOLAR CELLS

F. A. LINDHOLM and J. G. FOSSUM (Florida, University, Gainesville, FL) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 422-431. Research sponsored by the Solar Energy Research Institute. refs

The purpose of this paper is to present strategies for the analysis of the difficult three-dimensional boundary-value problem that underlies the illuminated current-voltage characteristics of bulk and thin-film polycrystalline solar cells, especially polysilicon p/n junction cells. Emphasis is placed on a fundamental formulation of the boundary-value problem, which could serve as the basis of a complete numerical solution, and on the use of approximations that enable analytic solution. Recombination through an energy distribution of quantum states at the grain-boundary surface is described; from this description emerges an integration of the issues of energy-gap narrowing, relating to delocalized states, and trap-assisted recombination, relating to localized states.

(Author)

A82-44995

A NEW TECHNIQUE FOR PREPARING P-N JUNCTIONS FOR SI PHOTOVOLTAIC CELLS

J. C. C. FAN, T. F. DEUTSCH, G. W. TURNER, D. J. EHRlich, R. L. CHAPMAN, and R. M. OSGOOD, JR. (MIT, Lexington, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 432-436. USAF-DARPA-sponsored research. refs

A pulsed ArF excimer laser has been used to form p-n junctions in Si. The laser produces dopant atoms by photolysis of gas molecules and simultaneously heats the Si substrate to allow incorporation of the dopant. The junctions have been used to fabricate solar cells with dimensions of 0.5 x 1 cm. Conversion efficiencies exceeding 10% at AM1 have been achieved without the use of an antireflection coating. This one-step photochemical doping process has the potential for markedly reducing the cost of junction formation in solar cell fabrication.

(Author)

A82-44996* Lockheed Missiles and Space Co., Sunnyvale, Calif.

LASER PROCESSING OF SILICON SOLAR CELLS

J. S. KATZEFF, M. LOPEZ (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA), and D. R. BURGER (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 437-441. Research sponsored by the U.S. Department of Energy and NASA. refs

Results of a study to utilize an Nd:glass laser for production line annealing of ion implantation induced damage in solar cells are reported. Czochralski-grown and sawn Si wafers 7.6 cm in diam, 0.35 mm thick, were implanted with phosphorus junctions and boron BSFs. Annealing with electron beam, laser, and firing of an Al paste to form the BSFs in different cells was compared. The laser was employed at 1.06 and 0.53 micron and in combination of both, with a 20-50 nsec pulsewidth, and energy densities of 1.2, 1.5, 1.9, and 2.1 J/sq cm. Best optical coupling was observed with the combined wavelengths and a 20 nsec pulse, using energy densities less than 1.5 J/sq cm. Although the Al sintered cells displayed the best characteristics, laser annealing is concluded to offer electrically active, defect-free, shallow junction Si substrates for high efficiency cells. M.S.K.

A82-44997

THE FABRICATION OF A 17% AM1 EFFICIENT SEMICRYSTALLINE SILICON SOLAR CELL

G. M. STORTI (Solarex Corp., Rockville, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 442-445. refs

The results of investigations of the maximum efficiencies available from cast, polycrystalline Si solar cells made from the SEMIX process are reported. High efficiency cells were found to depend on choices of cells with bulk resistivity between 1.5-1.7 ohm-cm and a dislocation density of less than 10,000/sq cm. Maximized cells were fabricated by using slices less than 150 microns thick. The surfaces were texture etched to reduce reflectance and an Al back surface reflector was evaporated onto the slice surface. Photolithographically applied contacts preceded cutting into 2 cm x 2 cm pieces and subsequent evaporation of TaO₂ and MgF₂ layers onto the surface. Testing was undertaken in sunlight and in a xenon simulator. A highest cell efficiency of 17% was observed, with a current density of 36 mW/sq cm. Semicrystalline Si cells are concluded to offer efficiencies equivalent to those of single crystal Si. M.S.K.

A82-44998

SOLAR CELL EFFICIENCY ENHANCEMENT BY JUNCTION ETCHING AND CONDUCTIVE AR COATING PROCESSES

N. MARDESICH (Spectrolab, Inc., Sylmar, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 446-449.

Discussions on some injectable processes for enhancing the response of low cost terrestrial solar cells are presented. The procedure consists of (1) reduction of junction depth and removal of diffusion damage and defects by suitable etching processes after application of front contact and (2) reduction of light reflection and an increase in sheet conductivity by sputtering a conductive ITO AR coat on the etch front surface. By combining the two processes of plasma etching and ITO AR coating, a 43% total increase in short circuit current is expected for a cell with initial 3000 A junction depth. (Author)

A82-44999

AN IMPROVED SILICON SOLAR-CELL PROCESSING

J. MICHEL and B. G. MARTIN (Laboratoires d'Electronique et de Physique Appliquee, Limeil-Brevannes, Val-de-Marne, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 450-454. refs

Silicon solar-cell processing with a junction achieved by diffusion from the anti-reflective coating has been investigated. Spray-deposited boron-doped titanium oxide was used to make p(+)/n/n(+) structure. Different contact metallization techniques were tested. It is shown that this process is suitable for both efficient and low-cost cells. (Author)

A82-45000* Spire Corp., Bedford, Mass.

AN AUTOMATED PROCESS SEQUENCE USING PREFORMED CELL CONTACTS AND INTERCONNECTS WITH A TOTAL COST OF \$0.64 PER PEAK WATT IN 1986

A. J. ARMINI, G. A. LANDIS, and P. R. YOUNGER (Spire Corp., Bedford, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 455-459. NASA-sponsored research. refs

A process sequence is described which utilizes a preformed metal mesh electrostatically bonded to each cell to provide the front contact. Cells of 12 percent AM1 efficiency have been produced using this scheme. This method also permits access to both contacts on the cell from the back side. In addition, low cost cell interconnection is accomplished using a flexible 'printed circuit' sheet which is ultrasonically bonded to the cell contacts. The complete process sequence as well as automated equipment which also uses ion implantation and pulse annealing is described. The total cost for module fabrication is estimated at \$0.64 per peak watt for a 30 MW/year plant. (Author)

A82-45001* Spectrolab, Inc., Sylmar, Calif.

AN ANALYTICAL APPROACH TO PHOTOVOLTAIC ENCAPSULATION SYSTEM DESIGN

A. GARCIA, III (Spectrolab, Inc., Sylmar, CA), C. P. MINNING (Hughes Aircraft Co., Culver City, CA), and E. F. CUDDIHY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 460-465. Research sponsored by the U.S. Department of Energy and NASA.

This paper describes a set of analytical methods which have been developed to enable quantitative analysis of encapsulation system designs for terrestrial photovoltaic modules. Design factors determined most important include: encapsulant thickness and modules, emissivity of module surface, ribs on substrate modulus, and AR. (Author)

A82-45002

OPTICAL CHARACTERISTICS OF TEXTURED /100/ ORIENTED SILICON SURFACES - APPLICATIONS TO SOLAR CELLS

B. L. SOPORI and R. A. PRYOR (Motorola, Inc., Semiconductor Group, Phoenix, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 466-472.

This paper describes theoretical and experimental analyses of optical reflection and refraction characteristics of (100) oriented textured silicon surfaces. Three theoretical approaches (viz 'limited ray' optics, diffraction grating, and transmission line) are described which can be selectively used to simplify design analysis to optimize cell performance. Experimental measurements include diffuse reflectance of textured silicon wafers with differently prepared back surfaces, which enable separation of front (textured) surface characteristics from those of the back surface. Measurement of light propagation angles in the air and the substrate are done by direct viewing in visible and IR light. Results of this analysis can

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be used to design AR coatings and back surface reflectors for optimum cell performance. (Author)

A82-45003

EFFECTS OF ELECTRON IRRADIATION ON VARIATIONS OF AN ADVANCED SILICON SOLAR CELL

S. W. GELB, G. J. VENDURA, JR., and L. J. GOLDHAMMER (Hughes Aircraft Co., Space and Communications Group, El Segundo, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 473-478. refs

A comprehensive electron irradiation test of an advanced space production silicon solar cell was conducted. The cell itself, designated K6-3/4, was n on p and 10 ohm-cm with a shallow junction of 0.15 micron, a p(+) back surface field, a back surface reflector, and dual antireflection coatings consisting of TiO₂ and Al₂O₃. Actual experimentation, however, was performed on three distinct variations. Two involved units fabricated using similar paste p(+) processing but by separate manufacturers utilizing different silicon crystal orientations. The third included cells from a single manufacturer and orientation in which the back field drive-in followed the application of aluminum by evaporation deposition rather than by paste techniques. The samples were irradiated with 1 MeV electrons at fluences up to 1×10^{16} to the 16th electrons/sq cm. Results show similar behavior for cells of different source and orientation but significant dissimilarities with respect to evaporation and paste p(+) techniques. (Author)

A82-45004

EPITAXIAL SOLAR CELLS UNDER ELECTRON IRRADIATION

J. A. MINAHAN, D. J. DIONNE, and E. CASTORENA (Spectrolab, Inc., Sylmar, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 479-483. refs

An experimental study of epitaxial solar cells of varying base thicknesses has been made. Measurements were made of electrical characteristics before and after 3×10^{14} to the 14th MeV/sq cm electron irradiation. Epitaxial thicknesses were varied from 25 to 100 microns. By depositing 1 ohm-cm p type silicon on 02 ohm-cm p type substrate, a BSF configuration was obtained. After conventional diffusion methods were applied to produce a pn junction, open circuit voltages as high as 618 mV (AMO, 28 C) were obtained. Variation in V_{oc} between thinnest and thickest epitaxial layers was minimal. Short circuit currents displayed direct correlation with epitaxial layer thickness. AMO solar conversion efficiency displayed a like correlation. From post-irradiation measurements $P(o)$ showed an inverse correlation with epitaxial layer thickness. $P(o)$ values ranged from .91 for 25 microns layers to .82 for 100 microns layers. (Author)

A82-45005

TRANSIENT SOLAR CELL RESPONSE TO X-RAY BURSTS

M. T. GATES and G. J. VENDURA, JR. (Hughes Aircraft Co., Los Angeles, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 495-498.

Solar cell transient electrical response to short intense bursts of X-rays was measured for several solar cell designs. Results showed that both the peak voltage and charge storage time were strongly dependent on the back surface field. (Author)

A82-45006* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

DAMAGE AND COEFFICIENTS AND THERMAL ANNEALING OF IRRADIATED SILICON AND GAAS SOLAR CELLS

B. E. ANSPAUGH and R. G. DOWNING (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 499-505. refs (Contract NAS7-100)

Electron and proton damage coefficients have been measured for several types of silicon cells of recent manufacture using 1 MeV electrons and protons with energies of 8.3, 17.5 and 40 MeV. LPE (AlGa)As-GaAs cells were also irradiated and pseudodamage coefficients derived under the assumption that the irradiation changes the diffusion length in only one of the n- or p-type layers. After irradiation the cells were annealed isochronally up to 450 C. The damage coefficient and annealing data for silicon cells are in substantial agreement with previous work. The GaAs cells have pseudo-damage coefficients which are dependent on fluence, and have about the same energy dependence as Si damage coefficients. (Author)

A82-45007* Pennsylvania Univ., Philadelphia.

METALLIZATION FOR LARGE-AREA SOLAR CELLS

M. WOLF (Pennsylvania, University, Philadelphia, PA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 506-511. Research supported by the U.S. Department of Energy (Contract JPL-954976)

In large area, low cost solar cells of any type, the contact and grid structure metallization is an important factor which has an effect on the efficiency of the solar cell and its reliability. The present investigation is concerned with aspects of solar cell efficiency. An optimized metallization design leads to minimum total power loss, which is related to a simultaneous minimization of ohmic voltage drops and of shading of the front surface of the cell by the overlaid metal. The requirements regarding the design for a low-loss metallization pattern for the front surface of large area solar cells are represented by a set of design rules listed in a table. The total shading and voltage drop on such cells can be held to about 5%. However, not every metallization process is suited for meeting the requirements of the low-cost design. The low losses can be achieved only by use of several bus lines containing a bulk conductor, such as a wire. G.R.

A82-45008

CONTRACT RESISTIVITIES BETWEEN SOLAR-CELL-TYPE SI AND TRANSITION METAL NITRIDES

M. MAENPAA, I. SUNI (California Institute of Technology, Pasadena, CA; Technical Research Centre of Finland, Esbo, Finland), M.-A. NICOLET (California Institute of Technology, Pasadena, CA), F. HO, and P. ILES (Applied Solar Energy Corp., City of Industry, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 518-521. Research supported by the U.S. Department of Energy. refs

Contact resistivities of TiN, Ti-TiN, HfN, Hf-HfN, TaN and Ta-TaN metallizations on solar-cell-type n(+)Si with a shallow p-n junction have been investigated. Metal and nitride layers were sputter-deposited. Linear contact patterns were used for the measurements. The transmission line model was applied to determine the contact resistivities. Contact resistivity values of less than about 0.0001 ohm-cm squared have been achieved with all structures. Electrically the structures are stable up to heat treatments of 700 C. The interfacial layers between the substrate and the deposited material have been found to play an important role in the behavior of the contact. The studied metallizations have been estimated to be electrically acceptable for cells with 100 times solar concentrations. (Author)

A82-45009

RELIABILITY OF SILICON SOLAR CELLS WITH A PLATED NICKEL-COPPER METALLIZATION SYSTEM

L. A. GRENON, N. G. SAKIOTIS, and M. G. COLEMAN (Motorola, Inc., Semiconductor Group, Phoenix, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 522-526. refs

In order to achieve the goal of low cost photovoltaics, low cost processes that contribute to a long solar cell service life must be established. In this paper, the interactions between the silicon and the nickel contact are examined with respect to long term reliability. The effects of heat treatment of the contacts on diode performance are empirically examined by studying changes in electrical parameters of cells as a function of time and temperature. The results show that, utilizing the appropriate plating technique and establishing the appropriate assembly technique, a low cost, highly reliable nickel-copper metallization system can be used on silicon solar cells. (Author)

A82-45010

DEVELOPMENT OF FINE LINE SILICON SHADOW MASKS FOR THE DEPOSITION OF SOLAR CELL GRIDS

D. S. CAMPORESE, T. P. LESTER, and D. L. PULFREY (British Columbia, University, Vancouver, Canada) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 527-529. refs

Recent developments in the fabrication of silicon shadow masks to delineate fine linewidth grid patterns for solar cells are described. Line-widths down to 10 microns have been achieved with masks prepared by anisotropically etching V-grooves into one surface of a pre-thinned wafer. These masks have been used in a simple procedure to fabricate MISIL solar cells with total area conversion efficiencies of 13.7%. (Author)

A82-45011

THERMAL STABILITY OF IMPURITIES IN SILICON SOLAR CELLS

M. H. HANES, R. H. HOPKINS, A. ROHATGI, P. RAI-CHOUDHURY (Westinghouse Research and Development Center, Pittsburgh, PA), R. B. CAMPBELL (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, PA), and H. C. MOLLENKOPF (Hemlock Semiconductor Corp., Hemlock, MI) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 530-533. Research sponsored by the U.S. Department of Energy. refs

Elevated temperatures were employed as an age accelerating mechanism to test the effects of typical impurities on long-term performance of Si solar cells. Czochralski-grown p-type wafers were junction diffused with POC13 at 850 C and aged at temperatures from 400-800 C from 10 min to 200 hr. The wafers contained Fe, Cu, Ti, Md, Nb, Ni, and Ag contaminants. The degradation mechanism was assumed to be linear in the initial stages and was modeled numerically, including prediction of a time to failure, defined as an efficiency of 90% the original figure. Deep level transient spectroscopy was used to measure carrier trapping centers and dark and lighted current-voltage measurements to assay junction degradation and shunt and series resistance effects. Metallic impurities were determined to have negligible impact on cell degradation at expected long-term solar cell operating temperatures. However, studies of the more complex effects of Fe and Cu are recommended. M.S.K.

A82-45012* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

TECHNOLOGY REQUIREMENTS FOR GAAS PHOTOVOLTAIC ARRAYS

J. SCOTT-MONCK and D. ROCKEY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 539-543. refs (Contract NAS7-100)

An analysis based on percent GaAs solar cell weight and cost is performed to assess the utility of this cell for future space missions. It is shown that the GaAs substrate cost and the end-of-life (EOL) advantage the cell can provide over the space qualified silicon solar cell are the dominant factors determining potential use. Examples are presented to show that system level advantages resulting from reduction in solar panel area may warrant the use of GaAs at its current weight and projected initial cost provided the EOL advantage over silicon is at least 20 percent. (Author)

A82-45013

DESIGN APPROACH TOWARD 100KW FLEXIBLE SOLAR ARRAYS

B. GOERGENS, H. BEBERMEIER, and G. BEHRENS (Telefunken AG, Hamburg, West Germany) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 544-549. refs

New requirements for large flexible Shuttle launched solar arrays are: protection against shadowing, retractability, high power/mass ratio, easy maintenance. In the scope of ESA studies the design for solar arrays in the 100 KW range has been investigated leading to the use of glass fibre reinforced kapton substrate and 5cmx5cm, 150 microns, BSF-BSR solar cells in connection with 2cmx2cm flat shunting diodes on the array for protection against shadow impacts. A rear side wiring system of 10 micron Ag bars completely covering the array rear side was selected to be the optimum choice from overall system aspects. High voltage application is limited to approximately 500V maximum in order to avoid discharge events and damage of the solar array. For achieving full retractability a new on array padding technique has been developed. Small crosslike pads of RTV silicone material between the solar cells are preventing the cells from damage during launch and retrieval in orbit. (Author)

A82-45014

SHUNT AND BLOCKING DIODES FOR PROTECTION OF SPACE SOLAR ARRAYS

K.-D. RASCH and K. ROY (Telefunken AG, Heilbronn, West Germany) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 550-553. European Space Research and Technology Centre (Contract ESTEC-3662/78/NL/HP)

A thin large area protection diode for blanket integration on space solar arrays is presented. The diode (2 cm x 2 cm x 0.02 cm) can be used as a shunt or a blocking diode in the extensive temperature range from - 150 C to + 150 C. The characteristics for forward and reverse bias conditions are given. The switching behavior for critical modes in the high temperature range is tested. Maximum ratings are discussed. The diode shows no remarkable electrical degradation in an electron radiation environment. Advantages of the diode are high thermal radiation, high reflectance and low heat generation. (Author)

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A82-45015

A RATIONAL APPROACH TO DESIGN AND TEST A SPACE PHOTOVOLTAIC GENERATOR

D. C. RICHARD (ESA, Solar Energy Conversion Section, Noordwijk, Netherlands) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 554-559.

Design suggestions and tests of an ESA space photovoltaic generator are presented, in an attempt to reduce cost and development duration. Attention is given to the internal mechanics of the solar cell which is reduced to a module consisting of a two dimensional mathematical model limited to the size of half a solar cell, and a two dimensional model limited to the free length of a series interconnector. Reliable material properties are essential to design, and static and fatigue properties are considered. Stress sensitivity analyses reveal that stress level is most effectively decreased by increasing the adhesive thickness. Fatigue studies indicate that mechanical loads add to thermal fatigue in interconnectors, and a microshaker has been developed to test interconnectors at frequencies below 10 Hz. A multipanel test rig has also been developed, and tests imply that development duration and cost have been reduced. R.K.R.

A82-45016* Rockwell International Corp., Downey, Calif.

A PENTAHEDRAL PYRAMIDAL CONCENTRATOR DESIGN FOR SPACE SOLAR ARRAY

L. HSU (Rockwell International Corp., Space Operations and Satellite Systems Div., Downey, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 560-564.

(Contract NAS8-32988)

A truncated pentahedral pyramidal solar concentrator configuration has been selected as the most favorable candidate capable of providing low-cost multi-hundred-kilowatts (kW) solar array in low earth orbit. This concentrator has the advantages of: commonality for applications using either gallium arsenide (GaAs) or silicon (Si) solar cells, cost effectiveness, structural simplicity, and compatibility with the Shuttle. Results of concentrator optical ray trace, benefit of radiator, deployment mechanism, array power, and cost analysis are discussed. (Author)

A82-45019

SEMICRYSTALLINE MATERIAL FROM METALLURGICAL GRADE SILICON

J. LINDMAYER and J. PUTNEY (Semix Inc., Gaithersburg, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 572-575. refs

A functional approach to producing solar cell material from metallurgical grade Si is presented as a means to producing polycrystalline cells of acceptable efficiencies without costly, separate purification steps. Grain boundaries were found to be generally absent from cells manufactured from mixtures of metallurgical grade Si and semiconductor grade Si. It was concluded that impurities were sinking into the grain boundaries, and acceptable cells could be produced without expensive chemical refinement techniques. The Simultaneously Present Large Impurity Technology (SPLIT) program was initiated to deal with cells with high impurity contents. Current construction of an Si feedstock plant to produce 1000 tons of metallurgical grade Si is noted. M.S.K.

A82-45020

A NEW DIRECTIONAL SOLIDIFICATION TECHNIQUE FOR POLYCRYSTALLINE SOLAR GRADE SILICON

T. SAITO, A. SHIMURA, and S. ICHIKAWA (Nippon Electric Co., Ltd., Basic Technology Research Laboratories, Kawasaki, Japan) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 576-580. Research supported by the Ministry of International Trade and Industry. refs

A new directional solidification (casting) technique using powder mold releasing agent is described for producing polycrystalline solar grade silicon. Crack-free and stress-free growth of silicon was attainable with fused quartz crucibles coated with nitride powder, such as silicon nitride Si₃N₄, on the inner crucible walls. The degree of nitrogen contamination was negligible because of the low nitrogen solubility in solid silicon. Other impurities contents were less than the ppm level. The average grain diameter was close to 0.1 cm. Diffused junction solar cells (n+/p structure) were fabricated by using this boron doped 1 ohm-cm material. An AM1 conversion efficiency of 12.4% on the cells of 20 cm sq area was obtained. The minority carrier diffusion length of this material was estimated to be greater than 80 microns. (Author)

A82-45021

GROWTH OF SILICON SHEETS FROM METALLURGICAL-GRADE SILICON

T. F. CISZEK, M. SCHIETZELT, L. L. KAZMERSKI, J. L. HURD, and B. FERNELIUS (Solar Energy Research Institute, Golden, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 581-588. refs

Direct conversion of metallurgical grade silicon and Direct Arc Reactor (DAR) silicon into sheet form has been carried out using the Edge-Supported Pulling (ESP) technique. The 7 mm meniscus height associated with ESP permits the growth of 5 cm wide sheets, and the thermal stability provided by the edge filaments makes this method relatively insensitive to disruption by surface instability. Resistivities for metallurgical grade silicon sheets are 0.5-0.23 ohm-cm, and for DAR are 0.10-0.23 ohm-cm. Constitutional supercooling occurred under some growth conditions with both materials, and was sometimes severe enough to cause difficulties, particularly with metallurgical grade silicon. A tendency for higher impurity levels at grain boundaries than within grains was observed. The impurity and structural analysis of the material, and the electrical characteristics of solar cells made from metallurgical silicon sheets are also covered. A.B.

A82-45022

LARGE AREA SILICON SHEET VIA EFG TUBE GROWTH

A. S. TAYLOR, R. W. STORMONT, C. C. CHAO, and E. J. HENDERSON (Mobil Tyco Solar Energy Corp., Waltham, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 589-594. refs

The EFG growth of small diameter silicon tubing has been reported. The work has now been extended to large polygons to produce inexpensive sheet material for solar cells. The advantages of tube growth remain essentially uncompromised. With a periphery of 48.8 cm and growth speeds of up to 3.0 cm/minute, formation rates of 146 sq cm/minute are achieved with nine-sided polygons. Substrates for solar cells are readily cut from the nonagons. The resulting material is similar to that of the smaller tubing. Solar cells with more than 13% efficiency are fabricated. (Author)

A82-45023

ION-IMPLANTED THIN-FILM SOLAR CELLS ON SHEET SILICON

R. G. WOLFSON and R. G. LITTLE (Spire Corp., Bedford, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 595-597. refs

Thin silicon films were chemically vapor deposited on silicon sheet prepared from low-B, low-P metallurgical-grade feedstock. Junctions were ion implanted, and cells were fabricated by a standard high-efficiency process sequence. Device characterization showed identical performance in thin-film cells on the sheet and on industry-standard Czochralski substrates, with an average AM1 efficiency of 11.0 percent. Spectral response curves indicated a longer effective minority-carrier lifetime in the film but a diffusion length limited by the film thickness. It is concluded that the process described can utilize metallurgical-grade silicon as a low-cost substrate for thin-film solar cells. (Author)

A82-45024* Applied Solar Energy Corp., City of Industry, Calif.

IMPROVED PERFORMANCE FROM SOLAR CELLS MADE FROM CANDIDATE SHEET SILICON MATERIALS

H. I. YOO, P. A. ILES, D. C. LEUNG (Applied Solar Energy Corp., City of Industry, CA), and S. HYLAND (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 598-602. Research supported by the U.S. Department of Energy and NASA. refs

Performance of solar cells made from various candidate silicon sheets is updated and the results are presented. Solar cells were fabricated using a baseline process and other process variations, and tested under AM1 conditions. Performance of the baseline solar cells indicates that remarkable improvements in material quality have been achieved for most of the sheets, showing efficiencies close to that of the control cells made from conventional CZ silicon. Process variations (or additions), in general, have resulted in significant improvements in all performance with a degree of change dependent on the process chosen and to a certain extent the sheet quality. (Author)

A82-45025* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INVESTIGATION OF SOLAR CELLS FABRICATED ON LOW-COST SILICON SHEET MATERIALS USING 1 MEV ELECTRON IRRADIATION

A. H. KACHARE, S. L. HYLAND (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), and G. F. J. GARLICK In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 603-607. Research sponsored by the U.S. Department of Energy and NASA. refs

The use of high energy electron irradiation is investigated as a controlled means to study in more detail the junction depletion layer processes of solar cells made on various low-cost silicon sheet materials. Results show that solar cells made on Czochralski grown silicon exhibit enhancement of spectral response in the shorter wavelength region when irradiated with high energy electrons. The base region damage can be reduced by subsequent annealing at 450 C which restores the degraded longer wavelength response, although the shorter wavelength enhancement persists. The second diode component of the cell dark forward bias current is also reduced by electron irradiation, while thermal annealing at 450 C without electron irradiation can also produce these same effects. Electron irradiation produces small changes in the shorter wavelength spectral responses and junction improvements in solar cells made on WEB, EFG, and HEM silicon. It is concluded that these beneficial effects on cell characteristics are due to the reduction of oxygen associated deep level recombination centers in the N(+) diffused layer and in the junction. N.B.

A82-45026* Spectrolab, Inc., Sylmar, Calif.

SOLAR CELLS FABRICATED WITH UNCONVENTIONAL SILICON MATERIALS

J. A. MINAHAN, E. CASTORENA, and D. J. DIONNE (Spectrolab, Inc., Sylmar, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 608-613. Research sponsored by the U.S. Department of Energy and NASA.

Solar cells have been fabricated using silicon materials supplied in the DOE/JPL Large Solar Array program. Each of the silicon materials studied in this program was produced in a unique manner and with intent of producing silicon in a grade and form that would offer the possibility of economic deployment in photovoltaic arrays for generation of electricity. This report will attempt to provide an overview of the results for some of the materials and highlight in particular results obtained for solar cells fabricated from the advanced CZ silicon. Emphasis will be given to consideration of the purity of virgin silicon material used in the heat exchange method. (Author)

A82-45028

RECENT PROGRESS IN THE DEVELOPMENT OF ADVANCED SOLAR CELLS

D. L. FEUCHT (Solar Energy Research Institute, Golden, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 648-653. refs (Contract EG-77-C-01-4042)

A large number of advanced photovoltaic materials and concepts are being explored which have potential for efficient low-cost electric conversion. The progress in many of these technologies, which has been considerable over the past few years, will be discussed in the paper. In order to demonstrate technical feasibility by 1986 for achieving the cost goals of \$0.15 to \$0.50/W(pk) for advanced modules by 1990 there are several problem areas which must be addressed. These are also discussed briefly. (Author)

A82-45029

A UNIFIED ANALYSIS OF ALL THE SILICON RIBBON AND SHEET PROCESSES

E. FABRE (Photowatt International, S.A., Argenteuil, Val-d'Oise, France) and C. BELOUET (Laboratoire d'Electronique et de Physique Appliquee, Limeil-Brevannes, Val-de-Marne, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 654-659. refs

The main sheet and ribbon silicon growth processes are discussed in the scope of their economic competitiveness for a mass production of low-cost solar cells. It is argued that the ingot approach will be superseded by material-shaping techniques mainly based on melt-growth processes. It is shown that melt-growth processes stem from the same basic principle: meniscus-controlled growth. An analysis of their growth features clearly distinguishes the WEB process from its competitors, which appear to present similar potentialities as far as the properties of the layers are concerned, the differences in their current achievements reflecting mainly their respective maturity. The future trends regarding the specific processing problems bound to these silicon shaped materials are briefly discussed. (Author)

A82-45030

MIS SILICON SOLAR CELLS - POTENTIAL ADVANTAGES

G. CHEEK (Solar Energy Research Institute, Golden, CO) and R. MERTENS (Leuven, Katholieke Universiteit, Heverlee, Belgium) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 660-665. refs

Recent studies of the Metal Insulator Semiconductor (MIS) and Semiconductor Insulator Semiconductor (SIS) type solar cells are presented. The principle advantages of the cells include enhanced blue response, low-temperature fabrication processes, higher open

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circuit voltages, and simple processing technology, but these advantages need to be re-examined. For example, blue response advantages can also be found in pn junctions, and low-temperature processes may not be significant. It is found that the fabrication techniques are more complex and more sensitive to materials and surface preparation techniques than those of pn junctions. In addition, in order to enhance MIS/SIS stabilities, several conclusions were made including the need to avoid moisture during fabrication, the use of AR coatings to improve stability by reducing metal oxidation, and a more rapid degradation of polycrystalline silicon cells than single crystal cells. Production efficiency and fabrication costs must be considered if MIS/SIS cells are to be economically competitive. R.K.R.

A82-45031

THIN-FILM GAAS SOLAR CELLS

J. C. C. FAN, C. O. BOZLER, and R. W. MCCLELLAND (MIT, Lexington, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 666-672. Research sponsored by the Solar Energy Research Institute and U.S. Air Force. refs

GaAs solar cells using an n(+)/p/p(-) structure have been fabricated which show conversion efficiencies of 21% (AM1) on single-crystal GaAs and Ge substrates. The GaAs solar cells were prepared on Ge-coated Si substrates and thin single-crystal GaAs cells were prepared on reusable GaAs substrates in order to lower the cost of the cells. Solar cells with 12% efficiencies have been produced by depositing heteroepitaxial Ge films on Si substrates, and then growing epitaxial GaAs layers on these films. The CLEFT process has been used to separate single-crystal GaAs layers as thin as 5 microns from reusable GaAs substrates. In addition, a 17% (AM1) GaAs solar cell, only 10 microns thick and bonded to a glass substrate, has been fabricated. It is concluded that these thin-film techniques eliminate the cost and availability of GaAs as major obstacles to the utilization of GaAs solar cells. N.B.

A82-45032

OPTICAL LIMITATIONS OF THE AM1 SHORT CIRCUIT CURRENT IN A-SiH_x/ SOLAR CELLS

C. R. WRONSKI, G. D. CODY, B. ABELES, R. B. STEPHENS, B. BROOKS, and R. SHERRIER (Exxon Research and Engineering Co., Linden, NJ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 673-678. refs

The optical upper limits to the short circuit current is given by the ratio of photons absorbed in the 'active' region of the solar cell to photons incident on the cell. Using a multiple layer optical absorption model, this quantity is calculated for a variety of idealized a-SiH(x) solar cells for AM1 scaled to 100 mW/cm². The model is also applied to fitting the measured carrier collection efficiencies of several a-SiH(x) solar cells. (Author)

A82-45033

OPTIMIZATION STUDIES OF MATERIALS IN HYDROGENATED AMORPHOUS SILICON SOLAR CELLS. II

J. J. HANAK, V. KORSUN, and J. P. PELLICANE (RCA Laboratories, Princeton, NJ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 679-684. Research supported by RCA refs (Contract XJ-9-8254)

In this material optimization study for i-n, p-i-n, and n-i-p solar cells made by rf glow discharge the following developments and observations have been made: an improved cermet, Pt-Y₂O₃, as a contact to the p-layer; inverse dependence of solar cell performance on the deposition rate; direct dependence of the optimum deposition temperature on deposition rate; lowering of the p-layer thickness (by 5 X) by increasing the doping level from 0.1% to 1% of B₂H₆; increase in the conductivity of the n-layer and in the cell performance by increasing the doping level from 0.2% to 2% of PH₃; improvements in the collection width of i-a-Si:H.

Inverse dependence of the fill factor on i-layer thickness is stronger for n-i-p than for p-i-n cells, apparently because of longer average path for hole collection. Consequently p-i-n cells should be more efficient because of greater thicknesses that can be used. (Author)

A82-45034

ANALYSIS OF PHOTOGENERATED CARRIER COLLECTION AND LOSS MECHANISMS IN N-I-P AND P-I-N A-SI:H SOLAR CELLS

M. K. HAN, R. LAHRI, W. A. ANDERSON (New York, State University, Amherst, NY), and J. COLEMAN (Plasma Physics Corp., Locust Valley, NY) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 685-689. refs (Contract XS-9-8041-9)

The principal carrier collection region in N-I-P and P-I-N a-Si:H solar cells was determined by variation of undoped layer thickness. The carrier collection in these cells takes place near the top junction rather than the bottom junction. This may be attributed to the fact that the i-layer is lightly doped by impurity residues used in forming the back contact. Analysis of the spectral response under dc reverse and forward bias predicts carrier generation and recombination mechanisms. Geminate recombination is not a dominant recombination mechanism in a-Si:H as evidenced by almost 95% internal carrier collection efficiency. Thickness of the top semiconductor layer in N-I-P and P-I-N cells may be reduced to less than 100 Å to give a 20-30% increase in J(sc) without any loss of V(oc) and FF. (Author)

A82-45035

MODEL FOR FIELD AND LIGHT DEPENDENT EFFECTS IN A-SI SOLAR CELLS

A. ROTHWART (Drexel University, Philadelphia, PA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 690-693. refs (Contract DE-FG02-80CS-83105)

A model of hydrogenated glow discharge deposited amorphous silicon in a p-i-n solar cell structure is analyzed. The key feature of the model is that the compensated i-layer consists of donor-like states above and acceptor-like states below the Fermi level. In the p-i-n solar cell, charge stored in these levels create high field space charge regions near the n and p contacts, and depending upon the total thickness of the i-layer there can be a field free 'dead layer' in the center of the cell. The dark current voltage relation is derived based on recombination in the 'dead layer'. Under illumination a redistribution of charge in the band gap states occurs that affects the current-voltage relation and causes the light generated current to be sensitive to both voltage and spectral content. Prolonged exposure to light or any other process that changes the density or distribution of the gap states will affect solar cell characteristics. (Author)

A82-45036

THE EFFECT OF FLUORINE ON THE PERFORMANCE OF AMORPHOUS SILICON SOLAR CELLS

D. E. CARLSON and R. W. SMITH (RCA Laboratories, Princeton, NJ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 694-697. Research supported by RCA refs (Contract XJ-9-8254; XG-0-9372-1)

The role of fluorine in amorphous silicon has been investigated by studying the effects of adding various fluorine-containing gases (SiF₄, HF and F₂) to a SiH₄ discharge during the deposition of doped layers and during the fabrication of p-i-n solar cells. The resistivity of phosphorus-doped films can be reduced somewhat by the addition of fluorine-containing gases to the discharge, but for boron-doped films the resistivity is always increased. The conversion efficiency of p-i-n solar cells is not significantly affected when fluorine-containing gases are present during the deposition

of the p or n layer, but the performance generally falls when these gases are present during the deposition of the undoped layer. (Author)

A82-45037
PHOTOVOLTAIC BEHAVIOR OF AMORPHOUS Si:H AND Si:F:H SOLAR CELLS

Y. KUWANO, M. OHNISHI, H. NISHIWAKI, S. TSUDA, H. SHIBUYA, and S. NAKANO (Sanyo Electric Co., Ltd., Research Center, Hirakata, Osaka, Japan) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 698-703. Research supported by the Agency of Industrial Science and Technology. refs

A new fabrication process for the a-Si solar cell has been developed. P, i, and n layers are deposited in consecutive, separated reaction chambers in this process. The photovoltaic behavior of a-Si:H and a-Si:F:H solar cells which were fabricated by a glow discharge reaction in SiH₄, and in SiF₄+SiH₄, respectively, is investigated. It is found that the photovoltaic performance of the a-Si:H solar cell is strongly influenced by the intensity of the incident light. Also analyzed is the electric power loss of three types of integrated cell modules by means of a distributed constant model. (Author)

A82-45038
A REALISTIC COMPARISON OF MINIMUM PHOTOVOLTAIC MODULE COST PROJECTIONS

M. G. COLEMAN and L. A. GRENON (Motorola, Inc., Semiconductor Group, Phoenix, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 713-717. refs

Some long-term cost projections for thin film photovoltaic devices indicate a major advantage for these technologies over crystalline silicon photovoltaics, ultimately replacing silicon as the predominant material. This paper addresses the assumptions made for the thin film cost projections and compares them with the analogous assumptions for silicon. Analysis of cell manufacturing, encapsulation, and balance of systems costs are performed to show that it is unlikely that the thin film materials, even if free, will ever realize a cost advantage in photovoltaic systems over silicon. (Author)

A82-45039
SYSTEM DESIGN AND RELIABILITY CONSIDERATIONS FOR AN INTERMEDIATE-SIZE PHOTOVOLTAIC POWER SYSTEM FOR A REMOTE APPLICATION

G. T. NOEL, L. H. STEMBER, and D. C. CARMICHAEL (Battelle Columbus Laboratories, Columbus, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 725-731. refs

The design of a photovoltaic power system for remote applications is described. The preliminary requirements placed on the system are high reliability of power and low life-cycle cost, considering equipment, remote installation, and operation and maintenance costs. The design incorporates flat-panel modules assembled onto steel frames and prewired prior to shipment to the site, in order to minimize on-site installation costs, skilled labor requirements, and risk of costly delays and failures. Other components include power conditioning units, battery storage, battery charger, back-up diesel generators, and controls. A methodology for system reliability analysis using the fault-tree technique is illustrated to aid in system design, and an assessment is made of mean time between failures (MTBF), mean time to restore/repair (MTTR), and system availability. (Author)

A82-45041* Solarex Corp., Rockville, Md.

THE SOLAREX BLOCK IV MODULE

J. F. HOELSCHER (Solarex Corp., Rockville, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 745-749. (Contract JPL-955404)

Several innovative concepts were introduced for the Block IV contract. Semicrystalline silicon manufactured by SEMIX Inc. is the basic cell material. A front metallization pattern combined with a wraparound-style interconnect and in-plane stress relief combine to provide a new method to reliably accomplish series-paralleling. Laminated modules using Ethylene Vinyl Acetate (EVA) as the encapsulant were manufactured for the first time. (Author)

A82-45042* Hughes Aircraft Co., Culver City, Calif.
THERMAL AND OPTICAL PERFORMANCE OF ENCAPSULATION SYSTEMS FOR FLAT-PLATE PHOTOVOLTAIC MODULES

C. P. MINNING, J. F. COAKLEY, C. M. PERRYGO (Hughes Aircraft Co., Culver City, CA), A. GARCIA, III (Spectrolab, Inc., Sylmar, CA), and E. F. CUDDIHY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 750-755. Research sponsored by the U.S. Department of Energy and NASA. refs

The electrical power output from a photovoltaic module is strongly influenced by the thermal and optical characteristics of the module encapsulation system. Described are the methodology and computer model for performing fast and accurate thermal and optical evaluations of different encapsulation systems. The computer model is used to evaluate cell temperature, solar energy transmittance through the encapsulation system, and electric power output for operation in a terrestrial environment. Extensive results are presented for both superstrate-module and substrate-module design schemes which include different types of silicon cell materials, pottants, and antireflection coatings. (Author)

A82-45043
THE PROTECTION OF PHOTOVOLTAIC POWER SYSTEMS FROM LIGHTNING

C. B. ROGERS (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 761-766. Research supported by the U.S. Department of Energy.

Lightning protection techniques at nine prototype photovoltaic power system sites with outputs from 18-225 kW are described. Noting that protection schemes are devised to fit isokeraunic data for specific sites, grounding is cited as a common feature for all systems. The grounds are, in separate instances, connected to junction boxes, frames of the solar cell panels, lead from the dc center, from the dc negative terminal, from the frames and equipment, at the array turntable, or from the building rebar frames. The dc power cables are protected by either metal conduit, metal conduit ground wire, direct burial, by rigid metal conduit, ground conductors, or by ground conductors at the ends of the conduit run. Costs run from 0.01-0.28\$/W, with all the systems outfitted with bypass and blocking diodes. Direct stroke protection is viewed as less important than isokeraunic data. M.S.K.

A82-45044
LOSSES IN CU₂S-CDS SPRAYED SOLAR CELLS

M. SAVELLI, H. LUQUET, J. BOUGNOT, M. PEROTIN, C. GRIL, and J. MARUCCHI (Montpellier II, Universite, Montpellier, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 767-771. Research sponsored by the Commissariat a l'Energie Solaire and European Economic Community. refs

In the first part of this paper, attention is given to the recent evolution in the photovoltaic performances of Cu₂S-CdS sprayed

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solar cells (backwall structure). An efficiency of 7.4 percent with a short-circuit current of 23 mA and an open circuit voltage of .450 volt for an area of 1 sq cm under AM1 have been observed.

(Author)

A82-45045 **INVESTIGATION OF THE RELIABILITY OF SPRAYED BACKWALL CU₂S/CDS SOLAR CELLS FOR TERRESTRIAL APPLICATIONS**

E. D. CASTEL and M. J. SOUBEYRAND (Photon Power, Inc., El Paso, TX) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p.772-776. refs

The salient results of recent accelerated life-test studies are presented. No degradation of short-circuit current is observed. The electrical output of the device shows a slight initial decay and levels off at a level which depends upon the temperature at which the test was conducted. The degradation results from an erosion in series resistance and open-circuit voltage. As far as its aging characteristics are concerned, the device is found to be insensitive to light, UV exposure or thermal cycling. The only two significant stress factors are humidity (in the presence of oxygen) and elevated temperatures. All tests were performed on unencapsulated cells.

(Author)

A82-45046 **10% CONVERSION EFFICIENCY IN THIN FILM POLYCRYSTALLINE CADMIUM-ZINC SULFIDE/COPPER SULFIDE SOLAR CELLS**

R. B. HALL, R. W. BIRKMIER, J. E. PHILLIPS, and J. D. MEAKIN (Delaware, University, Newark, DE) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 777-779. Research supported by the U.S. Department of Energy. refs

Thin film cadmium-zinc sulfide/copper sulfide solar cells have been developed with conversion efficiencies greater than 10% in direct sunlight. The development of these cells was based on decreasing the electron affinity mismatch between the Cu₂S and CdS and thereby raising the open-circuit voltage above that achievable with the standard CdS/Cu₂S solar cell. The electron affinity of the CdS was reduced by the incorporation of Zn by the co-evaporation of CdS and ZnS. With improved preparation of Cd(1-x)Zn(x)S (with x between .1 and .2) films, and the same process that produced Cu₂S/CdS cells with efficiencies in excess of 9%, the increased open-circuit voltage has led to efficiencies greater than 10%.

(Author)

A82-45048 **CU₂S/CDS CELL DEGRADATION - LATERAL DIFFUSION EFFECTS**

H. R. ZWICKER, L. A. BRICKMAN, H. C. HADLEY, and K. J. MATYSIK (SES, Inc., Newark, DE) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 787-792. refs

Certain thin-film Cu₂S/CdS cells operated into load under illumination degrade by loss of I(sc), with no loss of V(oc) or FF. These devices suffer loss of average stoichiometry accompanied by grid structure-related variation in local J(sc), which is here associated with lateral ion (copper) migration in a direction towards the grid system. A theoretical model based on balancing field-driven Cu(+) ion motion against a restoring diffusive flow accounts for the major measured features of this form of degradation.

(Author)

A82-45049 **ATOMIC ABSORPTION ANALYSIS AND AUGER DEPTH PROFILES OF HEAT-TREATED POLYCRYSTALLINE CU_X/CDS SOLAR CELLS**

J. V. FLORIO, F. G. RAMOS (SES, Inc., Newark, DE), and K. J. MATYSIK (SES, Inc., Delaware, University, Newark, DE) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 793-799. refs

The degradation of Cu(x)S stoichiometry on thin film Cu(x)S/CdS substrates in oxygen ambients is shown to be due predominately to the growth of a dilute acid-soluble cadmium/oxygen phase rather than a copper oxide phase. The change in stoichiometry is quantitatively related by the following reaction: $x/2 O_2 + Cu_2S + xCdS$ yields $Cu(2-2x)(+)Cu(2x)(2+)S(1+x)XCdO$. The junctions were depth profiled to assess the effect of reducing and oxidizing heat treatments on the junction: a reducing treatment decreased the Cd concentration in the Cu(x)S film whereas an oxidizing treatment increased the Cd concentration in the Cu(x)S, mainly at the vacuum/Cu(x)S interface. The transport of Cd to the surface was accompanied by a redistribution in the diffuse interfacial region between Cu(x)S and CdS.

(Author)

A82-45050 **DEVELOPMENT OF A 9.4% EFFICIENT THIN-FILM CUINSE₂/CDS SOLAR CELL**

R. A. MICKELSEN and W. S. CHEN (Boeing Aerospace Co., Seattle, WA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 800-804.

(Contract XJ-9-8021-1)

The development of a polycrystalline, thin-film solar cell utilizing a heterojunction structure based upon N-type CdS and P-type CuInSe₂ semiconductor materials is described. The cell, prepared entirely by vacuum deposition and sputtering techniques onto inexpensive substrates, has potential applications as a low-cost, mass produced device for photovoltaic power generation systems. A device efficiency of 9.5% with photocurrents in excess of 35 mA/sq cm under simulated AM-1 illumination is reported for a total semiconductor film thickness of approximately 5-microns. Results of cell characterization including I-V and spectral responses are presented. Finally, the effects of cell heat treatment are described which indicate the importance of oxygen in improving the cell response.

(Author)

A82-45051* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SOME TESTS OF FLAT PLATE PHOTOVOLTAIC MODULE CELL TEMPERATURES IN SIMULATED FIELD CONDITIONS

J. S. GRIFFITH, M. S. RATHOD, and J. PASLASKI (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA; New York, State University, Binghamton, NY) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 822-830. Research sponsored by the U.S. Department of Energy and NASA. refs

The nominal operating cell temperature (NOCT) of solar photovoltaic (PV) modules is an important characteristic. Typically, the power output of a PV module decreases 0.5% per deg C rise in cell temperature. Several tests were run with artificial sun and wind to study the parametric dependencies of cell temperature on wind speed and direction and ambient temperature. It was found that the cell temperature is extremely sensitive to wind speed, moderately so to wind direction and rather insensitive to ambient temperature. Several suggestions are made to obtain data more typical of field conditions.

(Author)

A82-45052

EFFECTS OF CELL SORTING AND MODULE MATCHING ON ARRAY OUTPUT

T. J. LAMBARSKI, D. L. KADLEC (BDM Corp., Albuquerque, NM), and C. B. ROGERS (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 841-844.

As a result of differences between the individual cells of a photovoltaic (PV) array with respect to the obtainable short circuit current, the power output provided by such an array is reduced in comparison to the output obtained in the ideal case of cells with uniform characteristics. The sorting of cells into bins according to the value of the cell short circuit current and the use of cells from only one bin within a given module can improve the power output of the modules. However, module matching within a series string may be required to preserve this improvement. The present investigation is concerned with an assessment of the effectiveness of this sorting and matching technique. Attention is given to the best possible output obtainable in the case of cells with identical characteristics, and the improvements achieved for assemblies of cells with nonuniform properties by means of bin sorting. G.R.

A82-45053

SIMULATION AND SIMPLIFIED DESIGN OF PHOTOVOLTAIC POWER SYSTEMS

D. L. EVANS, W. A. FACINELLI, and L. P. KOEHLER (Arizona State University, Tempe, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 845-850. U.S. Department of Energy refs (Contract DOE-13-0313)

Results of TRNSYS simulations of photovoltaic systems with and without battery storage are described. The systems have south facing, flat arrays that are max-power tracked and have one day or less of storage. Studies of the sensitivity of system performance, in terms of the fraction of the electrical load supplied by the solar energy system, to variables such as array size, battery size, location, time of year, and load shape are reported. A simplified method for calculating system performance is described and examples of its accuracy are presented. (Author)

A82-45054

PARAMETRIC ANALYSIS OF STAND-ALONE RESIDENTIAL PHOTOVOLTAIC SYSTEMS AND THE SOLSTOR SIMULATION MODEL

D. L. CASKEY, E. A. ARONSON, and K. D. MURPHY (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 851-854. Research supported by the U.S. Department of Energy. refs

Grid-connected residential photovoltaic (PV) systems have been studied in great detail during the past few years. However, stand-alone systems have received considerably less attention. This paper describes the results of an evaluation of the economic feasibility of stand-alone systems. The SOLSTOR simulation program, developed by Sandia, was the primary analysis tool. The results indicate that stand-alone PV systems offer considerable economic advantage over the fossil-fueled generator systems. This is true even with no escalation of fuel prices, with PV array costs of twice the 1986 DOE goal, with present day battery costs, and in the Northeast as well as in the Southwest part of the United States. The on-site generator was generally used less than 1400 hours per year, and in fact can be eliminated in many cases in the Southwest. (Author)

A82-45055* Cleveland State Univ., Ohio.

A THEORY OF THE N-I-P SILICON SOLAR CELL

C. GORADIA (Cleveland State University, Cleveland, OH), I. WEINBERG, and C. BARAONA (NASA, Lewis Research Center, Cleveland, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 855-860. refs (Contract NAG3-144)

A computer model has been developed, based on an analytical theory of the high base resistivity BSF $n(+)(\pi)p(+)$ or $p(+)(\nu)n(+)$ silicon solar cell. The model makes very few assumptions and accounts for nonuniform optical generation, generation and recombination in the junction space charge region, and bandgap narrowing in the heavily doped regions. The paper presents calculated results based on this model and compares them to available experimental data. Also discussed is radiation damage in high base resistivity $n(+)(\pi)p(+)$ space solar cells. (Author)

A82-45056

EFFECT OF HIGH LEVEL CONDITIONS ON THE OPEN CIRCUIT VOLTAGES OF P(+)-N-N(+)/+ AND N(+)-P-P(+)/+ BACK SURFACE FIELD SILICON SOLAR CELLS

S. N. SINGH and G. C. JAIN (National Physical Laboratory of India, New Delhi, India) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 861-866. refs

The effect of high level conditions on the open circuit voltages of front illuminated $P(+)-N-N(+)$ and $N(+)-P-P(+)$ back surface field (BSF) silicon solar cells has been investigated. It has been found out that volume recombination can have a decisive effect on the open circuit voltages of BSF cells. In general, $V_{sub OC}$ of a $P(+)-N-N(+)$ cell is higher than the $V_{sub OC}$ of an $N(+)-P-P(+)$ cell and this difference increases with increase in volume recombination. However, the open circuit voltages of the two cells tend to be equal for a negligible volume recombination. This is perhaps the reason that the best $P(+)-N-N(+)$ and $N(+)-P-P(+)$ BSF cells have exhibited nearly equal open circuit voltages in practice. (Author)

A82-45057

OPTICAL CONFINEMENT IN THIN SI-SOLAR CELLS BY DIFFUSE BACK REFLECTORS

A. GOETZBERGER (Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung, Freiburg im Breisgau, West Germany) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 867-870. refs

Recently it has been realized that high efficiency Si-cells should be very thin and should have minority carrier and optical confinement. It is suggested here that a diffuse back reflector with cosine characteristic which should be simple technologically is a good choice for confinement. Because of the high index of refraction only 8.55 % of the reflected distribution is lost by reradiation. The total absorption efficiency can be obtained by summation of a geometric series. A cell of 15 microns thickness with diffuse reflector should be equal in absorption efficiency to conventional cell of more than 200 microns. (Author)

A82-45059

THEORETICAL LIMIT EFFICIENCY OF TWO JUNCTION TANDEM SILICON-GERMANIUM SOLAR CELLS INTENDED FOR THERMOPHOTOVOLTAIC APPLICATION

E. S. VERA, J. J. LOFERSKI, and M. SPITZER (Brown University, Providence, RI) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 877-882. Research supported by the Amperex Electronic Corp., U.S. Navy, and NSF. refs

The principal conclusion of the reported investigation is that an overall conversion efficiency of 26% is possible for the

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considered two junction silicon/germanium cascade solar cell arrangement consisting of a silicon and germanium cell, less than 50 and 90 microns thick respectively receiving an overall input power density of 25 W/sq cm from a 2000 C blackbody radiation source. It is pointed out that there are basically two approaches to increasing efficiency through multijunction solar cell systems. In the spectrum splitting approach optical devices are used to separate the incident light into two or more spectral components which can be separately directed onto individual solar cells of different energy band gaps. In the tandem cell approach two or more solar cells of different energy band gaps are stacked in series. (Author)

A82-45060

GRATING-TYPE SI SOLAR CELL DESIGN AND ANALYSIS

H. L. HWANG, D. C. LIU, Y. L. YEN (National Tsinghua University, Hsinchu, Republic of China), and J. J. LOFFERSKI (Brown University, Providence, RI) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 883-887. refs

Grating structures are expected to have considerably better spectral response to short wavelengths than in conventional diffused structures. This paper reviews the experimental results and design principles of grating Si cells. Numerical simulations were done to analyze the Si grating cell performance. The deep junction concept is in contrast to the conventional shallow junction cells. The computational results indicate that BSF are essential to be incorporated in the grating structure and the current output of a grating cell can be substantially increased by the incorporation of minority carrier mirrors. (Author)

A82-45061

JUNCTION-FIELD AND COLLECTION EFFICIENCY IN THE CURRENT SATURATION RANGE

K. W. BOER (Delaware University; SES, Inc., Newark, DE) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 888-891. Research supported by the U.S. Department of Energy. refs

It is shown that the collection-efficiency of the emission current from the emitter depends on the junction (-emitter - interface) recombination but not on the junction field. Only if the current from the emitter is limited by field-quenching within the junction can a field-dependence be expected in the current saturation range. Such correlation is observed for CdS/Cu₂S solar cells and judged as evidence for field-quenching. Means to increase the collection efficiency are suggested. (Author)

A82-45063

SPECTRAL RESPONSE AND CAPACITANCE MEASUREMENTS OF A-SI SOLAR CELLS

R. D. PLAETTNER, H. PFLEIDERER, B. RAUSCHER, W. KRUEHLER, and M. MOELLER (Siemens AG, Forschungslaboratorien, Munich, West Germany) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 917-921. Research supported by the Bundesministerium fuer Forschung und Technologie. refs

Hydrogenated, amorphous silicon was used for the implementation of solar cells. With pin/ITO solar cells efficiencies of up to 5.4% (AM1) were realized. To gain better insight into their performance characteristics, spectral response measurements were taken at AM1 background illumination and evaluated using a charge-collection model. The calculations yielded values for the drift length of electrons (0.8 micron) and holes (0.66 micron), for the diode quality factor (approximately 2), the saturation current $I_{sub 0}$ (10 to the -9th A/sq cm), and the built-in voltage $V_{sub 0}$ (0.88 V). Impedance measurements indicated that the space charge depletion width extends almost over the entire cell thickness (approximately 0.5 micron). (Author)

A82-45064

CONVERSION EFFICIENCY OF LARGE AREA A-SI:H SOLAR CELL

Y. UCHIDA, H. SAKAI, M. NISHIURA, and H. HARUKI (Fuji Electric Corporate Research and Development, Ltd., Yokosuka, Kanagawa, Japan) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 922-927. Research supported by the Agency of Industrial Science and Technology. refs

In hydrogenated amorphous silicon (a-Si:H) solar cells with an ITO/nip/SS structure, conversion efficiencies of 6.47%, 5.2% and 4.2% have been obtained for the cells with 1.2 sq cm, 49 sq cm, and 100 sq cm areas under AM1 illumination, respectively. The n-i-p a-Si:H layers have been prepared in a capacitive rf glow discharge apparatus. The decrease of the conversion efficiency with increasing cell area relates to decrease in the short circuit current $J_{sub SC}$ and the fill factor FF. It is found that $J_{sub SC}$ is lowered by the areal inhomogeneity of the a-Si:H layers and FF is lowered mainly by series resistance which comes from the ITO film and the grid electrodes. (Author)

A82-45065

RIBBON GROWTH-CELL PROCESSING - SYNERGISTIC EFFECTS

K. V. RAVI, R. C. GONSIORAWSKI, A. R. CHAUDHURI, C. V. H. RAO, C. T. HO, J. I. HANOKA, and B. R. BATHEY (Mobil Tyco Solar Energy Corp., Waltham, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 928-933. refs

The influence of ribbon growth conditions and solar cell processing variables on the conversion efficiency of EFG silicon ribbon solar cells have been examined. The key variable in crystal growth is the type of crucible employed for containing the molten silicon. It is observed that the use of quartz crucibles results in the highest solar cell efficiencies, whereas graphite crucibles result in reduced efficiencies. Processing conditions such as the diffusion temperature and diffusion source also have an important effect. Greater than 14% AM1 efficiencies in large area (approximately 50 sq cm) ribbon solar cells have been achieved. (Author)

A82-45066* Honeywell Corporate Research Center, Bloomington, Minn.

LARGE-AREA SILICON-ON-CERAMIC SUBSTRATES FOR LOW-COST SOLAR CELLS

S. B. SCHULDT, J. D. HEAPS, F. M. SCHMIT, J. D. ZOOK, and B. L. GRUNG (Honeywell Corporate Technology Center, Bloomington, MN) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 934-940. NASA-sponsored research refs (Contract XS-0-9100-2)

The SCIM (Silicon-Coating-By-Inverted Meniscus) process to produce SOC (silicon-on-ceramic) substrates has been investigated for various growth conditions and substrate velocities (4-30 cm/min). Slotted mullite-based substrates (10-cm-wide by 100-cm-long) have been coated with smooth, continuous silicon layers, with thicknesses in the range from 100 to 300 microns. Thermal stress (which can be a problem at low velocities) is prevented by proper thermal design. The highest SCIM-coated SOC cell efficiencies to date are 7.5% (AM1, AR) as compared to 10.5% (AM1, AR) for dip-coated SOC cells. Substantial improvements in cell efficiency are expected when high purity parts are installed in the SCIM-coater. (Author)

A82-45067

RECENT ADVANCES IN SILICON SHEET GROWTH BY THE RIBBON-TO-RIBBON /RTR/ PROCESS

K. R. SARMA, R. W. GURLER, R. N. LEGGE, R. J. ELLIS, and I. A. LESK (Motorola, Inc., Semiconductor Group, Phoenix, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 941-948. refs (Contract XS-9-8277-1; XS-0-9100-1)

Significant advances are reported in Ribbon-to-Ribbon (RTR) technology using scanned CO₂ laser beams for producing thin sheets of silicon for low-cost solar cells. Through control of the growth ambient and melt-solid interface shape, ribbons with high purity and very large grain size were obtained. Also, temperature profiles were developed for producing ribbons with no buckling and with low residual stresses. These improvements have led to production of 1 cm x 2 cm solar cells with AM1 conversion efficiencies approaching 13%, with the average being around 11.5%. Electron beams are also being investigated as a possible heat source in the RTR process. (Author)

A82-45068

THE EFFECTS OF METALLURGICAL GRADE SILICON ADDITIONS ON THE ELECTRICAL AND STRUCTURAL CHARACTERISTICS OF POLYSILICON SOLAR CELLS

S. M. JOHNSON, G. M. STORTI (Solarex Corp., Rockville, MD), R. W. ARMSTRONG, R. G. ROSEMEIER, M. E. TAYLOR (Maryland University, College Park, MD), and W. F. REGNAULT (Semix Inc., Gaithersburg, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 949-953. refs (Contract XS-9-8272-1)

The effects of MG silicon additions on the electrical and structural characteristics of polysilicon material were investigated by casting polysilicon ingots, using a mixture of high purity SG silicon with up to ten percent MG silicon, and fabricating solar cells using this material. As the percentage of MG silicon increases, solar cell efficiencies were degraded by low short-circuit current, due primarily to a reduction in the intragrain diffusion length and secondarily to grain boundary recombination, and reduced open-circuit voltages and fill factors due to a domination of the dark I-V characteristics by space-charge recombination. X-ray topographs are presented which show that the increase in MG silicon incorporated into the ingots is accompanied by a degradation in the crystal microstructure, which is known to decrease cell efficiencies. (Author)

A82-45069* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

CHARACTERIZATION OF HEM SILICON FOR SOLAR CELLS

K. A. DUMAS (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), C. P. KHATTAK, and F. SCHMID (Crystal Systems, Inc., Salem, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 954-958. Research sponsored by the U.S. Department of Energy and NASA.

The Heat Exchanger Method (HEM) is a promising low-cost ingot casting process for material used for solar cells. This is the only method that is capable of casting single crystal ingots with a square cross section using a directional solidification technique. This paper describes the chemical, mechanical and electrical properties of the HEM silicon material as a function of position within the ingot. (Author)

A82-45070

COMBINATION PHOTOVOLTAIC/THERMAL SOLAR COLLECTORS FOR RESIDENTIAL APPLICATIONS

P. R. YOUNGER, W. S. KREISMAN, M. J. NOWLAN, S. J. SOLOMON (Spire Corp., Bedford, MA), and S. J. STRONG (Solar Design Associates, Lincoln, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 959-963. Research supported by the Massachusetts Institute of Technology. refs

The design, development and fabrication of combination photovoltaic/thermal (PV/T) solar collectors for residential applications is reported. Liquid and air cooled, flat-plate collectors were designed in which close packed silicon solar cells absorbed the bulk of the solar radiation to provide both thermal and electrical energy. Air cooled collector cells had front and back open grid metallization to allow infrared radiation to pass through to a separate highly absorbing surface. Liquid cooled collector cells had solid back metallization optimized for infrared absorption. Details of the optical, electrical, thermal and mechanical characteristics of these collectors are presented. (Author)

A82-45072* Spire Corp., Bedford, Mass.

DESIGN, FABRICATION AND PERFORMANCE OF HIGH EFFICIENCY PHOTOVOLTAIC MODULES

M. J. NOWLAN, W. S. KREISMAN, and P. R. YOUNGER (Spire Corp., Bedford, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 972-975. Research sponsored by the U.S. Department of Energy and NASA.

Design details and performance and environmental test results of newly developed high performance and reliability photovoltaic modules are presented. Efficiencies averaging 14.3% for 3040 cells were obtained by using ion implantation for cell junction and back surface field formation. 152 rectangular (6.0 cm x 4.6 cm) cells arranged with a 97% local packing density comprise the circuit assembly, and cells are wired 4 in parallel by 38 in series. The top cover of the superstrate design module is composed of tempered low-iron glass to provide transparent protection for the optical surface. Results show that this design has an encapsulation system which does not fail in the event of reverse-bias operation, and an average module efficiency of 12.2% was achieved at a 58.6W power which varied only 2% among all 20 modules.

R.K.R.

A82-45074

CHARACTERISTICS OF PHOTOVOLTAIC DEVICES MANUFACTURED BY UNANALYZED, LOW ENERGY, HIGH CURRENT ION IMPLANTATION PROCESS

M. D. SIRKIS (Arizona State University, Tempe, AZ) and D. L. SALTZMAN (Motorola, Inc., Semiconductor Group, Phoenix, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 981-984. refs

A silicon solar cell has been produced using a large area unanalyzed high-current ion beam to form junctions by implantation. Mass analysis elimination leads to greatly simplified implantation equipment, and experiments were carried out to investigate the feasibility of using an unanalyzed beam. Ion beam components were implanted into wafers in proportion to their relative spectra intensities, and results supported feasibility, but trace impurities must be considered. To increase beam current, the large cross-section beam is used. Implanting is performed, and the result after metallization is a cell with a fill factor of 0.77 and an efficiency of 14%. R.K.R.

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A82-45075* Motorola, Inc., Phoenix, Ariz.

A USERS EVALUATION OF SAMIS

L. A. GRENON and M. G. COLEMAN (Motorola, Inc., Semiconductor Group, Phoenix, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 985-989. NASA-supported research.

SAMIS, the Solar Array Manufacturing Industry Simulation computer program was developed by Jet Propulsion Laboratories (JPL) to provide a method whereby manufacturers or potential manufacturers of photovoltaics could simulate a solar industry using their own particular approach. This paper analyzes the usefulness of SAMIS to a growing photovoltaic industry and clearly illustrates its limitations as viewed by an industrial user. (Author)

A82-45076

COMBINED PHOTOVOLTAIC/THERMAL COLLECTOR PANELS OF IMPROVED DESIGN

T. RUSSELL, J. BEALL, J. J. LOFFERSKI, B. ROESSLER, R. DOBBINS, J. SHEWCHUN, J. KRIKORIAN, C. CASE, G. DOODLESACK, and W. OATES (Brown University, Providence, RI) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 990-996. (Contract DE-AC03-79CS-30205)

The paper describes the design and performance of 'second generation' combined photovoltaic/thermal collectors utilizing air as the heat transfer fluid intended for use in residential systems. The absorptance of the solar cells used in these PV/T panels was improved by blackening the ohmic contacts and using textured cells covered with AR-coatings. Heat transfer from the cells to the air stream was improved by bonding metal fins to the rear surface of the cells or by narrowing the air flow channel to about 0.25 in. Computer modeling of the improved design indicates that η vs ΔT curves are substantially improved over first generation PV/T panel performance curves. A panel of this type was constructed and the results of its performance tests compare favorably to the analytical predictions. (Author)

A82-45077

BY-PASS DIODE DESIGN, APPLICATION AND RELIABILITY STUDIES FOR SOLAR CELL ARRAYS

M. GIULIANO, D. STARLEY, D. WARFIELD, and T. SCHUYLER (Solarex Corp., Rockville, MD) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 997-1000.

A planar-diffused structure is described for use as an unencapsulated by-pass or shunt diode in solar cell arrays. Design features result in reliable performance, low fabrication cost and ease of handling during assembly. Special consideration is given to heat dissipation related to the manner in which the diodes are mounted in the array. Operating life-test curves are presented which indicate excellent stability for continuous current levels as high as 8 amperes at a panel temperature of 60 C. Forward voltage drop for these diodes is less than 800 mV at 2.5 amperes and the reverse current is in the order of microamperes at 7 volts. (Author)

A82-45078

PULSED ELECTRON BEAM APPLIED TO SILICON SOLAR CELLS

J. MICHEL (Laboratoire d'Electronique et de Physique Appliquee, Limeil-Brevannes, Val-de-Marne, France), D. BARBIER, and A. LAUGIER (Lyon, Institut National des Sciences Appliquees, Villeurbanne, Rhone, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1007-1010.

Silicon solar cells have been made with the junction formed by phosphorous implantation followed by a short pulse of low energy electrons. The thermal effects associated to the pulse are described. The effect of beam fluence on cell characteristics has

been studied. It is found that the junction is as good as those made by classical diffusion. This leads to overall conversion efficiencies up to 12 percent which are higher than those of laser annealed cells and close to those of diffused solar cells.

(Author)

A82-45080

ADVANCES IN THE SERI/DOE PROGRAM ON CDS/CU₂S AND CDS/CU-TERNARY PHOTOVOLTAIC CELLS

J. LEONG and S. DEB (Solar Energy Research Institute, Golden, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1016-1020. Research supported by the U.S. Department of Energy. refs

The most significant achievement under the SERI CdS/Cu₂S and Cu-Ternary program is the development of two new high efficiency thin film cells, a frontwall Cu₂S/(Cd,Zn)S cell by the Institute of Energy Conversion, University of Delaware, and a backwall CdS/CuInSe₂ cell by the Boeing Aerospace Company. The reported AM1 efficiencies for these two devices are 10.2% and 9.5%, respectively. A 5.7% Cu₂S/CdS cell with Cu₂S sputter deposited by the Telic Corporation was also fabricated within the last year. A program to study the problem of instability in the Cu₂S/CdS cell has been initiated at Battelle-Columbus Laboratories. (Author)

A82-45081

LASER SCANNING OF UNGRIDDED SOLAR CELL MATERIAL

P. G. LASSWELL and B. C. PLUNKETT (Delaware, University, Newark, DE) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1021-1024. Research supported by the U.S. Department of Energy. refs

The use and utility of a laser scanner for the examination of finished solar cells has been described by a number of authors (1,2). In this paper a technique using laser scanning under reverse bias is described, and its utility in detecting defects in ungridded Cu(x)S/CdS solar cell material is demonstrated. Examination of ungridded cells has been used to detect localized shorting and inactive areas as part of a cell development program. (Author)

A82-45086* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

EPITAXIAL THIN FILM GAAS SOLAR CELLS USING OM-CVD TECHNIQUES

R. J. STIRN, K. L. WANG, and Y. C. M. YEH (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1045-1050. Research sponsored by the U.S. Department of Energy and U.S. Air Force refs

(Contract NAS7-100)

A new approach has been initiated at JPL to fabricate thin-film, high efficiency GaAs solar cells on low-cost, single-crystal Si substrates having a thin CVD interlayer of Ge to minimize the lattice and thermal expansion mismatch. For initial experiments, n(+)/p GaAs cells were grown by OM-CVD on single-crystal GaAs and Ge wafers. Details of the growths and performance results will be presented. Subsequently, a combined epitaxial structure of OM-CVD GaAs on a strongly adherent Ge interlayer on (100) Si was grown. This is the first report of the successful growth of this composite structure. Low module costs projected by JPL SAMICS methodology calculations and the potential for 400-600W/kg space solar arrays will be discussed. (Author)

A82-45087

GAAS SHALLOW-HOMOJUNCTION SOLAR CELLS ON EPITAXIAL GE GROWN ON SI SUBSTRATES

R. P. GALE, B.-Y. TSAUR, J. C. C. FAN, F. M. DAVIS, and G. W. TURNER (MIT, Lexington, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1051-1055. Research sponsored by the Solar Energy Research Institute and U.S. Air Force. refs (AD-A107056; ESD-TR-81-266)

Solar cells with conversion efficiencies of 12% (AM1) have been fabricated from single-crystal GaAs epilayers grown by CVD on Ge-coated Si substrates. The cells utilize an n(+)/p/p(+) shallow-homojunction GaAs structure on a thin (less than 0.2 micron) epitaxial Ge layer. The Ge layer provides a surface on which CVD GaAs can readily nucleate, and the GaAs/Ge interface acts as a barrier to propagation of dislocations from the Ge. Solar cells made in this material exhibit short-circuit current densities over 24 mA/sq cm. These solar cells are the first reported GaAs devices fabricated on Si substrates. (Author)

A82-45088

THIN FILM HETEROJUNCTION SOLAR CELLS BASED ON N-CDS AND P-CU TERNARY ALLOYS OF THE TYPE CUINYGA/1-Y/SE2ZTE2/1-Z/

J. J. LOFERSKI, M. KWIETNIAK, J. PIEKOSZEWSKI, M. SPITZER, R. ARYA, B. ROESSLER, R. BEAULIEU, E. VERA, J. SHEWCHUN (Brown University, Providence, RI), and L. L. KAZMERSKI (Solar Energy Research Institute, Golden, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1056-1061. refs (Contract XI-8012-1)

A82-45089

FABRICATION OF CDTE SOLAR CELLS BY HOT WALL VACUUM EVAPORATION

W. HUBER, A. LOPEZ-OTERO (Linz, Universitaet, Linz, Austria), C. FORTMANN, A. L. FAHRENBRUCH, and R. H. BUBE (Stanford University, Stanford, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1062-1067. refs

Layers of n-CdTe that had been doped with In during deposition were grown on monocrystalline BaF₂ and on bulk crystal CdTe substrates using the Hot Wall Vacuum Evaporation method. Mobilities of up to 590 sq cm/Vsec and carrier concentrations of up to 10 to the 17th/cu cm were measured at room temperature. Diode reverse saturation currents from 10 to the -10th to 10 to the -9th A/sq cm, a hole diffusion length of 1.2 microns, and an open-circuit voltage of 0.62 were measured under simulated AM1.5 sunlight for unoptimized n/p-homojunctions, n-CdTe:In films on large grain (1-2 mm) crystalline p-CdTe:P. In addition, a model was developed for the spectral dependence of the quantum efficiency. N.B.

A82-45090

SPRAY PYROLYSIS PREPARED CDTE SOLAR CELLS

H. B. SERREZE, S. LIS, M. R. SQUILLANTE, R. TURCOTTE, M. TALBOT, and G. ENTINE (Radiation Monitoring Devices, Inc., Watertown, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1068-1072.

(Contract XS-9-8104-3)

Achievement of all thin-film, CdTe-based heterojunction solar cells has been successfully demonstrated using a potentially very low cost chemical spray process. Open-circuit voltages over 600 mV and conversion efficiency up to 4% have been obtained. The active semiconductor layers are extremely thin, and preliminary investigations of wider bandgap windows, alternative acceptor dopants for the CdTe, and cell stability have shown very encouraging results. C.D.

A82-45091

CHARACTERIZATION OF THE CDSE THIN FILM SOLAR CELL

E. RICKUS and D. BONNET (Battelle Institut, Frankfurt-am-Main, West Germany) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1073-1076. Research sponsored by the Commission of the European Communities. refs

The conditions of preparation as well as investigations of the spectral response and the work function of the contact metal on CdSe-MIS-solar cells are reported and discussed. Using simple antireflection coatings cells 2-3 microns thick and 1 sq cm in size show efficiencies of 5 percent. Increasing the cell area poses no fundamental problems. Individual values of I_{sc}, U_{oc} and fill factor indicate potential efficiencies of around 10 percent. Technological steps towards this goal are proposed. (Author)

A82-45093* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

FIELD FAILURE MECHANISMS FOR PHOTOVOLTAIC MODULES

L. N. DUMAS and A. SHUMKA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1091-1098. Research sponsored by the U.S. Department of Energy and NASA. refs

Beginning in 1976, Department of Energy field centers have installed and monitored a number of field tests and application experiments using current state-of-the-art photovoltaic modules. On-site observations of module physical and electrical degradation, together with in-depth laboratory analysis of failed modules, permits an overall assessment of the nature and causes of early field failures. Data on failure rates are presented, and key failure mechanisms are analyzed with respect to origin, effect, and prospects for correction. It is concluded that all failure modes identified to date are avoidable or controllable through sound design and production practices. (Author)

A82-45094* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOVOLTAIC MODULE HOT SPOT DURABILITY DESIGN AND TEST METHODS

J. C. ARNETT and C. C. GONZALEZ (California Institute of Technology, Jet Propulsion Laboratory, Energy Technology Engineering Section, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1099-1105.

As part of the Jet Propulsion Laboratory's Low-Cost Solar Array Project, the susceptibility of fat-plate modules to hot-spot problems is investigated. Hot-spot problems arise in modules when the cells become back-biased and operate in the negative-voltage quadrant, as a result of short-circuit current mismatch, cell cracking or shadowing. The details of a qualification test for determining the capability of modules of surviving field hot-spot problems and typical results of this test are presented. In addition, recommended circuit-design techniques for improving the module and array reliability with respect to hot-spot problems are presented. N.B.

A82-45095

EFFECTS OF SHADING AND DEFECTS IN SOLAR CELL ARRAYS - A SIMPLE APPROACH

A. GUPTA and A. G. MILNES (Carnegie-Mellon University, Pittsburgh, PA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1111-1116. refs

Tradeoffs involved in solar cell array arrangements are discussed with the aid of examples and simple numerical calculations. The effect of various shading conditions on different arrays is studied, along with the arrays' tolerance of the effects of open or short-circuit cells. The effects of cell failure and the benefits

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of providing interconnections between series strings in a module spanned by a bypass diode are considered. It is found that bypass diodes are desirable both for reasons of shading and the possible presence of defects. Power losses caused by partial shading depend on the orientation of the shading relative to the line of the bypass diodes. Open circuit defects or spot shading cause loss of the current in the string, while numerous branch circuits reduces the voltage loss caused by short-circuit cells. Interconnections within a module are not likely to be beneficial in arrays where there may be a large number of bypass diodes.

C.D.

A82-45096

SOLAR CELLS FAILURE MODES UNDER REVERSE VOLTAGES AND RELIABILITY

A. M. RICAUD, F. FORGE, and P. E. SARRE (France-Photon, Angouleme, Charente, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1117-1121. European Economic Community (Contract EEC-718-78-12-ESF)

Improved reverse power dissipation capabilities in photovoltaic installations are presented. The primary technique involves connecting a bypass diode in parallel to short-circuit the string, once the voltage becomes negative. With a predetermined reverse voltage of 20 V at 60 C, a 36 cell module can be protected by one diode. It is shown that the effects of direct power loss are negligible when compared with advantages in reverse operations. A coupling optimization system was tested for efficiency in using the proposed protective devices, and the 6300 W, 220 V system can offer a limited power loss, a possible decoupling per branch allowing continual function of the system, and a reduction of the number of bypass diodes. Further investigation of the decoupling optimization may lead to more reliable photovoltaic systems.

R.K.R.

A82-45097* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE APPLICATION OF FRACTURE MECHANICS TO FAILURE ANALYSIS OF PHOTOVOLTAIC SOLAR MODULES

C. P. CHEN and M. H. LEIPOLD (California Institute of Technology, Jet Propulsion Laboratory, Applied Mechanics Technology Section, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1122-1125. Research sponsored by the U.S. Department of Energy and NASA. refs

Cracking of silicon solar cells and solar module transparent cover panels such as glass or polymethylmethacrylate (PMMA) is a major cause of photovoltaic solar module failure in field service. Silicon and cover materials are brittle, and cracking of these materials is expected to result from the extension of preexisting flaws under stress. Study of the cracking mechanisms is therefore an appropriate area for the application of fracture mechanics principles. In this study, fracture mechanics techniques were employed to identify the mode of crack propagation, to examine the fracture-initiating flaw, to estimate the nature and magnitude of fracture stress in the field, and to predict analytically the service lifetime. Recommendations for corrective actions are also made.

(Author)

A82-45098* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE SOLAR CELL LASER SCANNER

E. L. MILLER, S.-S. CHERN, and A. SHUMKA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1126-1133. Research sponsored by the U.S. Department of Energy and NASA.

As part of the Low Cost Solar Array Program at Jet Propulsion Laboratory, failure analyses have been performed on over 300 photovoltaic modules from thirty different manufacturers and five

countries. Because of the volume of work and the variety of module types encountered, it has been necessary to develop non-destructive techniques to rapidly locate the failure sites. This paper will present design details and results obtained with one instrument developed specifically for this purpose, the Solar Cell Laser Scanner (SCLS). The effects of applying a bias current to the modules will also be discussed, based upon experimental observations and computer generated predictions. (Author)

A82-45099

DETECTION OF A DEFECTIVE CELL IN A SOLAR MODULE THROUGH PHOTORESPONSE MODULATION

J. MAIRE, B. THEYS, and P. BARUCH (Paris VII, Universite, Paris, France) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1134-1138. Research supported by the Commissariat a l'Energie Solaire. refs

A method to detect a solar cell with an abnormally low short-circuit current is developed in which a small, modulated, probing light beam superimposed to the main solar illumination is directed on a single cell and the output ac signal is measured at the module terminals. A high impedance will result from a cell that is reverse biased, and the cell's photocurrent will not be shunted by the cell impedance and will flow through the other cells, yielding a modulated signal which can be detected at the module terminals which are connected to an adequately chosen load resistance. Since a normal cell would yield a much lower signal, the magnitude of this signal can then be used as an indicator for reverse biased cells, because of the low photocurrent. An advantage of this method is that it does not require physical access to the cells.

N.B.

A82-45100* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOVOLTAIC SYSTEMS OVERVIEW

J. L. HESSE (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1139-1145.

Selected photovoltaic systems currently under user-environment field test by the U.S. Department of Energy Photovoltaics Program are discussed, and operational results are summarized. There are many systems in the stand-alone sector that are cost effective now. As proven products become available, distributed residential, commercial, institutional and industrial on-site systems should be able to displace significant amounts of centrally-generated electricity throughout most of the United States. Finally, utilities should ultimately be able to augment their generating capacity with larger-scale systems. Field experience and industry interface has led to excellent overall product performance. (Author)

A82-45101

PHOTOVOLTAIC SYSTEMS RELIABILITY ANALYSIS

L. H. STEMBER (Battelle Columbus Laboratories, Columbus, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1153-1156. Research supported by the U.S. Department of Energy. refs

A study is discussed whose aim is to develop alternative system analysis models which incorporate design, maintenance, cost, and reliability information, and predict both annual maintenance cost and energy production over the life of a photovoltaic power system. For several models, methods of calculating system availability are described, including block diagrams and fault trees, state variables and Markov chains, and simulation. Relationships between the availability and lifecycle energy cost models are graphically shown, and diagrams illustrate the methods. C.D.

A82-45102* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOVOLTAIC MODULE AND ARRAY RELIABILITY

R. G. ROSS, JR. (California Institute of Technology, Jet Propulsion Laboratory, Energy Technology Engineering Section, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1157-1163. Research supported by the U.S. Department of Energy and NASA. refs

Several statistical reliability studies have been conducted in areas of photovoltaic component design covering cell failure, interconnect fatigue, glass breakage and electrical insulation breakdown. This paper integrates the results from these various studies and draws general conclusions relative to optimal reliability features for future modules. The described analysis is based on designing for specified low levels of component failures and then controlling the degrading effects of the failures through the use of fault tolerant circuitry and module replacement. Means of selecting the cost-optimal level of component failures, circuit redundancy, and module replacement are described. (Author)

A82-45103

OPTICAL ABSORPTION MEASUREMENTS OF PURE AND HEAVILY DOPED SILICON FROM 1.24 TO 4.63 EV AND THE EFFECT ON SOLAR CELL PERFORMANCE

G. E. JELLISON, JR., F. A. MODINE, C. W. WHITE, and R. T. YOUNG (Oak Ridge National Laboratory, Oak Ridge, TN) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1164-1169. refs (Contract W-7405-ENG-26)

A82-45106

GRAIN BOUNDARIES IN SILICON AS ANALOGS OF SURFACES

D. REDFIELD (RCA Laboratories, Princeton, NJ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1179-1182. Research supported by RCA Corp. refs (Contract DE-AC01-79ET-23108)

The electrical behavior of grain boundaries in silicon is investigated. Results of studies using several polycrystalline Si materials show that the potential barriers at grain boundaries are nearly negligible before annealing but grow markedly at 900-1000 C. In addition, it is found that the crystalline orientations have little to do with the existence of barriers, the chemical condition of the boundaries dominates their electronic behavior, the boundaries are quite free of impurities before heating, and annealing creates barriers by causing dissolved oxygen to segregate at boundaries. It is concluded that the electronic properties of these boundaries are very much like those of surfaces. N.B

A82-45108

A NEW TECHNIQUE FOR PREDICTING SILICON SOLAR CELL SHORT-CIRCUIT CURRENTS AT REFERENCE IRRADIANCE CONDITIONS

D. R. LORENTZ and C. E. BACKUS (Arizona State University, Tempe, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1189-1194. U.S. Department of Energy refs (Contract DOE-40-1356)

A combined analytical/experimental technique for the prediction of silicon solar cell short circuit currents at any reference irradiance condition has been developed. Concurrent short-circuit current and spectral irradiance measurements are used to compute an approximate spectral response which can then be integrated with any desired reference spectral irradiance to predict the short-circuit current at the reference condition. Theoretical results show that absolute errors of less than + or - 1.5% are present when testing within the guidelines for the calibration of Type I primary reference

cells presented in NASA TM 73702. Experimental results indicate that the use of standard glass cutoff filters OG1, RG2, and RG8 can be used for simple pyrheliometric measurements that allow calculation of sufficiently accurate irradiance functions so that the reference current prediction is repeatable within the accuracy of the pyrheliometer. (Author)

A82-45111

ELECTRICAL ADMITTANCE SPECTROSCOPY OF PHOTOELECTROCHEMICAL DEVICES

P. SMITH, T. MRAZ, L. THOMPSON, and K. RAJESHWAR (Colorado State University, Fort Collins, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1202-1207. Research supported by the Solar Energy Research Institute. refs

The use of steady state admittance spectroscopy to determine critical properties of the semiconductor-electrolyte interface is described. The analogy between MIS/SIS solid state diodes is used to develop a model of the interface impedance which includes the space charge capacitance, faradaic conductance, bulk conductance, and interfacial state relaxation times. Experimental measurements relating this technique to observed data are obtained using an automatic network analyzer. Data were obtained over a frequency range of 5hz-1mhz and range of applied voltages. The system is used to study room temperature molten salt AlCl₃:BPC electrolyte-semiconductor interfaces. Frequency independent values of the various admittance parameters are obtained. These include the Faradaic conductance and space charge capacitance. The technique features sequential identification of various elements without changing the estimated component values as model complexity is increased. (Author)

A82-45112

THE DELPHOS PROJECT

V. ALBERGAMO (Comitato Nazionale per l'Energia Nucleare, Rome, Italy) and P. BULLO (Ente Nazionale per l'Energia Elettrica, Milan, Italy) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1208-1213.

A new flat-plate photovoltaic system named Delphos (Demonstration Electric-Photovoltaic System) is being developed for use in Italian remote villages and islands. The system has a peak power of 1.12 MW, a silicon cell area of 9,770 sq m, and a nominal operating field voltage of 1,000 V. The field arrangement developed for the project consists of panels adjacently arranged on a single plane and supported by a raised structure allowing access from below. As a result, systematic shadowing is avoided, wiring problems are simplified, and annual energy collection is increased (highest at a tilt angle of approximately 35). Delphos will be able to function both in the stand alone mode and in connection with the national utility grid. Finally, the control and data acquisition system is composed of four subsystems: automatic plant management and protection, manual plant management, plant state visualization and alarms, and operation data acquisition.s,

A82-45113

RESIDENTIAL PV SYSTEMS FOR THE HOPI INDIAN TRIBE

S. REYES, JR. (U.S. Public Health Service, Indian Health Service, Albuquerque, NM), F. W. SARLES, and A. R. MILLNER (TriSolar Corp., Bedford, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1214-1218.

02 SOLAR ENERGY

A82-45114* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

A COMPREHENSIVE ANALYSIS OF THE PERFORMANCE CHARACTERISTICS OF THE MOUNT LAGUNA SOLAR PHOTOVOLTAIC INSTALLATION

A. SHUMKA and S. G. SOLLOCK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1237-1244. Research sponsored by the U.S. Department of Energy and NASA.

This paper represents the first comprehensive survey of the Mount Laguna Photovoltaic Installation. The novel techniques used for performing the field tests have been effective in locating and characterizing defective modules. A comparative analysis on the two types of modules used in the array indicates that they have significantly different failure rates, different distributions in degradational space and very different failure modes. A life cycle model is presented to explain a multimodal distribution observed for one module type. A statistical model is constructed and it is shown to be in good agreement with the field data. (Author)

A82-45115 OPERATING CHARACTERISTICS OF PHOTOVOLTAIC POWER SYSTEM

Y. TAKEDA, K. TAKIGAWA, and H. KAMINOSONO (Central Research Institute for Electric Power Industry, Komae, Tokyo, Japan) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1245-1250. refs

An experimental 3 kW photovoltaic power system has been constructed and tested in order to determine the optimum system which can be connected to the present electric power network. The experimental system has a solar cell array officially rated at 3.1 kWp (100 mw/sq cm, 25 C) with an optimum operation voltage of 300 V, a separately-excited inverter with a directed current in three phases of 200 V, and a conversion efficiency rated at 91%. Optimum track control at maximum power is necessary to obtain maximum output due to the diode characteristics of the solar cell. Results of a continuous experimental test of this system from April 1980 to February 1981 show that this system can operate without a negative influence on the electric power network, and the average value of output energy was found to be approximately 7.5 kWh/day. In addition, since the levels of insolation during the time of the test period were exceptionally low, higher output energies can be expected in other years. N.B.

A82-45116 THIN-FILM POLYCRYSTALLINE SILICON SOLAR CELLS - PROGRESS AND PROBLEMS

T. SUREK, A. P. ARIOTEDJO, G. C. CHEEK, R. W. HARDY, J. B. MILSTEIN, and Y. S. TSUO (Solar Energy Research Institute, Golden, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1251-1260. refs

Thin-film polycrystalline silicon solar cells offer a potential low-cost alternative to single crystal silicon. This paper reviews the progress in polycrystalline silicon solar cell research in areas of thin-film material and cell development, and in the basic understanding of the effects of grain boundaries and the passivation of these effects. Current concerns in this area include the scalability of the more promising approaches, the reliability and stability of the cells and modules, and an assessment of the low-cost potential of the technologies. Recent progress in addressing these important problem areas is described. (Author)

A82-45117 ZINC PHOSPHIDE THIN FILM SOLAR CELLS

M. BHUSHAN and A. CATALANO (Delaware, University, Newark, DE) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1261-1264. Research supported by the U.S. Department of Energy. refs

Results and analysis of large area (1 sq cm) Schottky devices on thin polycrystalline films of p-type zinc phosphide, Zn₃P₂, are reported. The films were grown on metallized mica and silicon steel substrates. Measured values of short-circuit current, when corrected for estimated 30% optical losses, range from 11.4 to 25.7 mA/sq cm. The diode parameters, reverse saturation current, diode factor and open-circuit voltage compare well with the Schottky diodes on single crystal Zn₃P₂. A maximum total area conversion efficiency of 2.7% on a 1 sq cm cell is reported. Grain-boundaries are shown to have no deleterious effects on current collection or open circuit voltage. (Author)

**A82-45119
CADMIUM TELLURIDE FILMS FOR PHOTOVOLTAIC DEVICES**
T. L. CHU, S. S. CHU, Y. PAULEAU, E. D. STOKES, C. L. JIANG, K. MURTHY, and R. ABDERRASSOUL (Southern Methodist University, Dallas, TX) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1271-1276. refs

The microstructure and crystallographic properties of thin films of cadmium telluride that have been deposited on ceramic and coated graphite substrates by the direct combination of cadmium and tellurium in a hydrogen atmosphere are studied by means of SEM and X-ray techniques. In addition, the electrical properties of these films are evaluated from the current-voltage characteristics of Schottky barriers. Results show that the deposition rate, the composition of the film, and the incorporation of dopants depend strongly on the Cd/Te molar ratio in the reactant mixture. Nearly stoichiometric films are found to have a carrier mobility of 20-30 sq cm/V-sec and an effective intragrain minority carrier diffusion length of 1-1.8 microns. Short-circuit current densities of up to 15 mA/sq cm and open-circuit voltages of up to 350 mV have been obtained under AM1 conditions for devices of 9 sq cm in area. However, the conversion efficiencies of these devices are found to be limited by the high series resistance associated with the high CdTe/substrate interface resistance and high resistivity of cadmium telluride films. N.B.

A82-45120 A BRIEF SUMMARY OF RESEARCH AT TSING HUA ON CUINS2 - A NEW PHOTOVOLTAIC MATERIAL

H. L. HWANG, M. H. YANG, C. R. CHEN, L. M. LIU, J. Y. LIN, B. H. TSENG (National Tsinghua University, Hsinchu, Republic of China), C. Y. SUN (Industrial Technology Research Institute, Hsinchu, Republic of China), and J. J. LOFERSKI (Brown University, Providence, RI) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1277-1282. refs

A new photovoltaic material, CuInS₂, has been investigated. Mainly due to its direct band gap of 1.5eV, CuInS₂ promises to offer high conversion efficiency as a solar cell. Single crystals were grown by chemical vapor transport, theoretical calculations and experiments were carried out in order to determine the optimum growth conditions, and similar calculations were done for heterojunction epitaxial layers. Since the properties of CuInS₂ were not well known, doping and annealing effects were studied, and methods to determine the CuInS₂ composition and impurity contents were developed. Fabrication of low cost arrays was attempted in two ways: by thin film employing both r.f. sputtering and flash evaporation methods, and by tandem cells of very high efficiency coupled with concentrators. The possibility of heterojunction epitaxial growth by chemical vapor transport, chemical vapor deposition, and liquid phase epitaxy was examined.

The structural and electrical properties, and current conduction mechanisms were studied. (Author)

A82-45121**PROCESSING-INDUCED DEFECTS IN AL(X)/GA(1-X)/AS P-N JUNCTION SOLAR CELLS FABRICATED BY THE LPE, MOCVD, AND THE MBE GROWTH TECHNIQUES**

S. S. LI (Florida, University, Gainesville, FL) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1283-1288. refs (Contract F33615-77-C-2059; AF TASK 36)

Studies of the grown-in deep-level defects in the Al(x)Ga(1-x)As p-n junction solar cells fabricated by the LPE, MOCVD, and the MBE techniques have been made using DLTS, C-V, and I-V measurements. It is shown that Al(x)Ga(1-x)As epitaxial layers grown by the LPE method has yielded the lowest defect density among the samples prepared by the three different growth techniques studied, while Al(x)Ga(1-x)As epitaxial layer grown by the MBE technique has shown the highest defect density. The main electron and hole traps observed in the undoped n-type Al(.3)Ga(.7)As epitaxial layers grown by the LPE and the MOCVD methods are given by the E(c) - 0.31 eV and E(v) + 0.18 eV level, respectively. The defect spectra in the MBE epilayer showed continuous trap levels with defect density several orders of magnitude higher than those of LPE samples. A 300 C thermal annealing for two and five hours on the LPE samples showed significant reduction in both the defect density and the recombination current in the Be-diffused Al(.3)Ga(.7)As p-n junction diodes. (Author)

A82-45122**ALGAASSB/GAASSB CASCADE SOLAR CELLS**

M. L. TIMMONS and S. M. BEDAIR (Research Triangle Institute, Research Triangle Park, NC) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1289-1293. refs (Contract XM-9-8136-1)

Monolithic cascade solar cells have been grown in the Al-Ga-As-Sb material system using 1.2 eV GaAsSb low bandgap cells and 1.8 eV AlGaAsSb tunnel junctions and high bandgap cells. This is the optimum bandgap combination for 450 K operation. Efficiencies have been low 1 to 2 percent - on non-optimized structures which had neither window layers nor AR coatings. The best Voc values have been about 1.1 V (1 sun, AM0) and 1.35 V at 30 suns, AM0. Substantial improvements in the Jsc for both component cells grown individually with diffused junctions have been obtained recently, reaching a maximum Jsc about 20 mA/sq cm (1 sun, AM0) measured for a 1.2 eV GaAsSb cell. Electrical and spectral response characteristics of these diffused-junction cells are presented along with those of cascade cells grown using abrupt junctions. (Author)

A82-45123**ITO-SILICON NITRIDE-SILICON TUNNELING SOLAR CELLS UNDER CONCENTRATED LIGHT ILLUMINATION**

A. MYZKOWSKI, L. E. SANSORES, and J. TAGUENA-MARTINEZ (Universidad Nacional Autonoma de Mexico, Villa Obregon, Mexico) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1294-1301. refs

A general theory of the tunneling solar cells (MIS and SIS structures) is presented. This new theory is valid even at strong illumination when free carriers are stored near to the semiconductor surface and the quasi-Fermi level drops appreciably across the insulator layer. Some numerical calculations of the conversion efficiency at high light concentration is done for the ITO-SiO(x)-pSi and ITO-Si3N4-pSi structures. The latter structure, having lower tunneling barrier and higher electron tunneling probability, performs far better than the former (eta approximately 24 percent in the

200-300 suns region). The influence of several material parameters on the conversion efficiency is discussed. (Author)

A82-45125**THIN FILM GALLIUM ARSENIDE SOLAR CELLS WITH REDUCED FILM THICKNESS**

S. S. CHU, T. L. CHU, C. L. JIANG, C. W. LOH, E. D. STOKES, and J. M. YU (Southern Methodist University, Dallas, TX) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1310-1315. refs (Contract EG-77-C-01-4042; XS-0-9002-3)

MOS solar cells have been fabricated from gallium arsenide films of 10 microns thickness deposited on tungsten coated graphite substrates. The deposition of gallium arsenide films was carried out by the reaction between gallium, hydrogen chloride, and arsine in a hydrogen flow system. Gallium arsenide films of about 10 microns thickness exhibited pronounced shunting effects due to grain boundaries. Effective passivation of grain boundaries is necessary to produce large area solar cells with good conversion efficiencies. MOS solar cells of 9/sq cm area with an AM1 efficiency of up to 8.5% have been prepared reproducibly from gallium arsenide films treated with ruthenium ion and thermal oxidation. (Author)

A82-45126**EFFECTS OF GRAIN BOUNDARY PASSIVATION IN POLYCRYSTALLINE SOLAR CELLS**

R. JANSSENS, R. MERTENS, and R. VAN OVERSTRAETEN (Leuven, Katholieke Universiteit, Louvain, Belgium) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1322-1325. Research supported by the Office du Premier Ministre and Nationale Fonds voor Wetenschappelijke Onderzoek. refs

A new technique for passivating grain boundaries in polycrystalline material has been developed: sintering of an Al-SiO2-Si structure. Solar cells made with this additional sintering step show average improvements of 5-10 mV in open circuit voltage and 1.0-1.5 mA/sq cm in short circuit current. After the procedure used to get the test results, qualitative results on solar cells made of two different materials are proposed. Next, various parameters influencing this passivation are discussed. Finally, some theoretical analysis is performed to explain the test results. (Author)

A82-45127**POLYCRYSTAL X-RAY TOPOGRAPHY AND THE PHOTORESPONSE OF GRAINS OR GRAIN BOUNDARIES IN POLYSILICON**

R. G. ROSEMEIER, R. W. ARMSTRONG (Maryland, University, College Park, MD), S. M. JOHNSON, G. M. STORTI (Solarex Corp., Rockville, MD), and C. C. WU (U.S. Navy, Naval Research Laboratory, Washington, DC) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1331-1336. refs (Contract XS-9-8272-1)

X-ray topographs and optical photoresponse measurements have been matched on a point-by-point basis across the surface of polysilicon solar cells to show the dependence of the photovoltaic properties on grain perfection and on the particular boundary structure between adjacent grains. Dislocations, subgrain boundaries, twins and inclusions are revealed within the relatively perfect microstructures of cells by the asymmetric crystal topography (ACT) method in surface reflection and by the Lang transmission topography method. The decreased photoresponse at particular grain boundaries is attributed to the smaller crystal dislocation portion of the larger total change in orientation across the grains. (Author)

02 SOLAR ENERGY

A82-45128

A SHORTING JUNCTION FOR MONOLITHIC MULTICOLOR SOLAR CELLS

L. M. FRAAS (Chevron Research Co., Richmond, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1353-1356. refs

Multicolor solar cells require shorting junctions interconnecting the light-sensitive junctions. Early two-color cell designs use tunnel junctions fabricated with high band gap materials. This approach leads to very high doping density requirements and stringent constraints on interdiffusion. Herein, it is observed that improved shorting junctions can be fabricated using a thin low band gap material. If the material is thin enough, it will be transparent. This approach has the advantage of reducing the barrier height for tunneling, thereby reducing the shorting junction resistivity. Germanium is an ideal lattice-matching material, and it can be deposited with CVD. (Author)

A82-45129

LASER BONDING FOR NON-LATTICE MATCHED STACKED CELLS

H. T. YANG and S. W. ZEHR (Rockwell International Microelectronics Research and Development Center, Thousand Oaks, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1357-1362. refs

(Contract XJ-9-8058-2)

An alternative to the development of a monolithic multicolor solar converter is to individually fabricate high quality subcells with optimum bandgap materials and subsequently join them together through a metallurgical bonding procedure in such a way that the needed transparent intercell ohmic contacts are produced. This approach avoids the lattice matching requirements throughout the structure. The feasibility of using a pulsed Nd:glass laser to accomplish such bonding through local heating of semiconductor materials at the bond interface is currently being explored. Pairs of GaAs and GaSb wafers have been successfully bonded in this way. The bonded interface has been found to be electrically conducting and optically transparent. The first GaAs/Al₂Ga_{0.8}Sb bonded cascade cell has been demonstrated. (Author)

A82-45132

RELIABILITY AND MAINTAINABILITY CONSIDERATIONS OF CONNECTOR SYSTEM FOR PHOTOVOLTAIC MODULES

T. SOTOLONGO (AMP, Inc., Largo, FL) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1382-1385.

Solar cells, usually 4 in. in diameter, are assembled into modules or panels, usually composed of 36 or 48 cells, which are in turn combined into arrays. Once the modules are assembled into arrays, they must be connected electrically to each other. A description is provided of a connector which electrically combines individual modules into arrays and protects the connections themselves against the elements of nature. The strong, rigid material used, the versatility and ease of handling of the rubber seals which provide environmental protection for the electrical contact, the quick releasing mechanism used make the considered connector a logical choice when protection from environmental hazards and longevity are needed. G.R.

A82-45133

THE INFLUENCE OF GRAIN BOUNDARIES ON SOLAR CELL PERFORMANCE

J. B. MILSTEIN, Y. S. TSUO, R. W. HARDY, and T. SUREK (Solar Energy Research Institute, Golden, CO) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1399-1404. refs

Thin-film polycrystalline solar cells are currently under intense study for large scale terrestrial application because of their lower

material and processing cost compared to single crystal silicon cells. The major structural difference between polycrystalline and single crystal material is the presence of grain boundaries. Grain boundaries lead to substantial loss in polycrystalline solar cell performance. An overview of the current grain boundary studies related to polycrystalline silicon solar cells is provided. Grain boundary effects are examined, taking into account deleterious effects, grain size effects, and the origin of grain boundaries. Grain boundary models are presented, giving attention to transport properties, double-depletion-layer models, trapping state densities, and thermal activation. Grain boundary passivation methods are considered, and major problem areas are investigated. It is believed that the achievement of more efficient and less costly polycrystalline silicon solar cells will be furthered by resolution of some of the discussed questions. G.R.

A82-45134

THE MINP SOLAR CELL - A NEW HIGH VOLTAGE, HIGH EFFICIENCY SILICON SOLAR CELL

M. A. GREEN, A. W. BLAKERS, Z. R. WILLISON, T. SZPITALAK, E. M. KELLER, E. GAUJA, and P. J. HART (New South Wales, University, Kensington, Australia) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1405-1408. Research supported by the National Energy Research Development and Demonstration Council of Australia. refs

A high voltage, high efficiency silicon solar cell has been designed, combining the better features of MIS and P-N junction cells. The MINP is basically a shallow P-N cell with an MIS contact made to the top of the cell. MINP performance advantages as compared to P-N junction cells are due to the low effective recombination velocity at the silicon surface under the MIS contact, allowing open circuit voltages of up to 678 mV. The high voltage results in improved efficiency, and for the 2 cm x 2 cm cell test structure, 16% total area efficiencies have been measured. High voltage cells also offer a decreased sensitivity to increasing temperature. In addition, the MINP device is well suited for ion implantation as electron concentration near the surface is more controllable, and ion implantation is a vacuum process, the preferred technique for the top contact in MINP cells. R.K.R.

A82-45135

INDUCED BACK SURFACE FIELD AND MISIM SOLAR CELLS ON PSI SUBSTRATES

N. G. TARR, D. L. PULFREY (British Columbia, University, Vancouver, Canada), and P. A. ILES (Applied Solar Energy Corp., City of Industry, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1409-1411. refs

This paper describes the use of Pt-SiO(x) MIS contacts to form negative barrier, minority carrier reflecting junctions to p-type silicon. It is shown that solar cells utilizing these junctions as back contacts can yield open-circuit voltages comparable to those obtained in cells fabricated on identical substrates, but furnished with diffused junction back surface fields. This effect has been observed in solar cells which have either a diffused front junction (N(+)-PIM cells) or a min MIS front junction (MISIM cells). The negative barrier contact has also been found to increase the infrared photocurrent response. (Author)

A82-45136

ON THE STABILITY OF SnO₂/N-Si AND ITO/N-Si SOLAR CELLS

H. P. MARUSKA, T. FENG, A. K. GHOSH, and D. J. EUSTACE (Exxon Advanced Energy systems Laboratory, Linden, NJ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1412-1417. refs (Contract XJ-0-9077-1)

The stability of heterojunction semiconductor-insulator-semiconductor solar cells is analyzed in

order to examine the changes in the photovoltaic parameters that can be correlated with the redistributions of charges at the interface. Results show that there are two distinct mechanisms for degradation, one optical and the other thermal, in SnO₂/n-Si and indium tin oxide/n-Si solar cells, while no changes in performance are found if the cells are kept at room temperatures in darkness. The dark current-voltage characteristics are changed by the thermal and optical processes in which light stress increases the dark saturation current and heat stress decreases the diode quality factor, while the open circuit voltage decreases in either case. The optical degradation mechanism is found not to cause changes in the photocurrent, but this current is decreased by the thermal process. It is concluded that the thermal degradation process is due to alterations in the thickness and composition of the silicon oxide interphase region, while the optical process is associated with a change in the energy distribution of the surface states of the Si/SiO(x) interface. N.B.

A82-45137
ELECTROSTATIC AND OTHER EFFECTS IN INVERSION LAYER MIS SOLAR CELLS

M. A. GREEN, T. SZPITALAK, M. R. WILLISON, A. W. BLAKERS, and Y. W. LAM (New South Wales, University, Kensington, Australia) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1418-1421. Research supported by the Australian Research Grants Committee and National Energy Research, Development, and Demonstration Council of Australia. refs

Stability studies of high performance inversion layer silicon MIS solar cells show that short term variations in the inversion layer charge can occur due to changing electrostatic conditions associated with the antireflection coating. This paper describes experiments aimed at clarifying the mechanisms involved. Although cells of reasonable efficiency have been made with relatively coarse grid spacings (12/cm), it is concluded that much finer spacings are required to ensure cell stability. A second part of this study is concerned with the physical structure, chemistry, and stability of the MIS contact itself, which is of fundamental interest not only in inversion layer MIS cells, but also in transparent metal MIS cells, MINP cells and other MIS-based devices. (Author)

A82-45139
EFFECTS OF OXYGEN IMPURITIES UPON SOLAR CELL PERFORMANCE

R. N. LEGGE and N. G. SAKIOTIS (Motorola, Inc., Semiconductor Group, Phoenix, AZ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1428-1431.

The effect of oxygen on resistivity, minority carrier diffusion length, and P-N junction I-V characteristics as it affects solar cell performance is the subject of this paper. It is shown that interstitial oxygen can be thermally activated into a donor state by either the act of crystal growth itself or by the temperatures that a sample experiences during processing. These excess donors affect the resistivity by changing the majority carrier concentration and, more importantly, the minority carrier lifetime is reduced. A procedure to reverse this effect is also presented. Finally, excess current in the dark I-V characteristics of p-n junctions formed on various substrates is shown to be associated with the presence of oxygen. (Author)

A82-45140
METALLURGICAL-SILICON SUBSTRATES PRODUCED BY HEM FOR EPITAXIAL THIN FILM SOLAR CELLS

C. P. KHATTAK, M. BASARAN, F. SCHMID (Crystal Systems, Inc., Salem, MA), R. V. D'AIELLO, P. H. ROBINSON, and A. H. FIRESTER (RCA Laboratories, Princeton, NJ) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1432-1437. refs (Contract XS-9-8274; XS-0-9171-1; XS-0-9100-3)

This paper describes the combination of two technologies: the use of the Heat Exchanger Method (HEM) for the formation of substrates derived from metallurgical grade silicon, coupled with the epitaxial growth of a thin active layer resulting in an all-silicon thin-film approach to the low-cost fabrication of solar cells. Commercially available metallurgical grade (MG) silicon of 98% purity has been directionally solidified by HEM, which reduces most of the impurities, except Al, Fe, B and P, to below detectability limits of spark source spectroscopic analysis. This method results in an almost single-crystal structure in 15 cm cube ingots after the first solidification. Epitaxial layers of 20 micrometer thickness were grown on this material when prepared as substrates, and n(+)/p junctions were formed by diffusion. Solar-cell efficiency of 11.6% (AM-1) in 1 sq cm size and 9.7% in 10 sq cm size has been demonstrated. (Author)

A82-45141
A 20-KILOWATT PHOTOVOLTAIC FLAT-PANEL POWER SYSTEM - AN OVERVIEW

H. ZWIBEL, E. YAZDANI, V. RISSER (New Mexico Solar Energy Institute, Las Cruces, NM), P. COULTER, and J. BROWN (El Paso Electric Co., El Paso, TX) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1447-1452. Research supported by the U.S. Department of Energy.

The 20-Kilowatt El Paso Photovoltaic Project is one of the four DOE-funded PRDA-38 flat-plate experiments selected for construction. The array field is composed of six parallel-connected subarrays, four containing 11 panels connected in parallel and two containing 10 panels connected in parallel. Each is composed of nine series-connected modules; a module is 105 centimeters by 42 centimeters and consists of 36 series-connected cells with a bypass diode around each set of 18 cells. The nominal output per module is 33 watts. Simulated peak output from the field is 20.3 kilowatts. The electrical output from the array is supplied directly to the load at 134 volts dc and a maximum current of 145 amperes. G.R.

A82-45142
UPDATE OF PHOTOVOLTAIC SYSTEM COST EXPERIENCE FOR INTERMEDIATE-SIZED APPLICATIONS

E. L. BURGESS, K. L. BIRINGER, and D. G. SCHUELER (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1453-1457. Research supported by the U.S. Department of Energy. refs

This paper presents the costs of six photovoltaic flat plate systems broken down into eight cost account categories. A typical ground mounted system from this group is compared to the costs of three lower cost systems: (1) a system using all of the best design features from among the six systems, (2) a mid-term system, and (3) a long-range system. A logical path to lower cost economically competitive systems is described. The major features of these low cost systems are standard modular design and recently developed low-cost design features. (Author)

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A82-45143 INTERMEDIATE PHOTOVOLTAIC SYSTEM/UTILITY INTERFACE EXPERIENCE

K. L. BIRINGER, J. F. MCDOWELL, C. B. ROGERS, and D. E. HASKINS (Sandia National Laboratory, Albuquerque, NM) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1458-1463. Research supported by the U.S. Department of Energy.

A description is given of 11 intermediate photovoltaic application projects, including the Arizona Public Service Company project, the E-Systems 27 kW photovoltaic concentrator application experiment, a 110 kW photovoltaic application experiment in Orlando, Florida, the Lea County photovoltaic flat plate photovoltaic experiment in southeastern New Mexico, the Mt. Laguna photovoltaic flat plate installation in California, the San Bernardino 35 kW photovoltaic flat plate project in California, and the Solar Power flat plate photovoltaic experiment in Massachusetts. It is pointed out that the most significant point to be made relative to the interface of photovoltaic systems with the utility grid is that it can be done successfully. G.R.

A82-45144 PHOTOVOLTAIC POWER SYSTEM FOR THE OKLAHOMA CENTER FOR SCIENCE AND ARTS /OCSA/

Y. P. GUPTA (Science Applications, Inc., McLean, VA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1464-1468. (Contract DE-AC04-79ET-20630)

This paper describes the essential features of a 150 kW photovoltaic (PV) system being presently installed at the OCSA. Included herein are the unique features of both the system design and systems analysis model which was significantly modified to incorporate specific system features. Certain problems encountered during the implementation phase are discussed together with the appropriate solutions utilized. It is anticipated that such problem-solution pairs will be applicable to the implementation of PV systems elsewhere as well. (Author)

A82-45145 DESIGN AND START-UP PERFORMANCE OF A 100 KW UTILITY INTERCONNECTED FLAT PANEL PHOTOVOLTAIC SYSTEM FOR THE BEVERLY HIGH SCHOOL

F. J. MARCHESE and R. R. ADDISS, JR. (Solar Power Corp., Woburn, MA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1469-1471. Research sponsored by the U.S. Department of Energy.

A82-45241 SILICON SOLAR CELL WITH A NOVEL LOW-RESISTANCE EMITTER STRUCTURE

P. G. BORDEN and R. V. WALSH (Varian Solid State Laboratory, Palo Alto, CA) Applied Physics Letters, vol. 41, Oct. 1, 1982, p. 649-651. Research supported by the U.S. Department of Energy. refs

A silicon solar cell with over 19 percent efficiency at 100 suns, AM1.5, 20 C, incorporating a novel front contact geometry, has been demonstrated. The cell has one third of its frontal area covered with metal and grid line spacing of 82 microns, as measured along the silicon surface. It uses V-groove etching, angle-contact metal evaporation, and a cover glass to allow high fractional grid coverage with low obscuration, thereby minimizing emitter resistance losses at high concentrations. (Author)

A82-45338 HIGH-EFFICIENCY ORGANOMETALLIC VAPOR PHASE EPITAXY ALGAAS/GAAS MONOLITHIC CASCADE SOLAR CELL USING METAL INTERCONNECTS

M. J. LUDOWISE, R. A. LARUE, P. G. BORDEN, P. E. GREGORY, and W. T. DIETZE (Varian Associates Corporate Solid State Laboratory, Palo Alto, CA) Applied Physics Letters, vol. 41, Sept. 15, 1982, p. 550-552. refs (Contract XP-9-8081-1)

A two-junction solar cell has been fabricated using an AlGaAs (1.82eV) top cell and a GaAs(1.43 eV) bottom cell. A processed metal interconnect is used to connect the two cells together in series. An efficiency of 21.5% at 980 mW/sq cm has been measured in a solar simulator with an open circuit voltage of 2.35 V, a short circuit current of 118.6 mA/ sq cm, and a fill factor of 0.76. An efficiency of 22% has been measured under 130 AM3 sun in a solar tracking concentrator. Organometallic vapor phase epitaxy is used to grow the entire nine-layer device. (Author)

A82-45537 SILICON PHOTOELEMENTS WITH MULTILAYER SELECTIVE COATINGS [KREMNIÉVYE FOTOLEMÉNTY S MNOGOSLOINNYMI SELEKTIVNYMI POKRYTIAMI]

M. M. KOLTUN, I. P. GAVRILOVA, and M. I. U. KOLENKIN Zhurnal Prikladnoi Spektroskopii, vol. 37, Aug. 1982, p. 340-343. In Russian. refs

A selective coating for infrared-transparent silicon photocells that are used in combined photothermal converters of solar radiation has been developed which makes it possible to simultaneously obtain electrical and thermal energy. An MgF₂-ZnS film is vacuum-deposited on the face surface of the photocell and interferential thickness layers of ZnS-Ni-ZnS and an opaque layer of a high reflectivity metal (such as Ag or Al) are deposited on the rear surface. The coating raises the absorptivity in the region of the solar spectrum to a value of approximately 0.9 (in conditions of AM2) and simultaneously lowers the emissivity factor to approximately 0.16 at room temperature. N.B.

A82-45566 PHYSICAL CHARACTERISATION OF PLASTIC-BASED PHOTOVOLTAIC MODULES

A. ADDEO, V. BONADIES, C. CARFAGNA, A. MOSCHETTI (Istituto G. Donegani, Naples, Italy), and L. NICOLAIS (Napoli, Università, Naples, Italy) Applied Energy, vol. 12, Oct. 1982, p. 77-85. Research supported by the Consiglio Nazionale delle Ricerche and Commission of the European Communities.

A new plastic photovoltaic module for the encapsulation of solar cells is described. Its physical characterisation, based on a complete mechanical analysis, indicates that acrylic materials are practical, economic and durable systems for photovoltaic cells. Moreover, the encapsulation procedure, performed by means of a very simple polymerisation technique, could be easily modified for industrial application. (Author)

A82-45567 EFFICIENCY OF FRESNEL LENSES WITH RESPECT TO THERMAL LOSSES

P. K. GUPTA (Indian Institute of Technology, New Delhi, India) Applied Energy, vol. 12, Oct. 1982, p. 87-98.

Experimental observations and heat loss calculations for a Fresnel lens under forced and natural convection have both been obtained. A lens with a 2.0 mm step width and 352.99 sq cm area when exposed to solar radiation and kept normal to solar radiation with an intensity of 43.116 cal/sq cm/h has given a steady-state temperature of 187.5 C at its focus. (Author)

A82-45744#

DETERMINATION OF THE CUMULUS CLOUD SIZE DISTRIBUTION ON THE BASIS OF LANDSAT IMAGERY [BESTIMMUNG DER CUMULUS-GROESSENVERTEILUNG AUS LANDSAT-BILDERN]

E. KARG, H. MUELLER, and H. QUENZEL (Muenchen, Universitaet, Munich, West Germany) (Deutsche Meteorologische Gesellschaft, Symposium ueber Strahlungstransportprobleme und Satellitenmessungen in der Meteorologie und Ozeanographie, Cologne, West Germany, Mar. 22-26, 1982.) *Annalen der Meteorologie*, no. 18, 1982, p. 142-144. In German.

A solar-tower power station transforms solar energy into heat which is used for the generation of electric power by conventional technological approaches. A mirror system is used to direct solar radiation to a receiver mounted on a tower. Changes concerning the insolation cause temperature variations in the receiver. These temperature variations subject the receiver material to thermal stresses and prevent a steady operation of the power station. The magnitude of the solar power transmitted to the receiver is largely determined by the characteristics of the cloud cover and the individual clouds. The present investigation is concerned with suitable methods for the determination of cloud size, and the characteristics of cloud size distribution. It is found that currently only the Landsat system provides the basis for a suitable cloud size determination. By increasing the mirror area, the power station can be made less sensitive to changes in the cloud cover. G.R.

A82-45880

AN ANALYSIS OF THE TECHNICAL AND ECONOMIC PERFORMANCE OF A PARABOLIC TROUGH CONCENTRATOR FOR SOLAR INDUSTRIAL PROCESS HEAT APPLICATION

J. A. CLARK (Michigan, University, Ann Arbor, MI) *International Journal of Heat and Mass Transfer*, vol. 25, Sept. 1982, p. 1427-1438. refs

Design parameters and economic projections of importance to the commercial realization of mass-produced parabolic trough solar concentrators as industrial heat suppliers are presented. Numerical formulas are defined for obtaining a figure of merit for the thermal efficiency of a concentrator, taking into account the reflectivity, the mirror-receiver intercept factor, the end loss factor, tracking and misalignment errors, the absorptivity-transmissivity product at normal incidence of the receiver tube and its glass envelope, and durability. An economic analysis which includes all costs, tax write-offs, comparisons with conventional fuels, inflation rate, time of borrowing, maintenance, profits, and conversion efficiencies is developed. It was determined that the trough systems will become competitive in the U.S. when installed costs are \$15.79/sq ft over a 10-yr investment period M.S.K.

A82-45904

OPTICAL STUDIES OF MULTILAYER DIELECTRIC-METAL-DIELECTRIC COATINGS AS APPLIED TO SOLAR CELLS

F. DEMICHELIS, E. MINETTI-MEZZETTI, and V. PEROTTO (Torino, Politecnico, Turin, Italy) *Solar Cells*, vol. 6, Sept. 1982, p. 323-333. refs

In this paper a study of antireflection coatings for solar cells which provide maximum transmittance in the range of the spectral response of the cell and maximum reflectance in the IR portion of the spectrum of normally incident radiation is reported. Dielectric-metal-dielectric filters with a relatively low number of dielectric layers are designed as coatings for silicon and GaAs solar cells. (Author)

A82-45905

EFFICIENCY CALCULATIONS OF VARIOUS HETEROSTRUCTURE SOLAR CELLS WITH N/INDIUM TIN OXIDE/ AS THE TOP WIDE BAND GAP SEMICONDUCTOR

V. K. JAIN, R. K. PUROHIT, and B. L. SHARMA (Solid State Physics Laboratory, Delhi, India) *Solar Cells*, vol. 6, Sept. 1982, p. 335-342. refs

A82-45906

D.C.-TO-A.-C. INVERTERS FOR PHOTOVOLTAICS

P. LONGRIGG (Solar Energy Research Institute, Golden, CO) *Solar Cells*, vol. 6, Sept. 1982, p. 343-356.

The technology of current and voltage-sourced inverters as it applies to the dc to ac power conditioning of photovoltaic power supplies is reviewed. The three generic types and one derivative type of dc to ac inverters, which are required in order to interface a photovoltaic system with an ac interface, what may be expected from them in terms of performance, and what can be done to improve their performance are discussed. In addition, two of the primary technical deployment problems with this type of technology, harmonic injection and the power factor in the utility interactive mode, are examined in detail. N.B.

A82-45907

SOLAR CELLS FROM METALLURGICAL SILICON ZONE MELTED IN POLYCRYSTALLINE SILICON TUBES

G. C. JAIN, S. N. SINGH, and R. KISHORE (National Physical Laboratory of India, New Delhi, India) *Solar Cells*, vol. 6, Sept. 1982, p. 357-363. Research supported by the Ministry of Science and Technology. refs

The results of a new approach to utilize metallurgical grade (MG) silicon powder to obtain polycrystalline silicon wafers for the fabrication of solar cells are reported. A polycrystalline silicon tube is filled with MG silicon powder and is used as a consumable container which facilitates the float zone melting of the powder. This leads to the dilution of impurities in the melt; an in situ purification of the melt also takes place during solidification. This method has given an air mass one conversion efficiency of about 4.3% in cells 2 sq cm in area and there is significant scope for improvement in both the efficiency and the cell area. (Author)

A82-45908

PRESENT STATUS OF PHOTOVOLTAIC RESEARCH AND DEVELOPMENT IN JAPAN

K. TAKAHASHI (Tokyo Institute of Technology, Tokyo, Japan) *Solar Cells*, vol. 6, Sept. 1982, p. 365-374.

A82-45909

ANALYSIS OF SOLAR CELL ARRAY PERFORMANCE WITH OPEN-CIRCUIT DEFECTS

S. NOZAKI and A. G. MILNES (Carnegie-Mellon University, Pittsburgh, PA) *Solar Cells*, vol. 6, Sept. 1982, p. 375-403. refs

An algorithm and computer model have been developed in order to study the effects of open-circuit defects in a solar cell array that is organized into many parallel branches and many series blocks within a branch, with bypass diodes provided across each block. The analysis yields a complicated set of simultaneous equations that can usually be simplified and solved by a computer of moderate power. Several examples of this method are considered, in which the effects of up to 50 open circuits that are randomly distributed in an array of 10,000 cells with ten parallel branches and 25 series bypass blocks in each branch are examined. It is found by calculation that, when the load resistance for the array is assumed to be constant, there is one distribution of 50 open-circuit cells which results in the reduction of the power output to 91.85% of that for a perfect array if bypass diodes are present. If the bypass diodes are not provided, the same defect results in a power output of 87.19%. N.B.

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A82-45910

THE DEPENDENCE OF THE OPEN-CIRCUIT VOLTAGE OF SILICON SOLAR CELLS ON EMITTER SURFACE PARAMETERS

J. NIJS, F. DHOORE, R. MERTENS, and R. VAN OVERSTRAETEN (Leuven, Katholieke Universiteit, Heverlee, Belgium) *Solar Cells*, vol. 6, Sept. 1982, p. 405-418. Research supported by the Office Du Premier Ministre of Belgium and National Fonds voor Wetenschappelijk Onderzoek; European Economic Community refs
(Contract EEC 439-78-1ESB)

Three types of solar cells were fabricated: n(+)-p cells and high efficiency n(+)-p-p(+) and p(+)-n-n(+) back-surface field cells. The only variable parameter was the surface condition on the emitter side: either the surface treatment after metallization or the front (emitter surface) metal coverage factor. The influence of these surface conditions on the saturation current and hence on V_{oc} was determined. It was concluded that in the back-surface field cells the saturation current density due to the injection of minority carriers into the emitter was of the same order of magnitude as the bulk injection component. It was also concluded that the emitter is transparent to minority carriers. (Author)

A82-46292* Illinois Univ., Urbana.

REDUCTION OF SOLAR CELL EFFICIENCY BY EDGE DEFECTS ACROSS THE BACK-SURFACE-FIELD JUNCTION - A DEVELOPED PERIMETER MODEL

C. T. SAH (Illinois, University, Urbana, IL), K. A. YAMAKAWA, and R. LUTWACK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) *Solid-State Electronics*, vol. 25, Sept. 1982, p. 851-858. Research supported by the U.S. Department of Energy and NASA. refs

Material imperfections, impurity clusters and fabrication defects across the back-surface-field junction can degrade the performance of high-efficiency solar cells. The degradation from defects appearing on the circumference of a solar cell is analyzed using a two-region developed perimeter device model. The width of the defective perimeter region is characterized by the range or the distance-of-influence of the defective edge and this width is about two diffusion lengths. The defective edge is characterized by a surface recombination velocity. Family of theoretical curves and numerical examples are presented to show that significant reduction of open-circuit voltage can occur in high-efficiency cells which are thin compared with the diffusion length. In one example, the degradation is decreased from 135 mV to 75 mV when the cell size is increased from 10 to 100 times the diffusion length in a thin cell whose thickness is 1% of the diffusion length. (Author)

A82-46293

THEORY OF SCHOTTKY BARRIER HEIGHTS OF AMORPHOUS MIS SOLAR CELLS

J. T. LUE *Solid-State Electronics*, vol. 25, Sept. 1982, p. 869-874. refs

The Schottky barrier height of amorphous metal-insulator-semiconductor solar cells depends greatly on the density of surface states and on the density of localized states near the Fermi level. At low density of gap states, the barrier height is maximum for surface state densities around 10 to the 18th/sq m per eV. With illumination, the barrier height decreases as the collection of minority carriers near the interface increases. (Author)

A82-46294

PHOTOVOLTAIC PROCESSES IN METAL-SEMICRYSTALLINE SILICON SCHOTTKY BARRIERS AND IMPLICATIONS FOR GRATING SOLAR CELLS

A. W. DE GROOT and H. C. CARD (Manitoba, University, Winnipeg, Canada) *Solid-State Electronics*, vol. 25, Sept. 1982, p. 917-923. Natural Sciences and Engineering Research Council of Canada refs
(Contract NSERC-G-0442)

A82-46298

ON THE FLAT FERMI LEVEL APPROXIMATION IN THE SPACE CHARGE LAYER OF INDUCED-JUNCTION SOLAR CELLS

P. DE VISSCHERE (Gent, Rijksuniversiteit, Ghent; Fonds National de la Recherche Scientifique, Brussels, Belgium) *Solid-State Electronics*, vol. 25, Sept. 1982, p. 955-957.

A82-46299

THEORETICAL ANALYSIS OF A METAL P-N SCHOTTKY BARRIER SOLAR CELL

P. S. RAO and S. K. SHARMA (Indian Institute of Technology, New Delhi, India) *Solid-State Electronics*, vol. 25, Sept. 1982, p. 959, 960. Research supported by the Indian National Science Academy.

A82-46300* Illinois Univ., Urbana.

THICKNESS DEPENDENCES OF SOLAR CELL PERFORMANCE

C. T. SAH (Illinois, University, Urbana, IL) *Solid-State Electronics*, vol. 25, Sept. 1982, p. 960-962. Research supported by the U.S. Department of Energy and NASA.

The significance of including factors such as the base resistivity loss for solar cells thicker than 100 microns and emitter and BSF layer recombination for thin cells in predicting the fill factor and efficiency of solar cells is demonstrated analytically. A model for a solar cell is devised with the inclusion of the dopant impurity concentration profile, variation of the electron and hole mobility with dopant concentration, the concentration and thermal capture and emission rates of the recombination center, device temperature, the AM1 spectra and the Si absorption coefficient. Device equations were solved by means of the transmission line technique. The analytical results were compared with those of low-level theory for cell performance. Significant differences in predictions of the fill factor resulted, and inaccuracies in the low-level approximations are discussed. M.S.K.

A82-46429

EFFECTS OF ARGON PRESSURE ON THE STRUCTURE AND PROPERTIES OF DC PLANAR-MAGNETRON-SPUTTERED METAL AND SEMICONDUCTOR FILMS WITH IMPLICATIONS FOR SOLAR ENERGY APPLICATIONS

S. CRAIG and G. L. HARDING (Sydney, University, Sydney, Australia) *Journal of Vacuum Science and Technology*, vol. 21, Sept.-Oct. 1982, p. 833-837. refs

A82-46439

BLACK COBALT COATINGS FOR PHOTOTHERMAL CONVERSION OF SOLAR ENERGY PREPARATION AND CHARACTERIZATION

P. K. C. PILLAI and R. C. AGARWAL (Indian Institute of Technology, New Delhi, India) *Energy Conversion and Management*, vol. 22, no. 2, 1982, p. 111-116. refs

A82-46440

SHALLOW SOLAR POND - STATE-OF-THE-ART

H. P. GARG, B. BANDYOPADHYAY, U. RANI, and D. S. HRISHIKESAN (Indian Institute of Technology, New Delhi, India) *Energy Conversion and Management*, vol. 22, no. 2, 1982, p. 117-131. refs

The functional characteristics, design, and numerical modeling of shallow solar ponds (SSPs) are reviewed. SSPs consist of a sealed bag of water only a few centimeters thick which is exposed to solar heat in daylight for release of the energy at other hours. It is noted that the collection efficiency is directly proportional to the water depth while the grade of the energy is inversely proportional to water depth. Descriptions of Lawrence Livermore Laboratory prototype SSPs are provided, and show that a temperature range of 60 C in summer and 40 C in winter is attainable, with annual efficiencies of 50%. One system for military barracks is cited with 10,000 sq m of pond area supplying 800,000 l of hot water per day for building heat. Feasibility criteria of SSP construction are defined on cost, reliability, and O and M terms,

and it is concluded that a system designed for producing the minimum heat required is the rule to follow. M.S.K.

A82-46448
PHOTOELECTRIC CONVERTERS ON
CR/X/TE/Y/-ZN/X/CD/1-X/S HETEROJUNCTION

E. M. KONSTANTINOVA and N. R. STRATIEVA (B'lgarska Akademia na Naukite, Tsentralna Laboratoriia po Sl'ncheva Energiia i Novi Energiini Iztochnitsi, Sofia, Bulgaria) Bolgarskaia Akademia Nauk, Doklady, vol. 35, no. 6, 1982, p. 757-760. refs

The layer properties of $Zn(x)Cd(1-x)S(x)$ are investigated, and the use of these materials in heterojunction photocells and converters is evaluated. Results show that the calculated lattice mismatch of the semiconductor decreases with an increase of the Zn content in the solid solutions. A $Cr(x)Te(y)-Zn(x)Cd(1-x)S$ heterojunction is fabricated and is found to have an increase in efficiency of 1% when the open-circuit voltage is raised by about 150 mV and the other parameters are held constant. The open-circuit voltage for photocells based on $Cr(x)Te(y)$ and $Zn(x)Cd(1-x)S$, with $x = 0.05-0.3$, is measured under 80 mW/sq cm illumination, and is shown to be lower than the open circuit voltages for $Cr(x)Te(y)-Zn(x)Cd(1-x)S$ samples. In addition, the I-V characteristics of the samples are determined. It is concluded that the wide spectral sensitivity, the high open-circuit voltage, as well as satisfactory conversion efficiencies, of solar cells based on $Cr(x)Te(y)-Zn(x)Cd(1-x)S$ will allow the development of solar energy convertors with improved parameters. N.B.

A82-46475
CHARACTERISTICS OF N+/P SILICON SOLAR CELLS
FORMED BY PARTIALLY IONIZED MBE

H. UCHIDA, T. SUGIYAMA, and T. ITOH (Waseda University, Tokyo, Japan) Institute of Electronics and Communication Engineers of Japan, Transactions, Section E (English), vol. E65, July 1982, p. 385-389. refs

Silicon solar cells with $n(+)/p$ junctions are fabricated using partially ionized MBE (PI-MBE). Results show that the surface layer epitaxially grown on a p-type bulk silicon substrate can be heavily doped ($\rho = 0.001$ ohm-cm; 5.0×10 to the 19th cu cm carrier concentration) using As with the substrate temperature higher than or equal to 700 C. The I-V characteristics under AM1 illumination and the spectral responses obtained by a computer proofreading method are used to evaluate the cells. It is found that the cell conversion efficiency is 11.0-12.0%, and the fill factor is 0.70-0.75. N.B.

A82-46509
PHOTOELECTROCHEMISTRY OF THE THALLIC/THALLOUS
COUPLE - THE THALLIC ION CATALYZED PHOTO-OXIDATION
OF PROPYLENE

J. A. SWITZER, E. L. MOOREHEAD, and D. M. DALESANDRO (Union Oil Company of California, Union Science and Technology Div., Brea, CA) (Electrochemical Society, Meeting, Denver, CO, Oct. 11-16, 1981.) Electrochemical Society, Journal, vol. 129, Oct. 1982, p. 2232-2237. Research supported by the Union Oil Company of California. refs

Liquid-junction photovoltaic and photoelectrosynthetic applications of the thallic/thallos couple have been investigated. In the liquid-junction photovoltaic mode the redox couple produces large photovoltages with several semiconductors (TiO_2 , MoS_2 , CdS , and $GaAs$), and does not absorb appreciable semiconductor ultra-bandgap light. The couple also shows photoelectrosynthetic utility, since the thallic ion is a selective two-electron oxidizing agent for a variety of organic substrates. Preliminary work on the photoassisted epoxidation of propylene at n-type semiconductor electrodes (TiO_2) and powders (TiO_2 , WO_3 , and ZnO) is discussed. (Author)

A82-46511
THE PHOTOELECTROCHEMICAL KINETICS OF P-TYPE GAP

W. J. ALBERY and P. N. BARTLETT (Imperial College of Science and Technology, London, England) (Electrochemical Society, Meeting, Denver, CO, Oct. 11-16, 1981.) Electrochemical Society, Journal, vol. 129, Oct. 1982, p. 2254-2261. Research supported by the British Petroleum Co., Hooker Chemical Corp., and Science and Engineering Research Council. refs

Current voltage curves have been measured for the reduction of $H(+)$, $Fe(III)$, and methylviologen at illuminated p-type GaP. The mechanisms and kinetic pathways for the reactions have been elucidated using the ring-disk electrode where the ring electrode measures the fluxes of the Faradaic products from the disk. Faster processes involving surface intermediates have been followed by measuring the transient currents on switching the light on or off and by modulating the light source. The variation of the different Faradaic photocurrents with potential, with irradiance, and with rotation speed are quantitatively explained by a model in which photogenerated electrons diffuse to the surface of the semiconductor and there undergo competitive reactions with $H(+)$, $Fe(III)$, or surface states. (Author)

A82-46516
VISIBLE LIGHT CONVERSION OF ONE-DIMENSIONAL NICKEL
DITHIOLENE COMPLEX ELECTRODE

Y. UMEZAWA, T. YAMAMURA, and A. KOBAYASHI (Tokyo, University, Tokyo, Japan) Electrochemical Society, Journal, vol. 129, Oct. 1982, p. 2378-2380. refs

A82-46519
STUDIES OF PHOTOCORROSION AT THE
ZNSE-ELECTROLYTE INTERFACE BY PHOTOTHERMAL
DEFLECTION SPECTROSCOPY

B. S. H. ROYCE, R. GOLDSTEIN, R. MURATORE (Princeton University, Princeton, NJ), R. WILLIAMS, W. M. YIM (RCA Laboratories, Princeton, NJ), and F. SANCHEZ-SINENCIO (Electrochemical Society, Journal, vol. 129, Oct. 1982, p. 2393-2395. refs
 (Contract DAAG29-80-C-0053)

A82-47050#
NET ELECTRIC POWER OF CONCENTRATING SOLAR MIRROR
SYSTEMS FOR APPLICATION IN SPACE AS A FUNCTION OF
THE DISTANCE OF THE SUN

J. BLUMENBERG and P. PANAGOPOULOS (Muenchen, Technische Universitaet, Munich, West Germany) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 24 p. (IAF PAPER 82-401)

In the whole realizable temperature range up to 1800 K, spherical systems display more favorable optimum specific masses than parabolic systems. For all distances to the sun investigated here (between 0.3 and 5.0 AU), spherical systems show more favorable optimum specific masses than parabolic systems with the same thermodynamic processes. The closer to the sun the two systems operate, the better is the optimum specific mass of the system. Systems with a Rankine process exhibit a more favorable optimum specific mass than systems with a Brayton process. The Carnot process as an ideal comparative process always gives better values than Rankine and Brayton processes. The radiator temperatures of the Carnot and Rankine processes exhibit very good behavior. Up to a maximum process temperature of 1800 K, which is realizable in the near future, the radiator temperature does not exceed 950 K. The application of beryllium technology is considered possible. C.R.

02 SOLAR ENERGY

A82-47051#

PROSPECTS FOR INTERNATIONAL COOPERATION IN SPS RESEARCH, DEVELOPMENT AND DEMONSTRATION

R. A. WILLIAMSON and A. WASSERMAN (Office of Technology Assessment, Washington, DC) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 6 p. refs
(IAF PAPER 82-404)

Positive and negative aspects of international cooperation for the development of SPS satellites are discussed. The points raised are a result of a review by the U.S. Office of Technology Assessment, which projected a possible worldwide demand for 295-465 GW of SPS-derived electricity by the year 2030. The visibility of an SPS in the sky could possibly be a significant psychological factor for developing nations, although it may be impossible for any one nation to construct an SPS unilaterally. Sharing the expenses and resources among nations is calculated to make the construction of an SPS feasible. Member nations of the construction team would share in the power produced. Measures to avoid interference with other nations' spacecraft are noted to be necessary, as well as international agreements which prohibit antisatellite weapons. Attention is given to a distribution of research, the sharing of research data, and the sharing of financial burdens.
M.S.K.

A82-47255

SPACE PLATFORM SOLAR ARRAY - A PROGRESS REPORT

M. GERBASI (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) and P. GOLDSMITH (TRW Space and Technology Group, Redondo Beach, CA) In: Making space work for mankind; Proceedings of the Nineteenth Space Congress, Cocoa Beach, FL, April 28-30, 1982. Cape Canaveral, FL, Canaveral Council of Technical Societies, 1982, p. 1-27 to 1-38.

Technological requirements for the Space Platform Solar Array are discussed, presenting a summary of key aspects of the solar array design, identifying technological issues, and assessing testing efforts currently under way to resolve these issues. The performance of different types of arrays and the special requirements of future arrays, such as retraction and redeployment, are discussed, and the projected array for the Space Platform is shown and discussed. Recent test efforts include an extension/retraction mast test, KC-135 zero 'g' testing, plasma testing of solar panels, and temperature cycling of panel designs.
C.D.

A82-47592

CONDITIONS FOR ACHIEVING IDEAL AND LAMBERTIAN SYMMETRICAL SOLAR CONCENTRATORS

A. LUQUE and E. LORENZO (Madrid, Universidad Politecnica, Madrid, Spain) Applied Optics, vol. 21, Oct. 15, 1982, p. 3736-3738. refs

This paper is concerned with symmetrical bidimensional concentrators and it is proved that for a given source's angular extension a curve exists that divides the plane into two regions. No ideal concentrator can be found with its edges on the outer region and no Lambertian concentrator can be found with its edges on the inner region. A consequence of this theorem is that a concentrator is forced to cast some of the incident energy outside the collector to ensure its obtaining the maximum power.
(Author)

A82-47593

DISPERSIVE CONCENTRATING SYSTEMS BASED ON TRANSMISSION PHASE HOLOGRAMS FOR SOLAR APPLICATIONS

W. H. BLOSS, M. GRIESINGER, and E. R. REINHARDT (Stuttgart, Universitaet, Stuttgart, West Germany) Applied Optics, vol. 21, Oct. 15, 1982, p. 3739-3742. Commission of the European Communities refs
(Contract CEC-ESC-R-38-D(B))

The efficiency of photovoltaic generators based on different semiconductor materials with optimized band gaps can achieve considerably higher values than those contained with single-junction

solar cells. A new type of concentrating system is presented which allows high concentration and simultaneous splitting of the spectral region. This dispersive and concentrating (DISCO) system is based on volume phase transmission holograms which exhibit minimum absorption, high diffraction efficiency, and adjustable dispersion. The spectral imaging properties of volume phase transmission holograms can be optimized with respect to the requirements for solar applications.
(Author)

A82-47999

BREAKEVEN COSTS OF STORAGE IN OPTIMIZED SOLAR ENERGY SYSTEMS

R. W. LEIGH (Brookhaven National Laboratory, Upton, NY) Energy (UK), vol. 7, Aug. 1982, p. 689-703. refs
(Contract DE-AC02-76CH-00016)

This paper describes the results of an analysis of the breakeven cost, or value, of energy storage to solar energy systems. The value of storage depends strongly both on the solar fraction of the solar energy system in which the storage is employed and on the cost of the collectors used in the system. Various strategies for dealing with this ambiguity are presented. For a broad class of technically and economically practical solar energy systems, storage costs need only be low enough to make a system employing very small amounts of storage practical. Reductions in the cost of collectors will thereafter produce greater reductions in the total system costs or provide greater fuel displacement at constant total system cost than will reductions in the cost of storage, within the limits discussed in the body of the paper. The analysis makes use of a simple, accurate representation of solar energy system performance which may prove useful in other contexts.
(Author)

A82-48024

KINETIC AND SPECTROSCOPIC BEHAVIOUR OF PROFLAVIN TRANSIENTS STUDIED BY PULSE RADIOLYSIS

S. SOLAR, W. SOLAR, and N. GETOFF (Wien, Universitaet; Ludwig Boltzmann Institut fuer Strahlenchemie, Vienna, Austria) Zeitschrift fuer Naturforschung, Teil a, vol. 37a, Sept. 1982, p. 1077-1082. Research supported by the Bundesministerium fuer Wissenschaft und Forschung. refs

The semireduced transients of proflavin were investigated in airfree acid aqueous solutions by a combined pulse radiolysis-computer optimization procedure, in order to provide information for the application of proflavin as a sensitizer in photochemical and photoelectrochemical devices for solar energy utilization. The main product, semiquinone (C-radical; 75%), forms with k equals 6.4×10 to the 9th cu dm/mol sec, decays by dimerization (2k equals 2×10 to the 9th cu dm/mol sec) and dismutation (2k equals 0.5×10 to the 9th cu dm/mol sec), and possesses several absorption bands (epsilon 270 equals 1900, epsilon 360 equals 1530, and epsilon 460 equals 2250, and epsilon 530 equals 200 sq m/mol). The second transient, R.-species (N-radical, 16.5%), is produced with k equals 1.4×10 to the 9th cu dm/mol sec and decays preferentially by transformation into semiquinone with k equals 2×10 to the 5th/sec; its absorption band are: epsilon 295 equals 2300, epsilon 380 equals 1000, epsilon 440 equals 5000, and epsilon 680 equals 530 sq m/mol. In addition, H-adducts on various positions of the aromatic ring (8.5%) are formed with k equals 0.7×10 to the 9th cu dm/mol sec, decay according to a pseudo first order reaction, k equals 1.1×10 to the 4th/sec, and have absorption bands at epsilon 270 equals 2100 and epsilon 435 equals 1580 sq m/mol. N.B.

N82-28398# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ELECTRICAL CHARACTERIZATION OF SILICON PRODUCED BY ELECTROCHEMICAL PURIFICATION Progress Report, Jun. 1980 - Oct. 1981

A. E. KIBBLER Dec. 1981 44 p refs
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-005105; SERI/TP-212-1489) Avail: NTIS HC A03/MF A01

A procedure and methodology for the electrical characterization of small single crystal and polycrystalline silicon specimens are described. The tested material is manufactured by electrowinning or electrorefining processes in quantities ranging from 10 to 1000 milligrams. The material's potential for application in solar cell fabrication is indicated. The minimum measurement format includes: majority carrier type, resistivity, minority carrier diffusion length, minority carrier lifetime, Hall mobility, and Hall carrier density. The methods are proven to be reasonably reliable, reproducible (allowing for experimental variances), and usually successful in obtaining reportable results. The beginnings of device fabrication and measurement are investigated, which include: Schottky diodes, diffused junction diodes, MOS structures, conventionally diffused photocells, and ITO or SnO₂ photocells. DOE

N82-28568# Chicago Univ., Ill.
ENGINEERING DEVELOPMENT STUDIES FOR INTEGRATED EVACUATED CPC ARRAYS Interim Technical Progress Report

R. WINSTON and J. J. OGALLAGHER 30 Sep. 1981 27 p refs.

(Contract DE-AC04-81AL-16223)
(DE82-005676; DOE/AL-16223/1) Avail: NTIS HC A03/MF A01

A substantial improvement in optical efficiency over contemporary external reflector evacuated tube collectors was achieved by integrating the reflector surface into the outer glass envelope. The design, fabrication and preliminary test results are described for a prototype collector based on this concept. Efficiencies above 40% up to nearly 300 C may be achieved. A comprehensive test program to measure performance and operational characteristics of a 2 sq m panel (45 tubes) is being carried out and problems associated with the deployment and application of larger arrays are being studied. DOE

N82-28780* National Aeronautics and Space Administration. Pasadena Office, Calif.

METHOD OF FABRICATING SCHOTTKY BARRIER SOLAR CELL Patent

R. J. STIRN (JPL, California Inst. of Tech., Pasadena) and Y. C. M. YEH, inventors (to NASA) (JPL, California Inst. of Tech., Pasadena) 23 Mar. 1982 11 p Filed 16 Jan. 1981 Supersedes N81-26553 (19 - 17, p 2360)

(NASA-CASE-NPO-13689-4; US-PATENT-4,321,099;
US-PATENT-4,278,830; US-PATENT-APPL-SN-225501;
US-PATENT-APPL-SN-93714; US-PATENT-APPL-SN-837513;
US-PATENT-APPL-SN-683073; US-PATENT-APPL-SN-597430;
US-PATENT-CLASS-148-175; US-PATENT-CLASS-29-572;
US-PATENT-CLASS-427-531; US-PATENT-CLASS-427-74)
Avail: US Patent and Trademark Office CSCL 10A

On a thin substrate of low cost material with at least the top surface of the substrate being electrically conductive is deposited a thin layer of heavily doped n-type polycrystalline germanium, with crystalline sizes in the submicron range. A passivation layer may be deposited on the substrate to prevent migration of impurities into the polycrystalline germanium. The polycrystalline germanium is recrystallized to increase the crystal sizes in the germanium layer to not less than 5 microns to serve as a base layer on which a thin layer of gallium arsenide is vapor epitaxially grown to a selected thickness. A thermally-grown oxide layer of a thickness of several tens of angstroms is formed on the gallium arsenide layer. A metal layer, of not more about 100 angstroms thick, is deposited on the oxide layer, and a grid electrode is deposited to be in electrical contact with the top surface of the metal layer. An antireflection coating may be deposited on the exposed top surface

of the metal layer.

Official Gazette of the U.S. Patent and Trademark Office

N82-28784*# National Aeronautics and Space Administration. Pasadena Office, Calif.

WIND AND SOLAR POWERED TURBINE Patent Application

I. D. WELLS (JPL), J. L. KOH (JPL), and M. HOLMES, inventors (to NASA) (JPL) 19 May 1982 24 p

(Contract NAS7-100)
(NASA-CASE-NPO-15496-1; US-PATENT-APPL-SN-379602)
Avail: NTIS HC A02/MF A01 CSCL 10A

An efficient, cost effective wind and solar driven power generating station is described. It is well adapted for satisfying the electrical power requirements of a relatively small community located in a geographic area having favorable climatic conditions for solar and wind driven power generation. The disc shaped structure is mounted in an elevated position relative to the ground to expose it to the prevailing wind and solar radiation. The structure includes a first plurality of radially extending air passages which direct ambient wind to a radial flow turbine located in an opening in the center of the structure. A solar radiation absorbing surface which has black bodies is disposed over the first plurality of air passages. NASA

N82-28785*# National Aeronautics and Space Administration. Pasadena Office, Calif.

SOLAR CONCENTRATOR PROTECTIVE SYSTEM Patent Application

M. K. SELCUK, inventor (to NASA) (JPL) 25 Jun. 1982 15 p
(Contract NAS7-100)

(NASA-CASE-NPO-15662-1; US-PATENT-APPL-SN-392103)
Avail: NTIS HC A02/MF A01 CSCL 10A

A mechanism that blocks concentrated sunlight from reaching a receiver, in the event of a tracking failure or loss of coolant is described. Sunlight is normally concentrated by a dish reflector onto the opening of a receiver. A faceplate surrounds the opening, and coolant carrying tubes, line the receiver. If the concentrated sunlight wanders so it begins to fall on the faceplate, then the sunlight will melt a portion of a fuse wire and break the wire. Similarly, if there is no coolant in tubes, the wire portion will break. The wire is attached to a flange on a shutter frame, and breaking of the fuse wire allows the frame to fall. Normally, the shutter frame supports shutter elements that are held open by cam followers that bear against cams. NASA

N82-28799# Arizona State Univ., Tempe. Coll. of Engineering and Applied Sciences.

NEW LOOK AT LONG-TERM COLLECTOR PERFORMANCE AND UTILIZABILITY

D. L. EVANS, T. T. RULE, and B. D. WOOD Aug. 1981 58 p refs

(Contract DE-AC03-79CS-30203)
(DE82-005259; ERC-R-81015) Avail: NTIS HC A04/MF A01

A technique to calculate monthly collection efficiency or monthly utilizability for solar thermal flat plate and concentrating generic collectors was developed. The technique is applicable to collectors operating with a fixed fluid inlet temperature. The technique consists of empirically determined performance maps which enable quick evaluations of changes in collector design, geographic location and collector inlet temperature. The collector input variables are those commonly measured in most thermal test procedures; geographic input variables are the mean monthly temperature and K/sub T/. The method gives good results compared to long term hourly simulation. The technique allows determination of operating conditions for collector performance to depend on site-to-site solar radiation/weather variability and uncertainties which can be expected from its use. DOE

02 SOLAR ENERGY

N82-28802# Arizona State Univ., Tempe. Solar Energy Research Lab.

DYNAMIC ANALYSIS AND SIMULATION OF A LARGE SCALE THERMAL SIMULATOR

K. H. JANZEN, B. W. MCNEILL, and B. D. WOOD Oct. 1981
133 p refs

(Contract DE-AC03-79CS-30203)

(DE82-005588; ERC-R-81027) Avail: NTIS HC A07/MF A01

Computer simulation of a pneumatically controlled, thermal energy simulator system is discussed. Mathematical model of the system was developed. The model was formulated to assist in optimizing the performance of the thermal simulator system and to help in locating areas of improvement, and to provide a tool to assist in designing a thermal simulator system. Modelling goals consisted of formulating: (1) general, component models, (2) an easily modified system model, and (3) an easy to use computer program. The system component models include a pneumatic controller, three way mixing valve and actuator assembly and temperature transmitter, and a steam/water heat exchanger. The thermal simulator was used to experimentally validate the component and system models. System model validation results show that the system model predicts system response adequately. It is shown that the best performance occurred at low gain and high actuator span settings. DOE

N82-28803# Arizona State Univ., Tempe. Solar Energy Research Lab.

DESIGN AND VALIDATION OF A THERMAL SIMULATOR FOR SOLAR SYSTEM PERFORMANCE TESTING

J. F. KOTAS, B. D. WOOD, B. W. MCNEILL, and D. L. EVANS
Aug. 1981 144 p refs

(Contract DE-AC03-79CS-30203)

(DE82-005589; ERC-R-80031) Avail: NTIS HC A07/MF A01

A liquid thermal simulator which processes heat up to a maximum heat rate of 10.5 kW is discussed. Four in-line water heaters of varying power levels provide energy in discrete steps. Each heater is interfaced by a series of relays to a minicomputer, which also monitors fluid stream temperatures. Time constants and steady state power levels for each heater for six different flowrates were found. Two modes of heating element control were devised. It is shown that dynamic heater control minimized the difference between the desired heat rate and the simulator heat rate much better than the steady state control algorithm. Mathematical models of a flat plate collector and residential cooling load were developed. Simulator thermal output deviated a maximum of 3% from the actual collector output under the identical operating conditions. DOE

N82-28805# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

THERMAL AND ECONOMIC ANALYSIS OF SOLAR-ASSISTED HEAT PUMPS FOR LOW-TEMPERATURE IPH APPLICATIONS

S. K. CHATURVEDI and L. M. MURPHY Oct. 1981 57 p refs
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)

(DE82-006185; SERI/TR-632-880) Avail: NTIS HC A04/MF A01

The potential technical and economic merits of solar assisted heat pump (SAHP) systems (which are high temperature when compared with residential applications) for low-temperature IPH applications are considered. The system looks more promising as the weather becomes more severe, and thus appears to have significant benefit in the less clement industrial areas of the country and in areas where land constraints are a concern. Author

N82-28806# Automation Industries, Inc., Silver Spring, Md. Vitro Labs. Div.

SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SUMMERWOOD ASSOCIATES, HOUSE G, OLD SAYBROOK, CONNECTICUT, JUNE 1980 - MAY 1981

M. RAYMOND 1981 100 p refs

(Contract DE-AC01-79CS-30027)

(DE82-004408; SOLAR/1081-81/14) Avail: NTIS HC A05/MF A01

An active solar energy system designed to supply 62% of the space heating and 100% of the hot water is described. It is equipped with flat plate collectors with pyramidal optics reflectors, a 600-gallon concrete storage tank, and an auxiliary system consisting of a dual-source heat pump with electrical resistance heater. The solar fraction of space and water heating was 36%, substantially less than was expected, due to less solar energy being collected than was calculated. The solar savings ratio, conventional fuel savings, system performance factor, and solar system coefficient of performance are also given as well as outdoor temperature, heating degree-days, and daily insolation. The performance of the total system and of the collector, storage, hot water and space heating subsystems is analyzed, and the system operating energy, energy savings, and weather conditions are reported. The system is described and the sensors used are discussed. DOE

N82-28807# Department of Housing and Urban Development; Washington, D. C. Solar Heating and Cooling Demonstration Program.

SOLAR PROJECT DESCRIPTION FOR SADDLE HILL TRUST: LOT 77, SINGLE FAMILY RESIDENCE, MEDWAY, MASSACHUSETTS

D. MOORE 6 Nov. 1981 45 p Prepared in cooperation with Boeing Company, Seattle

(Contract DE-AB01-76CS-31020)

(DE82-003326; SOLAR/1040-81/50) Avail: NTIS HC A03/MF A01

The system consists of four flat plate air-based collectors with a gross area of 77 square feet, an air-to-water heat exchanger, and a 120-gallon preheat tank for storage. Preheated domestic water is supplied from the preheat tank to a conventional gas-fired 40-gallon domestic hot water tank which supplies the residential hot water demand. The original cost estimate for provisioning and installation of the solar system are given. Four modes of operation are described: collector-to-preheat, preheat-to-domestic hot water, night or cloudy collector condition, and overheat protection. The system performance evaluation instrumentation for the National Solar Data Network is described. T.M.

N82-28808# Automation Industries, Inc., Silver Spring, Md. NATIONAL SOLAR DATA PROGRAM PERFORMANCE RESULTS, VOLUME 4

1981 45 p refs

(Contract DE-AC01-79CS-30027)

(DE82-002536; SOLAR/0005-81/82) Avail: NTIS HC A03/MF A01

Monitored passive buildings are compared. Performance analysis methodology for passive heating systems in the National Solar Data Network (NSDN) is discussed. Performance of two passive domestic hot water systems is assessed. The NSDN passive program is discussed. Thermal performance of solar systems in the NSDN is assessed. DOE

N82-28809# Sandia Labs., Albuquerque, N. Mex.
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION
 EXPERIMENT OPERATIONAL PERFORMANCE REPORT.
 VOLUME 3: MT. LAGUNA RADAR STATION, MT. LAGUNA,
 CALIFORNIA**

Oct. 1981 20 p Prepared in cooperation with Boeing Computer Services Co., Seattle
 (Contract DE-AC04-76DP-00789)
 (DE82-003006; SAND-81-7090/3) Avail: NTIS HC A02/MF A01

The daily and monthly electric energy production, insolation, and efficiency are given. Energy production is graphed as a function of power level, array field voltage, cell temperature, and hour of the day. The input, output and efficiency of the power conditioner are given. The daily system availability is graphed. Heating and cooling loads, average ambient temperature, and average wind speed are given for the month, and cell temperature, ambient temperature, wind speed and insolation are graphed as a function of the hour of the day. Also the number of occurrences of winds at different azimuth angles is graphed. T.M.

N82-28810# Science Applications, Inc., McLean, Va.
**DESIGN HANDBOOK FOR PHOTOVOLTAIC POWER SYSTEMS.
 VOLUME 1: SIMPLIFIED METHODS FOR UTILITY
 INTERCONNECTED SYSTEMS**

Y. P. GUPTA and K. YOUNG Oct. 1981 319 p Prepared for Sandia Labs., Albuquerque, N. Mex.
 (Contract DE-AC04-76DP-00789)
 (DE82-003108; SAND-80-7147/1) Avail: NTIS HC A14/MF A01

Principles of photovoltaic power system operation and the elements of system design are discussed. Design characteristics and issues (related to site conditions, building architecture, energy use, and economics) which influence PV system design and performance are identified. Economic feasibility and preliminary array sizing for a PV system application are assessed. A system configuration appropriate for the given site, building, and energy application is provided. Standard techniques and concepts of economic evaluation that form the basis for determining cost effective sizes for PV solar arrays are presented. The building energy load data that is required to perform the PV system analyses are characterized. Procedures for estimating residential energy demand are included. The array, estimate performance, and evaluate the economic value of the PV system are sized. Key aspects of system design including module/panel interconnection, array structure, power conditioning, and utility/load interfaces are discussed. DOE

N82-28811# Delaware Univ., Newark. Inst. of Energy Conversion.

**ZN3P2 AS AN IMPROVED SEMICONDUCTOR FOR
 PHOTOVOLTAIC SOLAR CELLS Quarterly Report, 1 Jun. - 31 Aug. 1981**

Nov. 1981 37 p refs Sponsored by Midwest Research Inst.
 (Contract DE-AC02-77CH-00178)
 (DE82-004259; SERI/PR-8062-1-T13; QR-12) Avail: NTIS HC A03/MF A01

Al/Zn3P2 Schottky solar cells were prepared by depositing a thin film of Al on polycrystalline Zn3P2 wafers by dc sputtering. The samples were heated in air at 1000C for several hours. The change in spectral response of the cells and Auger depth profiles indicate that Al diffuses in Zn3P2. The $v_{sub} oc/$ and barrier height in these cells decreased after heating. Attempts were made to find an n-type dopant for Zn3P2. Zn3P2 wafers were annealed in the presence of In, Al, Ca, As and Na, and the conductivity type remained unchanged. The effect of heat treatment on Mg/Zn3P2 cells prepared on thin polycrystalline Zn3P2 films were studied. An n/p junction was formed after heating as evidenced from the change in the cell parameters ($v_{sub} oc/$, J_0) and the spectral response. The junction depth did not follow the time dependence after prolonged heating. It is suspected that a p() layer exists near the back contact due to diffusion of Fe in the Zn3P2 thin film during the film growth. Author

N82-28812# Sandia Labs., Albuquerque, N. Mex. Photovoltaic Concentrator Technology Div.

DESIGN STUDIES FOR CONCENTRATING PHOTOVOLTAIC ARRAYS

M. W. EDENBURN Nov. 1981 29 p refs
 (Contract DE-AC04-79DP-00789)
 (DE82-005113; SAND-81-0944) Avail: NTIS HC A03/MF A01

Several studies of the past 2 years were compiled. Design areas represented include cell cooling, optical components, and array tracking structures. Many design parameters were optimized to arrive at a minimum cost for energy from an array. T.M.

N82-28813# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ADVANCED SOLAR ENERGY RESEARCH PROGRAM Progress Report, 1 Oct. 1979 - 31 Mar. 1980

A. J. NOZIK, ed. Oct. 1981 87 p refs
 (Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
 (DE82-004791; SERI/PR-623-740) Avail: NTIS HC A05/MF A01

Photobiology, photochemical conversion and storage, photoelectrochemistry, and materials research are reported. Three areas of photobiological research under investigation are discussed: in vitro energy conversion, microbiological hydrogen production, and algal hydrocarbon production. Sensitizers for solar photochemistry, redox catalysis, coupled systems, and inorganic photochemistry are reviewed. Theory and modeling of the energetics of semiconductor/electrolyte junctions and the effects of inversion are reported as well as new semiconductor electrode materials and work on photoelectrodialysis. The mechanisms affecting materials performance in solar energy conversion systems and development of new materials that improve system efficiency, reliability and economics are reported. DOE

N82-28814# Midwest Research Inst., Golden, Colo.
EVALUATION OF THICK-FILE INKS FOR SOLAR CELL GRID METALLIZATION

S. HOGAN and K. FIROR Oct. 1981 58 p refs
 (Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
 (DE82-005615; SERI/TR-611-1186) Avail: NTIS HC A04/MF A01

Commercially available thick film conductor links were studied to determine their suitability for use as solar cell front electrical contacts. By varying processing parameters such as firing profile and length of HF etch, it is shown that most of the silver-based inks form good electrical contacts. Regardless of ink composition, adjustment of processing parameters is necessary to optimize the performance of a thick-film solar cell contact. The base metal conductor inks tested are found to be unsuitable for solar cell front metallization. The two major problems encountered were high diffusivities in silicon and high series resistances introduced by the base-metal contacts. T.M.

N82-28817# Mid-American Solar Energy Complex, Minneapolis, Minn.

SUMMARY OF THE NORTHSTAR HOME: AN EXTENSION OF THE SOLAR 80 PROGRAM

Sep. 1981 10 p
 (Contract DE-AC02-79CS-30150)
 (DE82-004688; MASEC-R-81-086; P-101-16) Avail: NTIS HC A02/MF A01

The objective of the Northstar program was to develop and evaluate a detailed design for a low cost house suited for cold climates which would be acceptable to mid-income families and would not need a furnace. The program's four phases are described, including a demonstration design, demonstration construction and monitoring, development of a family of alternative designs, and commercialization. A brief description of the home is included. DOE

02 SOLAR ENERGY

N82-28820# Sandia Labs., Albuquerque, N. Mex. Enhanced Oil Recovery Div.

ECONOMIC ANALYSIS BASED ON LAND COSTS OF COLLECTOR SPACING IN A COLLECTOR FIELD

D. O. LEE Oct. 1981 40 p refs

(Contract DE-AC04-76DP-00789)

(DE82-004519; SAND-81-1165) Avail: NTIS HC A03/MF A01

Three collector fluid outlet average field temperatures were used: 200, 250, and 300 C. Land cost varied from \$0.54/sq m to \$215.20/sq m, and collector costs from \$53.80/sq. m to \$322.80/sq. m FOB factory. Costs of fees, controls, foundations, etc., are considered as separate items which are added to the land and collector costs to obtain the total cost of the systems. These studies were normalized to a 5,000,000 Btu/day requirement. Thus, the life-cycle costs of the various configurations are, in essence, the cost of energy. T.M.

N82-28825# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ATMOSPHERIC EFFECTS ON SOLAR-CELL CALIBRATION AND EVALUATION

R. E. BIRD and R. L. HULSTROM Dec. 1981 32 p refs

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)

(DE82-007370; SERI/TR-215-1379) Avail: NTIS HC A03/MF A01

Atmospheric effects on cell short currents and calibration numbers for silicon, gallium arsenide and cadmium sulfide cells are illustrated. Radiative transfer codes are used to illustrate the effects of precipitable water, turbidity, air mass, and global normal irradiance compared with direct normal irradiance on cell performance. Precipitable water is shown to have a relatively large effect on GaAs (5%) as compared to a small effect (2%) on other cells. The quantitative effects of air mass and turbidity are illustrated. It was found that under some atmosphere conditions global calibration methods have a greater dependence on air mass than direct normal calibrations methods. DOE

N82-28830# Chicago Univ., Ill.

FUNDAMENTALS AND TECHNIQUES OF NONIMAGING OPTICS FOR SOLAR-ENERGY CONCENTRATION Annual Progress and Status Summary Report

R. WINSTON and J. J. OGALLAGHER 30 Oct. 1981 17 p refs

(Contract DE-AC02-80ER-10575)

(DE82-004885; DOE/ER-10575/2) Avail: NTIS HC A02/MF A01

The development of the theoretical formulation of nonimaging optical principles and the investigation of practical questions having to do with the implementation of newly developed designs for solar and other applications are discussed. Forms of ideal concentrators known at present as shapes which do not disturb the lines of flow of a vector field defining the so called vector lux J are discussed. A search for a differential equation (other than $\text{div } J = 0$) was unsuccessful in the geometrical optics framework. However, an extension to the physical optics domain based on new theories of radiometry in partially coherent light was initiated and appears more promising. Linear concentrator designs to reduce gap losses for tubular absorbers were analyzed in detail. Fresnel lenses and less conventional diffractive components (i.e. holograms) were studied. A ray trace optimization of two second stage concentrators was carried out. Experimental measurements and ray trace studies of the response of an actual concentrator shape and absorber configuration for a fabricated prototype shows that deviation from ideal behavior can be accurately modeled. DOE

N82-28835# Sandia Labs., Albuquerque, N. Mex.

INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT. VOLUME 4: MT. LAGUNA RADAR STATION, MT. LAGUNA, CALIF.

Dec. 1981 35 p Prepared in cooperation with Boeing Computer Services, Inc., Seattle

(Contract DE-AC04-76DP-00789)

(DE82-007565; SAND-81-7090/4) Avail: NTIS HC A03/MF A01

Performance data are given for a radar station in California for the months of September and October, 1981. Monthly and daily energy production, monthly and daily incident radiation totals, and monthly and daily array field efficiencies are presented. Energy production is graphed as a function of power level, voltage, cell temperature, and hour of the day for each month. Power conditioner input, output, and efficiency are given for each month. The daily availability is graphed for each month. Monthly insolation data, heating and cooling load, ambient temperature average for the month, wind speed and direction data, hourly cell temperature, ambient temperature, and hourly insolation data are presented. DOE

N82-28836# Sandia Labs., Albuquerque, N. Mex.

INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT. VOLUME 5: NEWMAN POWER STATION SITE, EL PASO, TEX.

Dec. 1981 35 p Prepared in cooperation with Boeing Computer Services, Inc., Seattle

(Contract DE-AC04-76DP-00789)

(DE82-007566; SAND-81-7086/5) Avail: NTIS HC A03/MF A01

Performance data are given for a photovoltaic power supply at a Texas electric utility for the months of September and October 1981. The monthly and daily total electrical energy yield, monthly and daily total solar radiation incident, and the monthly and daily efficiency of the photovoltaic array are given. The energy production is graphed as a function of power level, voltage, cell temperature, and hour of the day. The daily system availability is graphed. The monthly and hourly insolation, monthly and hourly ambient temperature, and monthly and hourly wind speed are given, as are the total monthly heating and cooling loads and wind direction distribution. DOE

N82-29354*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

A NEW STRATEGY FOR EFFICIENT SOLAR ENERGY CONVERSION: PARALLEL-PROCESSING WITH SURFACE PLASMONS

L. M. ANDERSON 1982 13 p refs Presented at the 17th Intersoc. Energy Conversion Eng. Conf., Los Angeles, 8-13 Aug. 1982; sponsored by IEEE

(NASA-TM-82867; E-1236; NAS 1.15:82867) Avail: NTIS HC A02/MF A01 CSCL 10A

An advanced concept for direct conversion of sunlight electricity, which aims at high efficiency by tailoring the conversion process to separate energy bands within the broad solar spectrum is introduced. The objective is to obtain a high level of spectrum-splitting without sequential losses or unique materials for each frequency band. In this concept, sunlight excites a spectrum of surface plasma waves which are processed in parallel on the same metal film. The surface plasmons transport energy to an array of metal-barrier-semiconductor diodes, where energy is extracted by inelastic tunneling. Diodes are tuned to different frequency bands by selecting the operating voltage and geometry, but all diodes share the same materials. Author

N82-29377*# Bend Research, Inc., Oreg.
MEMBRANE SEPARATION TECHNOLOGY IN THE 1980S Final Report

H. K. LONSDALE 2 Mar. 1982 45 p refs Prepared for JPL
 (Contract NAS7-100; JPL-956158)
 (NASA-CR-169203; NAS 1.26:169203; REPT-46-1) Avail: NTIS
 HC A03/MF A01 CSCL 07D

The current status of membrane technology is assessed and industrial processes in which membrane technology could effect energy savings or other advantages are identified. The extension of current trends is recommended; i.e., the development of ultrathin and highly permselective membranes, the use of specific carriers to enhance permselectivity and permit 'uphill' diffusion, and the improvement of separation efficiency. Membranes are predicted to be important in biotechnology and in the production of solar energy. Guidelines indicating where and how to look for opportunities where evolving membrane technology might fit are provided. J.D.

N82-29497# Mid-American Solar Energy Complex, Minneapolis, Minn.

MASEC THERMAL-ANALYSIS WORKBOOK DESIGN HEATING LOAD AND SOLAR CONTRIBUTION: CALCULATION PROCEDURES

Sep. 1981 69 p refs
 (Contract DE-AC02-79CS-30150)
 (DE82-001751; MASEC-H-81-089; P-101-18) Avail: NTIS HC
 A04/MF A01

A method is provided to determine the hourly heat loss of a building under design conditions. To accomplish this, each part of the building shell must be analyzed and its heat loss calculated. Three energy analysis worksheets are provided to help facilitate the process. The first is used to determine U values and areas for above grade components of the building shell. Heat loss through below grade walls, below grade floors, and slabs on grade are figured on the second. Finally, transmission losses above grade, infiltration losses, and a total estimated design heating load are calculated on the third. A performance analysis technique based upon the solar savings fraction calculation method is designed to provide a detailed estimate of the energy requirements per heating season of a building with passive solar elements. The procedure is implemented by completing three worksheets. The first summarizes thermal specifications, calculated values and heating loads. The second is used to determine the amount of solar energy that is absorbed by the building per square foot of solar glazing. The third is used to find values of the monthly solar savings fraction and monthly and annual auxiliary heating requirement. Also calculated are annual passive solar contribution, passive solar fraction, and thermal integrity factor. DOE

N82-29498# Los Alamos Scientific Lab., N. Mex.
PASSIVE TEST-CELL EXPERIMENTS DURING THE WINTER OF 1979-1980

J. C. HYDE Nov. 1981 40 p refs
 (Contract W-7405-ENG-36)
 (DE82-007354; LA-9048-MS) Avail: NTIS HC A03/MF A01

The performance of a variety of passive solar heating configurations in 14 passive test cells were monitored. The cells included attached greenhouses, masonry and water walls with black-chrome absorber surfaces, night insulation, and phase-change thermal storage walls. The results of these side-by-side tests were used to make quantitative comparisons of the delivered performance of these configurations for the conditions under which they were tested. DOE

N82-29630# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.

WIND LOADS ON SOLAR COLLECTOR STRUCTURE

R. A. WILKE and H. L. CHEVALIER Sep. 1981 42 p refs
 (Contract DE-AC04-79AL-11774)
 (DE82-010970; DOE/AL-11774/T1) Avail: NTIS HC A03/MF
 A01

Unsteady wind loads upon a full scale collector in a natural environment and turbulent flow loads upon a model of a collector array are examined. A description of the collector structure is described, the data acquisition system is outlined, and the results obtained are given. The interaction between the wind strength and dynamic nature, and the structure itself were not determined either from the full scale data or the model test data from the wind tunnel. (LEW) DOE

N82-29709* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

METHOD OF MAKING A HIGH VOLTAGE V-GROOVE SOLAR CELL Patent

J. C. EVANS, JR., A. T. CHAI, and C. P. GORADIA, inventors (to NASA) 22 Jun. 1982 6 p Filed 24 Dec. 1980 Supersedes
 N81-16529 (19 - 07, p 0927)

(NASA-CASE-LEW-13401-1; US-PATENT-4,335,503;
 US-PATENT-APPL-SN-219678; US-PATENT-CLASS-29-572;
 US-PATENT-CLASS-136-249; US-PATENT-CLASS-148-1.5;
 US-PATENT-CLASS-357-30) Avail: US Patent and Trademark
 Office CSCL 10A

A method is provided for making a high voltage multijunction solar cell. The cell comprises a plurality of discrete voltage generating regions, or unit cells, which are formed in a single semiconductor wafer and are connected together so that the voltages of the individual cells are additive. The unit cells comprise doped regions of opposite conductivity types separated by a gap. The method includes forming V-shaped grooves in the wafer and thereafter orienting the wafer so that ions of one conductivity type can be implanted in one face of the groove while the other face is shielded. A metallization layer is applied and selectively etched away to provide connections between the unit cells.

Official Gazette of the U.S. Patent and Trademark Office

N82-29714*# National Aeronautics and Space Administration. Pasadena Office, Calif.

SALTLESS SOLAR POND Patent Application

E. I. H. LIN, inventor (to NASA) (JPL, California Inst. of Tech., Pasadena) 28 May 1982 24 p
 (Contract NAS7-100)

(NASA-CASE-NPO-15808-1; US-PATENT-APPL-SN-383068)
 Avail: NTIS HC A02/MF A01 CSCL 10A

A specifically-designed honeycomb structure is placed on the surface permits penetration of short wave solar radiation into the water, but efficiently insulates the resulting heated body of water from losing heat to the atmosphere by conduction, convection or infrared radiation. The honeycomb structure includes several honeycomb panels which are mounted adjacent to one another in a modular fashion to float on the surface of the water. Each honeycomb panel includes a multitude of honeycomb cells having a height-to-width or aspect ratio of at least approximately 14 to 1. The honeycomb cells effectively suppress convection of air in the panels. A radiation shield, comprising a cross-plate mounted substantially in the midsection of each cell, significantly reduces heat losses by infrared radiation. NASA

02 SOLAR ENERGY

N82-29716*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ANALYSIS AND DESIGN OF A 10 TO 30 KW GRID-CONNECTED SOLAR POWER SYSTEM FOR THE JPL FIRE STATION AND FIRST AID STATION

R. H. JOSEPHS 15 Apr. 1982 57 p refs Sponsored in part by NASA

(Contract NAS7-100; DE-AI01-80CS-30507)

(NASA-CR-169157; JPL-PUBL-82-51; NAS 1.26:169157) Avail:

NTIS HC A04/MF A01 CSCL 10B

The design and performance of a modestly sized utility-connected power conditioning system and its supporting photovoltaic collector are described and estimated. Utility preparations and guidelines to conform with the output of a small generating station with that of a large power network are examined. Author

N82-29720*# DHR, Inc., Washington, D.C.

APPLICATION OF PHOTOVOLTAIC ELECTRIC POWER TO THE RURAL EDUCATION/COMMUNICATION NEEDS OF DEVELOPING COUNTRIES Final Report

A. CABRAAL, D. DELANSANTA, and G. BURRILL Jul. 1982

61 p refs Prepared in cooperation with Associates in Rural Development, Inc., Burlington, Vt. Sponsored in part by Agency for International Development

(Contract DEN3-248)

(NASA-CR-167894; NAS 1.26:167894) Avail: NTIS HC A04/MF A01 CSCL 10B

The suitability (i.e., cost competitiveness and reliability) of photovoltaic (PV) power systems for rural applications in developing countries is considered. Potential application sectors include health delivery, education and communication where small amounts of electricity are needed to meet critical needs. Author

N82-29722*# Hughes Research Labs., Malibu, Calif.

MEDIUM ENERGY PROTON RADIATION DAMAGE TO (ALGA)AS-GAAS SOLAR CELLS Final Report, 8 Aug. 1979 - 1 May 1982

R. Y. LOO, G. S. KAMATH, and R. C. KNECHTLI Jul. 1982 93 p refs

(Contract NAS1-15926)

(NASA-CR-165946; NAS 1.26:165946) Avail: NTIS HC A05/MF A01 CSCL 10A

The performance of (AlGa)As-GaAs solar cells irradiated by medium energy 2, 5, and 10 MeV protons was evaluated. The Si cells without coverglass and a number of GaAs solar cells with 12 mil coverglass were irradiated simultaneously with bare GaAs cells. The cell degradation is directly related to the penetration of depth of protons with GaAs. The influence of periodic and continuous thermal annealing on the GaAs solar cells was investigated. N.W.

N82-29723*# ARCO Solar, Inc., Chatsworth, Calif.

AUTOMATED SOLAR PANEL ASSEMBLY LINE Final Report

H. SOMBERG May 1981 101 p Sponsored in part by DOE; prepared for JPL

(Contract JPL-955278; NAS7-100)

(NASA-CR-169206; DOE/JPL-955278-81/5; NAS 1.26:169206)

Avail: NTIS HC A06/MF A01 CSCL 10A

The initial stage of the automated solar panel assembly line program was devoted to concept development and proof of approach through simple experimental verification. In this phase, laboratory bench models were built to demonstrate and verify concepts. Following this phase was machine design and integration of the various machine elements. The third phase was machine assembly and debugging. In this phase, the various elements were operated as a unit and modifications were made as required. The final stage of development was the demonstration of the equipment in a pilot production operation. Author

N82-29724*# Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering.

PROCESSED-INDUCED DEFECTS IN EFG RIBBONS

B. CUNNINGHAM and D. G. AST May 1982 14 p refs Sponsored in part by DOE Prepared for JPL

(Contract JPL-956046)

(NASA-CR-169205; DOE/JPL-956046-82/3; NAS 1.26:169205;

REPT-4) Avail: NTIS HC A02/MF A01 CSCL 10A

The defect structure of processed edge defined film-fed growth (EFG) silicon ribbons was studied using a variety of electron microscopic techniques. Comparison between the present results and previous studies on as-grown ribbons has shown that solar cell processing introduces additional defects into the ribbons. The creation of point defects during high temperature phosphorus diffusion induces dislocation climb, resulting in the formation of dislocation helices in the diffused layer. B.W.

N82-29727# Teknologisk Inst., Tastrup (Denmark).

SOLAR HEATING SYSTEM IN BLOVSTROED. THE 2 1/2 YEAR MEASUREMENTS OF A 10M(2) HOT WATER SYSTEM

B. BOEHM and P. STEENSEN May 1981 41 p refs In DANISH

(DE82-901187; NP-2901187) (US Sales Only) HC A03/MF A01; DOE Depository Libraries

The experimental solar water heating system in Blovstroed (Denmark) was tested. The heat losses from the storage tank and piping were about twice as large as planned. The practical hot water consumption was smaller than planned. The solar collector itself had some insignificant damages and some rust on the absorber. The net yield was 692 kWh with water consumption about 1278 kWh. A new system based on experience of that from Blovstroed is expected to yield 390 kWh/sq m solar collector (5 times better performance). DOE

N82-29730# Arizona Univ., Tucson. Optical Sciences Center.

CHEMICAL VAPOR DEPOSITION OF AMORPHOUS SILICON FOR PHOTOTHERMAL SOLAR-ENERGY CONVERTERS Final Report, 1 May 1978 - 30 Apr. 1981

B. O. SERAPHIN May 1981 63 p refs

(Contract ER-78-S-02-4899)

(DE82-005290; DOE/ER-04899/T1) Avail: NTIS HC A04/MF A01

The chemical vapor deposition (CVD) of amorphous silicon alloys of sufficient solar absorptance and long time stability at temperatures in excess of 5000 C is studied. Deposited onto a substrate layer of high infrared reflectance such as CVD molybdenum, a reflector absorber tandem of good spectral selectivity for high temperature photothermal solar energy conversion results that can economically be fabricated in a flow through process was tested at 5000 C in vacuum. The role of the alloying atoms in determining the thermal stability and the optical properties of a noncrystalline material was also investigated. DOE

N82-29731# GTE Labs., Inc., Waltham, Mass.

DEVELOPMENT OF MATERIALS FOR A LUMINESCENT SOLAR COLLECTOR Annual Progress Report, 1 Sep. 1979 - 31 Dec. 1980

A. LEMPICKI, L. ANDREWS, and B. C. MCCOLLUM 1981 29 p refs

(Contract ER-78-C-02-4996; DE-AC02-78ER-04996)

(DE82-007518; DOE/ER-04996/2) Avail: NTIS HC A03/MF A01

Progress is reported in research of inorganic fluorescent materials for application as flat panel luminescent solar collectors. Efforts were concentrated on luminescent metal ions doped into glasses. The spectroscopic and photophysical properties of Cr(3+) in glasses were examined. Sensitization of Nd(3+) by codoping with Cr(3+) is discussed. The Cr(3) to Nd(3+) energy transfer was characterized in lithium lime silicate and aluminum phosphate glasses as a function of active ion densities. DOE

N82-29733# Booz-Allen and Hamilton, Inc., Bethesda, Md.
SOLAR CENTRAL RECEIVERS: THE TECHNOLOGY, INDUSTRY, MARKETS, AND ECONOMICS
 1 Sep. 1981 68 p
 (Contract DE-AC03-81SF-11436)
 (DE82-005296; DOE/SF-11436/1-EXEC-SUMM) Avail: NTIS HC A04/MF A01

Solar central receiver (SCR) technologies are described and compared briefly with other solar thermal technologies. Divergence in the capabilities of SCR technical options and the fact that no single SCR technology has emerged as the best technology for all applications are discussed. The necessity for continued technical development of both components and systems is presented. The geographic segmentation of the addressable market for SCR technology is considered. Economics and market factors favorable to adoption of SCR technology in the mid-1990's are described. The ways the competitive economics of SCR technology and its adoption rate in the market place can be improved with the implementation of specific federal programs are pointed out. The ways a cohesive federal program can serve to advance the date of free market competition and create a sustainable SCR industry are discussed. DOE

N82-29735# Center for the Environment and Man, Inc., Hartford, Conn.
VISCOSITY-STABILIZED SOLAR PONDS Final Report
 7 Aug. 1981 53 p refs
 (Contract DE-AC02-76CS-32980)
 (DE82-007513; DOE/CS-32980/T1; DOE-FR04200-4) Avail: NTIS HC A04/MF A01

Work previously completed on polymer stabilized solar ponds is described. A detailed outline is provided of work proposed to expand upon and complete the work and to determine the feasibility, both technical and economic, of a polymer stabilized solar pond. Information is presented on the polymers that have been reported in the literature and by the manufacturer of the polymer Carbopol. Proposed management and schedules and descriptions of the proposed personnel and facilities are included. Some candidate organic materials are described. Data relating to solar input, the relationship between the total energy available, the requirements for domestic heat, and present preliminary design ideas are discussed. DOE

N82-29737# San Bernardino West Side Community Development Corp., Calif.
THE 35 KILOWATT PEAK PHOTOVOLTAIC POWER SYSTEM, PHASE 1 Final Report
 M. L. STARY and D. BURGESS Nov. 1981 108 p
 (Contract DE-AC04-76DP-00789)
 (DE82-005714; SAND-81-7035) Avail: NTIS HC A06/MF A01

A 35 kilowatt peak photovoltaic power system is being implemented at a new industrial park in the city of San Bernardino, California. Phase I of this program includes the establishment and operation of a test station to obtain site specific weather data and to operate three types of photovoltaic arrays, fixed flat plate, tracking flat plate and concentrator, and system analysis and design of the Phase II, 35 kilowatt peak power system for installation on the roof of an 18,000 square foot, light manufacturing facility. An important aspect of the program is the establishment of a training and safety program to acquaint unskilled, minority workers with the operation and maintenance of photovoltaic power systems. The results of the Phase I activity are presented. DOE

N82-29738# Westinghouse Research and Development Center, Pittsburgh, Pa.
DEVELOPMENT OF COPPER SULFIDE/CADMIUM SULFIDE THIN-FILM SOLAR CELLS Technical Progress Report, 13 Jul. 1980 - 12 Oct. 1980
 J. R. SZEDON, W. J. BITER, J. A. ABEL, and H. C. DICKEY 5 Nov. 1981 15 p refs
 (Contract DE-AC02-77CH-00178)
 (DE82-005255; SERI/PR-8143-1-T4; TPR-5) Avail: NTIS HC A02/MF A01

The accuracy of substrate temperature control during CdS deposition was achieved by welding thermocouples to a molybdenum foil tab which was subsequently welded to the copper foil substrate. Structural features of the CdS films were consistent with control of the substrate temperature at 2200 C. Direct measurement of optical and electronic properties of the Cu₂S films used in cells requires removal of the copper foil substrate for optical transmission characterization. Simple etching of a window in the substrate is not acceptable since the CdS film cracks around the periphery of the window. Encouraging cell performance results were obtained with evaporated grids which consisted of two layers: a thin layer of either gold (840A) or copper (60A) on the Cu₂S surface and a 2.5 (SIGMA)m thick overlayer of lead. DOE

N82-29739# Ames Lab., Iowa.
PHOTOELECTROCHEMICAL SOLAR CELLS BASED ON D-BAND ELECTROCHEMISTRY AT TRANSITION METAL DISELENIDES Final Report
 B. A. PARKINSON, K. K. KAM, G. KLINE, and C. LEVY Nov. 1981 77 p refs
 (Contract W-7405-ENG-82; EG-77-C-01-4042)
 (DE82-006287; IS-4784) Avail: NTIS HC A05/MF A01

The photoelectrochemical behavior of synthetic crystals of WS₂, MoS₂ and crystals with mixed metal and chalcogen composition was studied and compared with the behavior of MoSe₂ and WSe₂. The composition and stoichiometry of the crystals and the composition of the electrolyte were varied and the behavior of the materials in a regenerative liquid junction solar cell was measured and analyzed. The quantum yields as a function of wavelength and photon flux were investigated and sunlight to electricity conversion efficiencies were measured. The formation of iodine layers on the photoelectrode surface under high illumination intensity was observed and discussed with respect to the use of these materials with solar concentrators. Various configurations for photoelectrochemical photovoltaic solar cells are reviewed and evaluated. Both flat plate cells and cells with moderate light concentration are examined. Several novel systems where the electrolyte plays a role in light concentration are proposed. DOE

N82-29741# Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center.
DEVELOPMENT OF COPPER SULFIDE/CADMIUM SULFIDE THIN-FILM SOLAR CELLS Technical Progress Report, 13 Oct. 1980 - 12 Jan. 1981
 J. R. SZEDON, H. C. DICKEY, J. A. ABEL, and W. J. BITER 5 Nov. 1981 43 p refs
 (Contract DE-AC02-77CH-00178)
 (DE82-005254; SERI/PR-8143-1-T5; TPR-6) Avail: NTIS HC A03/MF A01

Means were explored to better control wet-chemistry conditions attending formation of the Cu₂S layer on CdS-based solar cells. Dilution of active solutions in contact with the Cu₂S layer results in poorer cell performance. Use of an argon gas knife to dry the cell surface after etching, barrier formation, and rinsing allows greater control of process conditions and gives good cell results. Electroplating offers a promising low-cost alternative to evaporation of gold-grid electrodes. Cells with plated grids were significantly higher in efficiency than control cells with evaporated grids. DOE

02 SOLAR ENERGY

N82-29742# Automation Industries, Inc., Silver Spring, Md. Vitro Labs. Div.

CORROSION AND SCALING IN SOLAR HEATING SYSTEMS

R. J. FORESTI, JR. Dec. 1981 38 p refs

(Contract DE-AC01-79CS-30027)

(DE82-006139; SOLAR/0909-81/70) Avail: NTIS HC A03/MF A01

Corrosion, as experienced in solar heating systems, is described in simplistic terms to familiarize designers and installers with potential problems and their solutions. The role of a heat transfer fluid in a solar system is briefly discussed, and the choice of an aqueous solution is justified. The complexities of the multiple chemical and physical reactions are discussed in order that uncertainties of corrosion behavior can be anticipated. Some basic theories of corrosion are described, aggressive environments for some common metals are identified, and the role of corrosion inhibitors is delineated. The similarities of thermal and material characteristics of a solar system and an automotive cooling system are discussed. Based on the many years of experience with corrosion in automotive systems, it is recommended that similar antifreezes and corrosion inhibitors should be used in solar systems. The importance of good solar system design and fabrication is stressed and specific characteristics that affect corrosion are identified. DOE

N82-29745# Brookhaven National Lab., Upton, N. Y. Center for Analysis of Energy Systems.

BREAKEVEN COSTS OF STORAGE IN OPTIMIZED SOLAR ENERGY SYSTEMS

R. W. LEIGH Sep. 1981 36 p refs

(Contract DE-AC02-76CH-00016)

(DE82-006967; BNL-51428) Avail: NTIS HC A03/MF A01

The results of an analysis of the breakeven cost, or value, of energy storage to solar energy systems are described. It is shown that the value of storage depends strongly both on solar fraction of the solar energy system in which the storage is employed, and on the cost of the collectors used in the system. Various strategies for dealing with this ambiguity are presented, and it is shown that for a broad class of technically and economically practical solar energy systems, storage costs need only be low enough to make a system employing very small amounts of storage practical. Reductions in cost of collectors will thereafter produce greater reductions in the total system costs or provide greater fuel displacement at constant total system cost than will reductions in the cost storage, within limits discussed. DOE

N82-29746# RCA Labs., Princeton, N. J. Display and Energy Systems Research Lab.

AMORPHOUS SILICON SOLAR CELLS Quarterly Report, 1 Jan. - 31 Mar. 1981

D. E. CARLSON, R. S. CRANDALL, J. DRESNER, D. GOLDSTEIN, J. J. HANAK, A. R. MOORE, R. E. SCHADE, D. L. STAEBLER, H. A. WEAKLIEM, and R. WILLIAMS May 1981 71 p refs

Sponsored in part by Midwest Research Inst.

(Contract DE-AC02-77CH-00178)

(DE81-030278; SERI/PR-0-9372-2; QR-2) Avail: NTIS HC A04/MF A01

The photoconductive response of Schottky-barrier and p-i-n solar cell structures was analyzed. It shows that the photoconductivity determines the fill factor, rather than the dark current, as in crystalline silicon cells. An analysis of the I-V curves of p-i-n cells shows that the electron and hole drift lengths are comparable. High conductivity p and n type films ($\sigma = 1-10$ (LAMBDA) (+1).cm(+1)) were produced in an rf discharge for T/sub s/ 4000 C and in a dc cathodic discharge for T/sub s/ 3500 C. Diffusion lengths of approx. 0.8 (SIGMA)m were measured in undoped a-Si:H films at illumination levels of approx. 0.1 Sun. The activation energy of the diffusion length is 0.28 eV. The technique for measuring the diffusion length was improved by a liquid Schottky-barrier contact. It is confirmed that carbon alloying of the p layer improves the performance of p-i-n cells illuminated through that layer and also that the stability is better for cells illuminated through the p layer. It is indicated that a major factor

determining the efficiency of ITO/n-i-p cells is the ITC/n contact. Several parameters were determined that affect device stability. A gradual boron profile enhances stability, as does a thin, undoped layer. Increased oxygen contamination increases the degradation of a-Si:H p-i-n cells. DOE

N82-29747# Massachusetts Inst. of Tech., Cambridge.

SOLAR PHOTOVOLTAIC/THERMAL (HYBRID) ENERGY PROJECT Final Report

D. B. SHELDON Sep. 1981 105 p refs

(Contract DE-AC02-77CS-34577)

(DE82-006200; DOE/CS-34577/T2; COO-4577-11) Avail: NTIS HC A06/MF A01

Development of photovoltaic/thermal (PV/T) collectors and residential heat pump systems is reported. Candidate collector and residential heat pump systems were evaluated using the TRNSYS computer program. It is found that combined heat pump and PV array is a promising method for achieving economical solar cooling. Where the cooling load is dominant, exclusively PV collectors rather than PV/T collectors are preferred. Where the heating load is dominant, the thermal component of PV/T collectors makes a significant contribution to heating a residence. PV/T collectors were developed whose combined efficiency approaches the efficiency of a double glazed, exclusively thermal collector. The design and operational problems of air source heat pumps are reviewed. Possible effects of compressor startup transients on PV power system operation are discussed. DOE

N82-29748# Delaware Univ., Newark. Inst. of Energy Conversion.

IMPROVED AMORPHOUS SI SOLAR CELLS Quarterly Progress Report, 1 Nov. 1980 - 1 Feb. 1981

V. L. DALAL Oct. 1981 26 p refs Sponsored by SERI

(Contract DE-AC02-77CH-00178)

(DE82-004714; SERI/PR-9195-1-T2) Avail: NTIS HC A03/MF A01

The growth of F-etched a-Si films is reported. Auger emission spectroscopy reveals that F concentration in these films is below the detection limit. High conductivity is reportedly obtained in both cathodic and anodic films. A model and supporting experimental data that suggest that a-Si films deposited from (SiF₄+H₂) mixtures are subjected to strong ionic etching during growth are presented. A systematic study of electron drift mobilities. Fabrication of a-Si:H solar cells with high internal currents is reported. High open-circuit voltages are reported, as well as an efficiency of 3.6% on 0.24 sq c. area. A technique was developed for studying the mobility x lifetime products for minority and majority carriers in a-Si:H devices using the quantum efficiency. DOE

N82-29749# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

LABORATORY EXPERIMENTS ON HEAT AND MASS EXTRACTION FROM SOLAR PONDS Quarterly Report, 1 Apr. - 30 Jun. 1981

F. ZANGRANDO Nov. 1981 27 p refs

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)

(DE82-006263; SERI/PR-252-1394; QR-1) Avail: NTIS HC A03/MF A01

The problem of heat and mass extraction from solar ponds is introduced, and a schedule for laboratory analysis of the topic is proposed. A literature review and preliminary conclusions based on existing analytical, numerical, and experimental work published on heat and mass extraction from partially stratified fluids, or related problems are presented. Work in the following areas is reviewed: selective withdrawal from stratified fluids; jets and plumes in stratified fluids and surface jets; flow recirculation in enclosed water bodies; stability of the interface between layers of different density; and energy exchange from buoyant jets. Author

N82-29752# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

OPEN-CYCLE LITHIUM CHLORIDE (SOLAR) COOLING Final Report, 1 Feb. 1980 - 31 May 1981

G. O. G. LOEF, S. RAO, and T. LENZ Dec. 1981 55 p refs
(Contract DE-AC03-79CS-30206)
(DE82-005665; DOE/CS-30206/T1) Avail: NTIS HC A04/MF A01

The characteristics of packed towers for use with open-cycle lithium chloride solar cooling are described, including types of packing, pressure drop, irrigated packings and allowable vapor velocity. The theory of packed column operation is outlined. Coefficients of heat transfer and mass transfer in a packed column in which water is vaporized from a LiCl solution by heated air were experimentally determined. The influences of air flow rate, humidity, and temperature on the coefficients of heat transfer and mass transfer in a packed column were also determined. Theoretical predictions of transfer coefficients and packed column sizes in an open cycle LiCl solar cooling system were verified. The feasibility of operating an open cycle cooling system was established. DOE

N82-29753# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SOLAR ENERGY CONTROLLED-ENVIRONMENT AGRICULTURE IN THE UNITED STATES AND IN SAUDI ARABIA

W. LUFT and J. FROECHTENIGT Nov. 1981 13 p refs
(Contract DE-AC02-77CH-00178)
(DE82-006140; SERI/TP-270-1465) Avail: NTIS HC A02/MF A01

Greenhouse designs proposed for use in hot climates to reduce the temperature by essentially passive means are illustrated. The project plans of the SOLERAS, solar powered, controlled environment agriculture are outlined. The water desalination technology being evaluated is reverse osmosis. The solar collection technologies include flat plate thermal collectors, solar ponds, photovoltaics and wind turbines. DOE

N82-29754# Colorado State Univ., Fort Collins. Solar Energy Research Inst.

NOVEL CONCEPTS IN ELECTROCHEMICAL SOLAR CELLS Final Report

J. DUBOW and R. KRISHNAN Oct. 1981 193 p refs
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-003372; SERI/TR-9272-1-T2) Avail: NTIS HC A09/MF A01

Work is reported toward developing novel concepts for the achievement of stable and efficient photoelectrochemical (PEC) systems for terrestrial applications. Small band-gap semiconductors can be effectively stabilized in room temperature molten salts. The transport properties of these salts are found to be inferior to acetonitrile and water. On the other hand, fine-tuning of the semiconductor/electrolyte interface for specific PEC applications is much more readily accomplished with molten salts than with more conventional electrolytes. Photoelectrosynthetic reactions involving very positive potentials are reported easily carried out at the semiconductor/molten salt interface. Specific ion adsorption or similar interactions of redox or electrolyte species with the semiconductor surface are found to lead to dramatic modification of the electrostatics at the interface, facilitating efficient electro-dynamic coupling at the interface under favorable circumstances. DOE

N82-29756# Delaware Univ., Newark. Inst. of Energy Conversion.

IMPROVED AMORPHOUS SI SOLAR CELLS Quarterly Progress Report, 1 Feb. - 30 Apr. 1981

V. L. DALAL Nov. 1981 37 p refs Sponsored in part by Solar Energy Research Inst.
(Contract DE-AC02-77CH-00178)
(DE82-006886; SERI/PR-9195-1-T3; QPR-5) Avail: NTIS HC A03/MF A01

Both n and p type a-Si:H films with very high conductivities were grown by diluting SiH₄ in Ar or H₂. These films have Fermi levels close to the conduction and valence bands (0.03 eV). The use of these heavily doped films as p() and n() junction layers in a p() in () cell should increase the diffusion voltage of the diode, thereby increasing both J/sub sc/ and V/sub oc/. The conductivity and thermoelectric power on films of diverse thickness was analyzed and reveals no systematic changes. However, the drift mobility shows a systematic increase with thickness. The analysis of cells by quantum efficiency vs. applied voltage revealed the electron ((SIGMA) tau) product is limiting transport in nip cells and not the hole ((SIGMA) tau) product. A new device design, Tandem parallel connected cells, improves the current collection in a-Si cells. This design may help increase J/sub sc/ to 15 to 16 mA/cm² in a-Si:H. DOE

N82-29758# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

PHYSICAL, CHEMICAL, AND ELECTRICAL STUDIES OF MIS SOLAR CELLS

M. A. GREEN Dec. 1981 31 p refs
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-007041; SERI/TR-213-1402) Avail: NTIS HC A03/MF A01

The physical, chemical, and electrical properties of high performance, MIS based silicon solar cells are investigated. It is shown that high resolution electron microscopy (HREM) can image the ultrathin oxides in these devices. HREM studies indicated that the oxide was of uniform thickness with no evidence of large pinholes or metallic inclusions. There appeared to be little physical difference between these ultrathin oxides and the substantially thicker oxides used in microelectronics. The chemical composition of these ultrathin oxides was investigated using X-ray photoelectron spectroscopy (XPS) and Auger electron spectroscopy (AES). Initial work with both XPS and AES indicated the presence of silicon dioxide. MINP solar cells incorporating the MIS structure displayed creditable efficiencies and exceptionally high open circuit voltages. A theoretical consequence of these high voltages is a reduced temperature coefficient of efficiency. DOE

N82-29759# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SOLAR POND-DRIVEN DISTILLATION AND POWER PRODUCTION SYSTEM

D. JOHNSON, C. M. LEBOEUF, and D. WADDINGTON Dec. 1981 24 p refs
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-010998; SERI/TR-631-1248) Avail: NTIS HC A02/MF A01

A solar pond driven distillation and power production system is described. The storage layer of the solar pond serves as the holding tank for the concentrated brine effluent from the distillation process as well as the collector and storage medium for solar energy used to heat incoming salty river water. Steam from the distillation process expands through a turbine/generator combination to provide power for the water circulation and vacuum pumps of the system. Water from the surface mixed layer of the pond is used to condense the steam. The closely integrated distillation and power production system converts an incoming stream of brackish or saline water into an outlet stream of the required purity. Salt and power are also products of the system. A thermodynamic analysis of the energy and mass balances of the system was performed and a performance model of the system

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is developed. This model is used to compute the requirements for desalting several saline tributaries of the Colorado River. DOE

N82-29762# Los Alamos Scientific Lab., N. Mex.
PASSIVE SOLAR RETROFIT STUDY FOR THE UNITED STATES NAVY

W. O. WRAY, C. R. MILES, and C. E. KOSIEWICZ Nov. 1981
27 p refs
(Contract W-7405-ENG-36)
(DE82-010975; LA-9071-MS) Avail: NTIS HC A03/MF A01

A passive solar retrofit study was conducted. The energy savings obtainable in concrete block buildings from several passive solar heating and conservation strategies were determined. Test cell data and computer simulation was employed to assess the merits of six retrofit options. The selected strategies were chosen on the basis of providing a series of options that will deliver increasing energy savings at the cost of correspondingly increased levels of commitment. DOE

N82-29766# Thermacore, Inc., Lancaster, Pa.
COST-EFFECTIVE SOLAR COLLECTORS USING HEAT PIPES
Final Technical Report, Jul. 1979 - Aug. 1981

D. M. ERNST 1981 66 p
(Contract DE-AC04-77CS-04099)
(DE82-011239; DOE/CS-34099/4) Avail: NTIS HC A04/MF A01

Evacuated tubular solar collectors were selected as the only economical non-concentrating approach capable of efficient operation of chillers. The General Electric TC family of collectors was chosen because of their high level of performance and compatibility with heat pipe integration. Three heat pipe fluid-vessel combinations were identified and are continuing to be life tested at design and stagnation conditions for time periods exceeding 33,000 hours. Testing was carried out at the lower end of the environmental temperature range by freeze/thaw testing several types of water heat pipes. Two heat pipe collectors were tested using trimethylborate/1010 steel and copper/water heat pipes. Both collectors should improve performance as compared to the standard General Electric TC-100. A cost analysis showed that in volume production the heat pipes could be made for \$1.50 each (1978 dollars) and would be cost effective for the performance achieved in collector testing. DOE

N82-29767# Teknologisk Inst., Tastrup (Denmark).
DURABILITY OF SOLAR COLLECTORS. EXPERIENCE OF SOLAR COLLECTORS EXPOSED TO NATURAL WEATHER CONDITIONS IN A CONTROLLED SIMULATED OPERATION DURING 3 YEARS ON TESTING STAND

T. V. HANSEN, G. MADSEN, and E. MIKKELSEN Jul. 1980
86 p In DANISH
(DE82-900723; NP-2900723) Avail: NTIS (US Sales Only) HC A05/MF A01; DOE Depository Libraries

Durability of several types of solar collectors after 3 years exposure was tested on an experimental testing stand with solar simulators. The collectors' resistance to corrosion in normal weathering conditions (snow, wind, rain) was tested; untightness of seals, changes in plastic foils, and glass recrystallisation are discussed. Recommendations are given on how to minimize the corrosive effects and choose the most suitable types and materials certified for outdoor durable exposure for villa-size solar heating systems. DOE

N82-29769# New Mexico Univ., Albuquerque. Bureau of Engineering Research.

NEW MEXICO SOLAR NETWORKS PROJECT Final Technical Report, 1 Jul. 1978 - 30 Jun. 1980

R. J. BAHM Sep. 1981 288 p refs
(DE82-901498; NP-2901498; EMD-2-67-2124) Avail: NTIS HC A13/MF A01

Ground based measurements of solar radiation availability for the State of New Mexico were collected and an archival computerized Data Base Management System was developed for storage of that data. The resulting data base contains over 3.5

million records of solar and meteorological data. The computer programs prepared for the data processing system are documented and 12 insolation maps of New Mexico are included. DOE

N82-29774# Clemson Univ., S.C. Agricultural Experiment Station.

RESEARCH AND DEMONSTRATION FACILITIES FOR ENERGY CONSERVATION AND SOLAR HEATING IN THE HOME Final Report

J. O. NEWMAN (Rural Housing Research Unit), L. C. GODBEY (Rural Housing Research Unit), M. A. DAVIS, D. O. EZELL, and W. H. ALLEN 15 Oct. 1981 98 p refs

(Contract ARC-77-160/SC-5725B)
(PB82-161431; ARC-77-160-SC-5725B) Avail: NTIS HC A05/MF A01 CSCL 13A

The design, testing and evaluation of two prototype solar holes are discussed. The first prototype is a greenhouse-residence designed with 6-in. wall cavities (to increase insulation thickness), a 381 sq. ft. solar collector used primarily for space heating, and a greenhouse that was utilized as a solar collector for growing vegetables. The house does feature a domestic hot water preheating system and an electrical resistance back-up heating system. The second prototype is an earth-insulated house designed primarily to study the physical features of the house in relation to the soil around it and the thermal interaction between the soil and the house environment. This house features a high temperature air collector that is used for domestic water heating. A special effort was made to have adequate daylight in the solar-earth house. A special study was conducted on the geometric configuration of the rock storage and the methods of admitting air to the rock storage. GRA

N82-29783# California Univ., Los Angeles. Lab. of Biomedical and Environmental Sciences.

ENVIRONMENTAL EFFECTS OF SOLAR THERMAL POWER SYSTEMS: ECOLOGICAL OBSERVATIONS DURING CONSTRUCTION OF THE BARSTOW 10 MWE PILOT STPS

F. B. TURNER, ed. Oct. 1981 106 p refs
(Contract DE-AM03-76SF-00012; DE-AC03-76SF-00012)
(DE82-005441; UCLA-12-1311) Avail: NTIS HC A06/MF A01

Meteorological variables and changes in the state of a limited array of indicator species or assemblages of species of plants and animals for environmental monitoring were compared. Observations include aerial photography of the site, saltation meter measurements of downwind from the site to measure fluxes of windblown sand, measurements of airborne particulates and atmospheric pollutants, and baseline temperature profiles made at two sites near the heliostat field to measure micrometeorological patterns. Annual plants both in off-field plots and in heliostat field, shrubs, birds, rodents, reptiles, and sensitive species listed as rare or endangered are observed. DOE

N82-29966# Teknologisk Inst., Tastrup (Denmark).
COMPUTER PROGRAM FOR SOLAR HEATING SYSTEM. FOR T159 PROGRAMMABLE POCKET COMPUTER

F. BASON and T. V. HANSEN 1980 92 p refs In DANISH
(DE82-900840; NP-2900840) Avail: NTIS (US Sales Only) HC A05/MF A01; DOE Depository Libraries

The aim of the solar program sponsored by Danish Ministry of Energy is to construct solar heating systems of high efficiency and durability, to make the solar heating prices competitive with other heating sources and to estimate the contribution of solar heating to the total heating needs. A popular evaluation of the existing and planned small-house heating systems is given with regard to insolation, seasonal variations, etc. DOE

N82-30143# Reuyl (John S.) Associates, Palo Alto, Calif.
SIMULATIONS OF THE ENERGY PERFORMANCE OF A SOLAR PHOTOVOLTAIC RESIDENCE AND HYBRID ELECTRIC AUTOMOBILE IN FRESNO, CALIFORNIA

J. S. REUYL and R. D. SCHUTT Jan. 1982 132 p refs
 (Contract DE-AC04-76DP-00789)

(DE82-007563; SAND-81-7044) Avail: NTIS HC A07/MF A01

Thermal and electrical performance in both stand-alone and grid-connected configurations were simulated with computer models using actual hourly solar and weather data for Fresno, California. The system centers around an energy-efficient residence that incorporates passive heating and cooling. For the simulations, 110 square meters of GE photovoltaic shingle modules (9.6 kW(e) rated power), a 10 kW(e) dc-ac inverter, and advanced lead-acid batteries of 61 kWh(e) capacity were added to the residence. The auto has 30 kWh(e) of lead-acid batteries and a 40-hp electric drive motor for propulsion. The auto was assumed to travel 100 km (62 miles) each day (36,500 km (22,680 miles) annually). A small (10 kW(e) backup liquid-fueled engine/generator in the auto provides supplemental electricity on cloudy days and for long-distance travel. The utility would provide backup electricity for the residence, or the auto engine/generator can provide this backup power to the residence as well as so-called waste heat from the engine for space heating and domestic hot water. DOE

N82-30474*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPONENT TECHNOLOGY FOR SPACE POWER SYSTEMS

R. FINKE 1982 13 p refs Presented at the 33rd Intern. Astronautical Federation Congr., Paris, 26 Sep. - 2 Oct. 1982 (NASA-TM-82928; E-1322; NAS 1.15:82928) Avail: NTIS HC A02/MF A01 CSCL 09C

The Lewis/OAST program for the development of Component Technology for Space Power Systems is described. The program is divided into five generic areas: semiconductor devices (transistors, thyristors, and diodes); conductors (materials and transmission lines); dielectrics; magnetic devices; and thermal control devices. Examples of progress in each of the five areas is discussed. Bipolar power transistors up to 1000 V at 100 A with a gain of 10 and a 0.5 μ sec rise and fall time are presented. A new class of semiconductor devices with a possibility of switching 1000 000 V is described. Several 100 kW rotary power transformer designs and a 25 kW, 20 kHz transformer weighting 3.2 kg have been developed. Progress on the creation of diamond-like films for thermal devices and intercalated carbon fibers with the strength of steel and the conductivity of copper at one third the mass of copper is presented. Author

N82-30609 American Society of Mechanical Engineers, New York. Solar Energy Div.

SOLAR ENGINEERING, 1981

R. L. REID, ed. (Tennessee Univ., Knoxville), L. M. MURPHY, ed. (Midwest Research Inst.), and D. S. WARD, ed. (Colorado State Univ.) 1981 776 p refs Proc. of the 3rd Ann. Conf. of Systems Simulation, Econ. Anal./Solar Heating and Cooling Operational Results, Reno, Nev., 27 Apr. - 1 May 1981 Sponsored in part by DOE

(CONF-810405; N-151746; LC-81-65532) Avail: Issuing Activity

Solar heating and cooling systems for residential, commercial, and industrial applications are discussed.

N82-30610 Vitro Labs., Silver Spring, Md.
PERFORMANCE COMPARISON OF SOLAR SPACE HEATING SYSTEMS OF SELECTED ACTIVE SITES IN THE NATIONAL SOLAR DATA NETWORK

P. W. KENDALL and H. O. HOLTE In ASME Solar Eng., 1981 p 1-14 1981 refs

Avail: Issuing Activity

Composite performance results for selected active solar space heating commercial sites in the National Solar Data Network are presented. The performance of instrumented sites monitored through the 1979-1980 heating season are analyzed. Sites analyzed in depth include four representative major types of active solar

heating systems. Parameters and performance indices presented include overall system delivered loads, solar fraction of load, solar savings ratio, coefficient of performance, energy collected and stored, and various subsystem efficiencies. The comparison of these factors has allowed evaluation of the relative performance of various system designs. A matrix of performance indices is presented for comparison of the representative solar heating installations. J.D.

N82-30611 Entec Products Corp., Fort Collins, Colo.

EXPERIENCES IN SOLAR COOLING SYSTEMS

D. S. WARD (Colorado State Univ.) and H. S. OBEROI In ASME Solar Eng., 1981 p 15-27 1981

Avail: Issuing Activity

Six of the nine solar cooling systems discussed in this paper had negative energy savings. In several cases the solar cooling system used substantially more energy than a conventional system could have been expected to use. Two systems, however, had significant energy savings. These systems (1 residential and 1 commercial) obtained system thermal efficiencies of 12.0 to 12.4 percent. Their system overall efficiencies averaged 11.2 and 5.2 percent respectively. The residential-sized system achieved an annual energy savings of about 16.8 GJ/year, or approximately .34 GJ/year.m² of collector. The commercial system had equivalent values of 137 GJ/year or about .22 GJ/year/sq m of collector. It should be noted that these efficiencies are much lower than those of well-designed and properly controlled cooling systems in commercial sizes. However, with realistic system modifications and subsequent improvements in performance these solar cooling systems can be expected to achieve savings in nonrenewable energy sources of approximately 1.2 GJ/year/sq m of collector. These savings can be compared to those associated with solar space and domestic hot water heating systems of 2.2 and 2.5 GJ/year/sq m of collector, respectively. Author

N82-30612 Air Force Academy, Colo. Dept. of Civil Engineering.

THE CONTINUING PERFORMANCE OF THE USAF ACADEMY RETROFIT SOLAR HOUSE

K. A. CORNELIUS and J. D. BENSON In ASME Solar Eng., 1981 p 28-35 1981 refs

Avail: Issuing Activity

The performance of a retrofit solar space heating system installed on a typical military family housing unit of mid-fifties construction at the U.S. Air Force Academy is analyzed. The home and the solar system were completely instrumented; system control and data storage were accomplished with an on-site microprocessor. The results presented cover the period from December 1975 to April 1979 and illustrate the effects on performance of varying the following parameters: (1) Energy conservation improvements to the home subsequent to installation of the solar system, (2) collector inclination angles, (3) collector working fluid flow rates, (4) collector flow rate control strategy, (5) storage mass and usable control temperatures, and (6) heat exchanger area between collector loop and storage. A side-by-side performance comparison of evacuated tube collectors to flatplate collectors and an overall system performance comparison to f-chart predictions are also included. Author

N82-30613 Acurex Corp., Mountain View, Calif.

OPERATION AND PERFORMANCE OF THE SOLAR STEAM SYSTEM AT THE JOHNSON AND JOHNSON PLANT IN SHERMAN, TEXAS

D. F. BRINK, M. A. MATTEO, and S. B. YOUNGBLOOD In ASME Solar Eng., 1981 p 36-42 1981 refs

(Contract DE-AC03-77CS-31713)

Avail: Issuing Activity

The operation of a solar system that produces 174 C (345 F) steam is described and analyzed. The system uses parabolic through collectors to heat pressurized water which then flashes to steam in a flash boiler; This steam is fed into the plant steam main for use in several manufacturing processes. The facility's performance has been monitored continuously since it began

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operation in January 1980. The collector field typically has delivered energy to the flash boiler at an average daily efficiency of 25 to 35 percent, with an hourly average efficiency ranging from 38 to 42 percent at peak insolation periods. The daily and hourly values for energy collected and steam generated on a clear day in September and presented, as well as a monthly summary for the first 11 months of operation. Author

N82-30614 Vitro Labs., Silver Spring, Md.
PERFORMANCE OF SOLAR ENERGY HOT WATER SYSTEMS
M. A. CRAMER, K. D. EVANS, J. M. ROENBUSCH, and R. A. WEINSTEIN *In ASME Solar Eng.*, 1981 p 43-52 1981 refs
Avail: Issuing Activity

A comparative analysis of solar energy hot water systems installed in sites monitored by the National Solar Data Network is presented. Two single family and two multi-family residences were selected for evaluation. These systems represent different types of hot water systems: passive hot water, active hot water with space heating, hot water with recirculation, and hot water thermosiphon. The data is provided in a number of forms including average monthly performance values for each hot water system, average monthly values for the summer and winter seasons, and estimated operational dollar savings. The conclusions are directed at both solar and conventional design features that cause good or bad performance. J.D.

N82-30615 Vitro Labs., Silver Spring, Md.
LONG-TERM PERFORMANCE TRENDS FOR TEN SOLAR SYSTEMS MONITORED BY THE NATIONAL SOLAR DATA NETWORK

L. G. DOAK and C. GERVASIO *In ASME Solar Eng.*, 1981 p 53-57 1981 refs
(Contract DE-AC01-79CS-30027)
Avail: Issuing Activity

Performance of ten solar sites in the National Solar Data Network are plotted over periods of two to three years. Performance trends for the collector array and the energy collection and storage subsystems are presented. Comparisons are made between performance trends for air and liquid collectors, and between active and passive systems. Observations on causes for trends over several years of operation are offered. Author

N82-30616 Tennessee Univ., Knoxville. Dept. of Mechanical and Aerospace Engineering.
PERFORMANCE OF A SOLAR AUGMENTED HEAT PUMP
A. F. G. BEDINGER, J. J. TOMLINSON, R. L. REID, and D. J. CHAFFIN *In ASME Solar Eng.*, 1981 p 58-67 1981 refs
Sponsored in part by the Tennessee Valley Authority
Avail: Issuing Activity

Performance of a residential size solar augmented heat pump is reported for the 1979-1980 heating season. The facility located in Knoxville, Tennessee, has a measured heat load coefficient of 339.5 watt/C (644 BTU/hr- F). The solar augmented heat pump system consists of 7.4 cu m of one inch diameter crushed limestone. The heat pump is a nominal 8.8 KW (2 1/2 ton) high efficiency unit. The system includes electric resistance heaters to give the option of adding thermal energy to the pebble bed storage during utility off-peak periods, thus offering considerable load management capability. A 15 KW electric resistance duct heater is used to add thermal energy to the pebble bin as required during off-peak periods. Hourly thermal performance and on site weather data was taken for the period November 1, 1979, to April 13, 1980. Thermal performance data consists of heat flow summations for all modes of the system, pebble bed temperatures, and space temperature. Weather data consists of dry bulb temperature, dew point temperature, total global insolation (in the plane of the collector), and wind speed and direction. An error analysis was performed and the least accurate of the measurements was determined to be the heat flow at 5%. Solar system thermal performance factor was measured to be 8.77. The heat pump thermal performance factor was 1.64. Total system seasonal performance factor was measured to be 1.66. Using a modified version of TRNSYS, the thermal performance of this system was

simulated. When simulation results were compared with data collected onsite, the predicted heat flow and power consumption generally were within experimental accuracy. J.D.

N82-30617 Colorado State Univ., Fort Collins. Solar Energy Applications Lab.
DEVELOPMENT AND IMPROVEMENT OF LIQUID SYSTEMS FOR SOLAR SPACE HEATING AND COOLING: CSU SOLAR HOUSE 1
G. O. G. LOEF, W. S. DUFF, and C. E. HANCOCK *In ASME Solar Eng.*, 1981 p 68-80 1981 refs
Avail: Issuing Activity

The performance of several types and numerous modifications of solar heating and cooling systems in three residential buildings is described. The performance of which has been closely monitored and compared. At approximately one-year intervals, the systems have been modified or changed in ways which are designed to improve solar energy delivery, operating convenience, reliability, economy, and overall practicality. The emphasis is on system integration of commercially available components. Systems in which liquids are used for solar heat collection and storage were also employed. Heat is supplied to the building by forced warm air heated by exchange with solar heated water from storage; space cooling is provided by lithium bromide absorption refrigeration driven by solar heated water. Service hot water is by exchange with the main solar collection and storage system, and auxiliary energy is by use of gas or electric heat supply equipment. Automatic controls regulate all operations, and extensive monitoring and data logging equipment provide continuous records of all significant operating conditions and results. J.D.

N82-30618 Alabama Univ., Huntsville. Solar Energy Center.
COMMERCIAL SOLAR WATER HEATING SYSTEMS OPERATIONAL TEST
G. R. GUINN, B. J. NOVELL, and L. L. HUMMER *In ASME Solar Eng.*, 1981 p 81-91 1981 refs
Avail: Issuing Activity

The performance of six commercially available solar water heaters is evaluated. The six systems are installed side-by-side on a typical roof structure and provide two examples each of silicone oil, antifreeze, and drain-back freeze protection. Each system is instrumented with Btu and KWH meters to assess performance under an imposed load profile. The systems, the instrumentation, operational results acquired over a 19 month interval, and performance over a 4 month interval are described. J.D.

N82-30619 Utah Univ., Salt Lake City. Dept. of Mechanical and Industrial Engineering.
EVALUATION OF FIVE SOLAR DOMESTIC WATER HEATING SYSTEMS

S. R. SWANSON and R. F. BOEHM *In ASME Solar Eng.*, 1981 p 92-98 1981 refs Sponsored in part by Utah Power and Light Co.
Avail: Issuing Activity

Five solar domestic water heaters were tested over a period of two years. Four of the systems are similar and utilize an experimental dual preheat tank arrangement with external heat exchanger. The fifth system uses a single tank with in-tank heat exchanger. Measurements were made of useful energy delivered to storage, hot water used, and electrical energy used for pumps and auxiliary heating. The results indicated that overall performance was lower than had been expected. Short term diagnostic tests were run, and a number of factors were determined to have a negative effect on system performance. These were low collector tilt angle, high pumping energy, mismatch of flows in heat exchanger, high thermal mass external to the storage tank, and a possible decrease in collector performance. Author

N82-30620 Philadelphia Electric Co., Pa. Commerical Operations Dept.

SOLAR DOMESTIC WATER HEATING PERFORMANCE TEST PROGRAM Interim Report

R. H. AURIS and W. J. DRAVING, JR. *In* ASME Solar Eng., 1981 p 99-103 1981

Avail: Issuing Activity

A test program operated since early 1978 to evaluate commercially available solar domestic water heating systems in actual installations is described. The readiness and expertise of suppliers and installers are assessed and the interaction between solar energy and utility power determined. Six different solar water heating systems were retrofitted to employees' homes in the Philadelphia area. In addition, existing solar systems in seven customers' homes were monitored. These 13 systems were instrumented to document the solar energy usage, purchased power, water usage, and water inlet, preheat and delivery temperature. One year of measurements were collected and analyzed. Operation of water and anti-freeze systems during periods of below freezing temperatures were compared. Maintenance and repair records permit an estimate of service costs to be made.

Author

N82-30621 Pennsylvania State Univ., Middletown.
PARTIAL RESULTS SUMMARY FOR SOLAR DOMESTIC HOT WATER MONITORING IN PENNSYLVANIA

W. K. AUNGST *In* ASME Solar Eng., 1981 p 104-111 1981 refs

Avail: Issuing Activity

A monitoring program for approximately fifty solar domestic hot water systems in Pennsylvania is described. The monitoring program utilizes relatively low cost instrumentation, which provides information which is collected by each individual homeowner. The data is then used to estimate each systems performance. Some of the more significant results obtained to date are summarized and the amount of solar energy utilized by the systems to aid the heating of the domestic hot water load determined. The dollar savings the homeowners are realizing through the use of their solar hot water systems are estimated.

J.D.

N82-30622 Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

DEVELOPMENT OF A DAY BY DAY SIMULATION OF SOLAR SYSTEMS

W. S. DUFF, G. J. FAVARD, and K. R. DENBRAVEN *In* ASME Solar Eng., 1981 p 112-121 1981 refs Sponsored in part by Midwest Research Inst.

Avail: Issuing Activity

Advantages of a simulation program for solar heating, cooling, and hot water systems using event incremented time-steps include short running times with accuracies similar to those of short fixed increment time-steps. Event incrementing is made possible through the use of analytic functions for data input. Currently, the ambient temperatures and radiation are entered as daily cosine functions or constants over a time-step. Loads may be represented as cosine waves, constants, or point values. This approach yields a substantially compressed data representation and allows direct analytic solutions for the system of nonlinear differential equations over long time-steps. These time-steps do not occur at fixed intervals, but instead are determined by events such as collector pump turn-on time, domestic hot water withdrawal, or a switch from solar to auxiliary usage. Resulting accuracies are close to those obtained from short time-step programs, while computer times are greatly reduced.

Author

N82-30623 Colorado State Univ., Fort Collins. Dept. of Mechanical Engineering.

THE MEASURED PERFORMANCE OF AN AIR THERMOSYPHON SYSTEM

L. S. MARSHALL, P. J. BURNS, and C. B. WINN *In* ASME Solar Eng., 1981 p 122-129 1981 refs

Avail: Issuing Activity

A simulation scheme was developed to evaluate a passive air thermosyphon system consisting of a double glazed collector, ducting, backdraft dampers to prevent reverse circulation of the air, and a rock box in the north wall for thermal storage. A test cell been constructed in order to obtain actual data. Temperature measurements and flow visualization in the air ducts are studied. The thermal performance of the system is evaluated by using measured data as input for the simulation model.

A.R.H.

N82-30625 California Univ., Berkeley. Lawrence Berkeley Lab.
INTERACTION OF A SOLAR SPACE HEATING SYSTEM WITH THE THERMAL BEHAVIOR OF A BUILDING

C. VILMER, M. L. WARREN, and D. AUSLANDER (California Univ., Berkeley) *In* ASME Solar Eng., 1981 p 135-144 1981 refs (Contract W-7405-ENG-48)

Avail: Issuing Activity

The thermal behavior of a building in response to heat input from an active solar space heating system is analysed to determine the effect of the variable storage tank temperature on the cycling rate, on-time, and off-time of a heating cycle and on the comfort characteristics of room air temperature swing and of offset of the average air temperature from the setpoint (droop). A simple model of a residential building, a fan coil heat-delivery system, and a bimetal thermostat are used to describe the system. A computer simulation of the system behavior has been developed and verified by comparisons with predictions from previous studies. The system model and simulation are then applied to determine the building response to typical hydronic solar heating system for different solar storage temperatures, outdoor temperatures, and fan coil sizes. The simulations were run only for those cases where there was sufficient energy from storage to meet the building load requirements. The results indicate that to maintain room temperatures within comfort limits by minimizing both swing and droop, a hydronic solar space heating system requires a control system that adjusts anticipation and setpoints in relation to the outdoor and the storage tank temperatures.

J.D.

N82-30626 Argonne National Lab., Ill.
EVALUATION OF RELIABILITY OF OPERATIONAL SOLAR ENERGY SYSTEMS

J. MAVEC, E. WAITE (Argonne National Lab., Idaho Falls, Idaho), and R. M. WOLOSEWICZ *In* ASME Solar Eng., 1981 p 145-150 1981 refs Sponsored by DOE

Avail: Issuing Activity

The reliability of two solar-energy systems using air as the heat transfer medium was studied using failure modes and effects analysis to examine the controls of the systems for three operating modes. Principal components are identified for each mode, and a fault tree and reliability block diagram are constructed to structure the fault or failed sequence. Established failure rates are assigned to each component, and an exponential failure distribution is assumed. For components operating on demand at a given average frequency, the adjusted demand and normal operating failure rates are combined to reflect the total contribution. Representative operational times and component frequencies are found for each operating mode. A fault-tree computer code obtains results at each level (component, outset, and tree) using repairable and nonrepairable models.

A.R.H.

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N82-30628 California Univ., Irvine. School of Engineering.
AN INVESTIGATION OF HORIZONTAL STORAGE TANKS FOR SOLAR HOT WATER SYSTEMS

M. F. YOUNG and J. W. BAUGHN *In ASME Solar Eng.*, 1981 p 159-167 1981 refs Prepared in cooperation with California Univ., Davis

Avail: Issuing Activity

The thermal behavior of a horizontal storage tank for possible use in a solar domestic hot water system was investigated analytically and experimentally. The experimental results demonstrate that axial temperature gradients is negligible compared to vertical temperature gradients. Severe mixing of the tank occurred when loads were removed unless a diffuser manifold was placed on the make-up water inlet. The analytical model used was one-dimensional (vertical) with some degree of mixing at the inlet and outlet boundaries. The temperatures at the top of the tank were predicted fairly well, but the temperatures at the bottom deviated somewhat from the predictions. It appears that some additional interior mixing not included in the present model occurs. A.R.H.

N82-30629 California Univ., Irvine. School of Engineering.
COMPARISON OF SOME RESULTS OF PROGRAM SHOW WITH OTHER SOLAR HOT WATER COMPUTER PROGRAMS

M. F. YOUNG and J. W. BAUGHN *In ASME Solar Eng.*, 1981 p 168-174 1981 refs Prepared in cooperation with California Univ., Davis

Avail: Issuing Activity

The SHOW (solar hot water) computer program is capable of simulating both one and two tank designs of thermosiphon and pumped solar domestic hot water systems. SHOW differs in a number of ways from other programs, the most notable of which is the emphasis on a thermal/hydraulic model of the stratified storage tank. The predicted performance for a typical two tank pumped system, computed by Program SHOW are compared, with results computed using F-CHART and TRNSYS. The results show fair to good agreement between the various computer programs when comparing the annual percent solar contributions. SHOW is also used to compute the expected performance of a two tank thermosiphon system and to compare its performance to the two tank pumped system. Author

N82-30631 California Univ., Berkeley. Lawrence Berkeley Lab. Passive Solar Analysis and Design Group.

DESCRIPTION OF AN EXACT, RECURSIVE METHOD TO SIMPLIFY SHADING CALCULATIONS

A. D. NAWROCKI and R. KAMMERUD *In ASME Solar Eng.*, 1981 p 187-195 1981 refs (Contract W-7405-ENG-48)

Avail: Issuing Activity

An exact, recursive method called SHADE is described which attempts to simplify shading calculations as performed by a programmable calculator or microcomputer. Preliminary applications of SHADE using a Hewlett Packard HP-41C programmable calculator are outlined. For a given solar hour, SHADE is used to compute the following quantities for overhang and side fin combinations which shade various openings: the percentage of the total area of the opening which is shaded; the shaded area itself; the cosine of the angle of incidence between the Sun and glazing surface; the direct insolation at this surface, with and without shading; and the direct solar power at this surface, with and without shading. A.R.H.

N82-30633 Los Alamos Scientific Lab., N. Mex.
THE SOLAR LOAD RATIO METHOD APPLIED TO COMMERCIAL BUILDING ACTIVE SOLAR SYSTEM SIZING

N. M. SCHNURR, B. D. HUNN, and K. D. WILLIAMSON, III (New Mexico State Univ., Las Cruces) *In ASME Solar Eng.*, 1981 p 204-215 1981 refs

Avail: Issuing Activity

The solar load ratio (SLR) design method was extended to commercial building combined active space heating and building service hot water (BSHW) systems and BSHW systems alone.

Both liquid and air heating systems are considered. The hour-by-hour computer simulations used to calculate system performance were carried out using the component-based simulator in the DOE-2 building energy analysis computer program. Hourly weather data for several cities were used. The major parameters that characterize the solar heating system are the generic collector type (defined by the slope and intercept of the collector efficiency curve), geographical location, and the hot water delivery temperature. The results are correlated using the SLR (the ratio of incident solar radiation to the building load imposed upon the heating coil) on either a monthly or an annual basis. Author

N82-30634 Solaron Corp., Englewood, Colo.
A RELIABLE METHOD FOR RATING SOLAR COLLECTORS
G. O. G. LOEF, D. JONES, and L. E. SHAW *In ASME Solar Eng.*, 1981 p 216-225 1981 refs

Avail: Issuing Activity

A method is outlined which accurately and meaningfully rates solar collectors in all parts of the country. The basis for the rating is a first order efficiency curve developed from test results obtained in an accredited laboratory by methods prescribed in the ASHRAE 93-77 procedure. Annual solar heat delivery per square foot of collector is then calculated for standard hot water and space heating applications in cities throughout the U.S. by use of the F-CHART procedure. Four collectors are analyzed by the FCHART method for space heating applications in five U.S. cities at five solar load fractions. It is shown that although all the collectors have comparable outputs under some conditions, they perform quite differently in different parts of the country and at different ratios of collector area to heating load. A.R.H.

N82-30635 California Univ., San Diego, La Jolla. Dept. of Applied Mechanics and Engineering Sciences.

DESIGN AND CONTROL TRADEOFFS FOR ROCKBINS IN PASSIVELY SOLAR HEATED HOUSES WITH HIGH SOLAR FRACTIONS

G. VERED and A. V. SEBALD *In ASME Solar Eng.*, 1981 p 226-238 1981 refs (Contract DE-AC04-79AL-10891)

Avail: Issuing Activity

Performance of active and passive rockbins are compared in Albuquerque NM, Santa Maria CA and Madison WI. The basic house is assumed to contain both Trombe wall and direct gain. The latter are assumed to be optimally sized and controlled for each weather zone. It is demonstrated that rockbins can be used to advantage in reduction of the early morning auxiliary energy consumption peak common to passive houses with night setback thermostats. The paper also analyzes performance sensitivity to rockbin configuration (active, radiant slab top down charge, radiant slab bottom up charge), and to control strategies for charging and discharging. Effects of fan energy are included. New results on the thermal conductivity of passive rockbeds are outlined. These results are shown to be crucial to understanding the role of rockbins in passive houses. Author

N82-30636 Maryland Univ., College Park. Dept. of Mechanical Engineering.

TRANSIENT SIMULATION OF ABSORPTION MACHINES

D. K. ANAND, R. W. ALLEN, and B. KUMAR *In ASME Solar Eng.*, 1981 p 239-247 1981 refs

Avail: Issuing Activity

A model for a water-cooled Lithium-Bromide/water absorption chiller is presented. Its transient response both during the start-up phase and during the shut-off period is predicted. The simulation model incorporates such influencing factors as the thermodynamic properties of the working fluid, the absorbent, the heat-transfer configuration of different components of the chiller and related physical data. The time constants of different components are controlled by a set of key parameters that have been identified. The results show a variable but at times significant amount of time delay before the chiller capacity gets close to its steady-state value. The model is intended to provide an insight into the mechanism of build-up to steady-state performance. By recognizing

the significant factors contributing to transient degradation, steps can be taken to reduce such degradation. B.W.

N82-30637 Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

GROUND COUPLED SOLAR HEAT PUMP: ANALYSIS OF FOUR OPTIONS

J. W. ANDREWS *In ASME Solar Eng.*, 1981 p 248-259 1981 refs Sponsored by DOE

Avail: Issuing Activity

Heat pump systems which utilize both solar energy and energy withdrawn from the ground are analyzed using a simplified procedure which optimizes the solar storage temperature on a monthly basis. Four ways of introducing collected solar energy to the system are optimized and compared. These include use of activity collected thermal input to the heat pump; use of collected solar energy to heat the load directly (two different ways); and use of a passive option to reduce the effective heating load.

Author

N82-30638 University of the West Indies, Saint Augustine (Trinidad). Dept. of Mechanical Engineering.

OPTIMUM OPERATING CONDITIONS OF ABSORPTION REFRIGERATION SYSTEMS FOR FLAT PLATE COLLECTOR TEMPERATURES

G. S. KOCHHAR and S. SATCUNANATHAN *In ASME Solar Eng.*, 1981 p 260-267 1981 refs

Avail: Issuing Activity

An evaluation is presented of the performance of absorption refrigeration cycles with a view to determining optimum conditions for use with flat plate solar collectors. Equations for the thermodynamic performance analysis of the NH₃ - H₂O systems are formulated and solved for various combinations of temperatures of the heat interacting components of the system using available equilibrium thermodynamic property equations. Equilibrium thermodynamic property equations for the H₂O - LiBr pair are developed and used to extend the performance analysis to the H₂O LiBr absorption cycle. It is shown that the COP increases sharply initially with generator temperature, reaches a peak value and levels off thereafter. COP also increases with lowering of condensing/absorption temperatures, the increases being significant for generation temperatures below about 80 C, which is well within the effective operational range of flat plate solar collectors.

Author

N82-30640 Vitro Labs., Silver Spring, Md. **ASSESSMENT OF AIR SOLAR SYSTEM PERFORMANCE WITH ALTERNATE METHODS OF ANALYSIS**

S. L. TAYLOR *In ASME Solar Eng.*, 1981 p 277-289 1981 refs

Avail: Issuing Activity

As an alternative to using detailed measurements to determine the energy losses of an active air solar system, the solar space heating contribution of solar systems is evaluated using the building as the control volume for the analysis. The method assesses solar performance using a minimum of instrumentation. A second method, used by some designers, for active solar system performance is presented which uses modified degree day design. It uses only the active space heating system as the control volume for the analysis. Discrepancies in the results suggest that space heating designers consider all heating energy flows into the building and not just the active space heating system. B.W.

N82-30641 Boeing Computer Services Co., Tukwila, Wash. Energy Technology Applications Div.

VALIDATION OF A ROCK BED THERMAL ENERGY STORAGE MODEL

F. G. VONFUCHS *In ASME Solar Eng.*, 1981 p 290-298 1981 refs

(Contract DE-AC02-77CS-34482)

Avail: Issuing Activity

The development of a one dimensional rock bed model utilizing historical models and those used by current researchers is

discussed. Heat transfer coefficients and assumptions, pressure drop, rock size and void fraction, axial conductivity, and other parameters are considered. Since the solution of the model differential equations can introduce instabilities and inaccuracies in the results, a discussion of the mathematical techniques used is included. The validation process consisted of formulating a test plan, instrumenting the rock bed, performing the tests then comparing the results with a simulation using the same parameters used in the test. Validation was quite good and is illustrated by several figures comparing observed and predicted axial temperature distributions. Author

N82-30643 Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

A COMPARISON OF DOE-2 AND TRNSYS SOLAR HEATING SYSTEM SIMULATION

A. EDEN and M. MORGAN *In ASME Solar Eng.*, 1981 p 309-318 1981 refs

Avail: Issuing Activity

The output of the solar energy section of DOE-2 called Component Based Simulator (CBS) and TRNSYS was analyzed. The adequacy and sensitivity of CBS was investigated when various active solar energy collectors and systems were interfaced with a standard space heating system. The analysis included both single- and double-glazed collectors with selectively and nonselectively coated absorbing surfaces, located in four different environments. The results of the study show remarkable agreement between the two programs. Minor differences in annual average collector efficiency and annual average part solar are illustrated as are the thermal load and insolation. In addition, difficulties encountered when performing this study modeling the collector systems are discussed and recommendations offered to facilitate the solar simulation process for future CBS users. B.W.

N82-30644 Vitro Labs., Silver Spring, Md. **HOURLY USE PROFILES FOR SOLAR DOMESTIC HOT WATER HEATERS IN THE NATIONAL SOLAR DATA NETWORK**

E. J. BARVIR, L. G. DOAK, R. E. WATERMAN, and C. GERVASIO *In ASME Solar Eng.*, 1981 p 319-324 1981 refs

(Contract DE-AC01-79CS-30027)

Avail: Issuing Activity

Daily hot water rates of consumption and the Hourly Profiles of Daily Hot Water Consumption for single and multiple family dwellings are provided. These new statistics obtained from the National Solar Data Network (NSDN) are significantly different from the statistics currently being used in TRNSYS, SOLCOST and F-Chart. The NSDN statistics suggest that both the daily demand and hourly use profiles used in performance models should be revised. B.W.

N82-30645 Regional Systems Services Group, Inc., Englewood, Colo.

IMPLEMENTATION OF AN AMBIENT TEMPERATURE OBSERVER-PREDICTION (ATOP)

N. L. WEAVER and W. S. DUFF (Colorado State Univ.) *In ASME Solar Eng.*, 1981 p 325-329 1981 refs Sponsored by DOE

Avail: Issuing Activity

An ATOP type control algorithm was developed and implemented on a programmable controller to set the rate of charge for a commercial off-peak electric furnace installed in CSU Solar House I. During a 15 day trial ATOP tracked ambient temperature to within 3.0 C rms and predicted following day average temperature to within 3.8 C rms. The ATOP based off-peak controller held peak demand to 9.5 kilowatts during the test period. For the same conditions the factory stock control hardware for the commercial off-peak furnace would have generated a peak demand of 18.8 kilowatts. However, the superior performance of the ATOP-based controller is due principally to the fact that it accounts for available energy in solar storage and in the off-peak furnace itself (which the factory control hardware does not). Author

02 SOLAR ENERGY

N82-30646* Ford Aerospace and Communications Corp., Newport Beach, Calif. Aeronutronic Div.

CONTROL SYSTEM DEVELOPMENT FOR AN ORGANIC RANKING CYCLE ENGINE

F. M. BERGTHOLD, JR., D. G. FULTON, and H. J. HASKINS *In* ASME Solar Eng., 1981 p 330-336 1981 refs
(Contract JPL-955115)

Avail: Issuing Activity

An organic Rankine cycle engine is used as part of a solar thermal power conversion assembly (PCA). The PCA, including a direct-heated cavity receiver and a shaft-mounted alternator, is mounted at the focal point of a parabolic dish concentrator. The engine controls are required to maintain approximately constant values of turbine inlet temperature and shaft speed, despite variation in the concentrated solar power input to the receiver. The controls design approach, system models, and initial stability and performance analysis results are presented herein. Author

N82-30647 Vitro Labs., Silver Spring, Md.

ANALYSIS, SIMULATION AND DIAGNOSIS OF SOLAR ENERGY CONTROL SYSTEM ANOMALIES

R. E. WATERMAN *In* ASME Solar Eng., 1981 p 337-344 1981 refs

(Contract DE-AC01-79CS-30027)

Avail: Issuing Activity

Control system anomalies in solar energy systems are examined and methods employed to investigate and diagnose controller malfunctions involve a blend of mathematical modelling and analysis of long term data from three solar homes in the National Solar Data Network. The diagnostic methods and results of this study should be of immediate practical value to designers, installers and owners concerned with obtaining maximum performance from their solar energy systems. B.W.

N82-30648 Science Applications, Inc., Albuquerque, N. Mex. Alternate Energy Systems Div.

SIMPLIFIED METHODOLOGY FOR CHOOSING CONTROLLER SET-POINTS

J. M. ALCONO and R. W. HERMAN *In* ASME Solar Eng., 1981 p 345-347 1981 refs

Avail: Issuing Activity

The selection of controller delta T set-points for solar energy systems must be made carefully to assure that unnecessary cycling of pump or fan motors does not occur, and that a maximum amount of the available solar energy is collected. An analysis of how set-points can be chosen based on the efficiency curve for the collector is given. R.J.F.

N82-30649 Wisconsin Univ., Madison. Solar Energy Lab.

A TRNSYS MICROPROCESSOR CONTROLLER

L. P. PIESSENS, W. A. BECKMAN, and J. W. MITCHELL *In* ASME Solar Eng., 1981 p 348-357 1981 refs

Avail: Issuing Activity

A control component for use with the TRNSYS simulation program was developed that simulates the operation of a microprocessor controller. The component uses a truth table in combination with comparisons between input signals to generate appropriate output control signals. Although temperatures are normal input signals, other inputs such as flow rate and solar radiation can also be used. Together with other standard TRNSYS components, proportional control, night setbacks, and time delays can be simulated. Examples are given of normal operation, and of situations in which instabilities occur. The use of the truth table for error detection is illustrated. Some general rules for selecting timestep and error bounds are formulated. An economic comparison is made between on/off and optimal control strategy to illustrate the use of the model. R.J.F.

N82-30650 Drexel Univ., Philadelphia, Pa. Dept. of Electrical and Computer Engineering.

EXPERIMENTAL VALIDATION OF DYNAMIC CONTROL MODELS

P. R. HERCZFELD, R. FISCHL, G. VARDAKAS, and R. L. T. WOLFSON (Middlebury College, Vt.) *In* ASME Solar Eng., 1981 p 358-366 1981 refs

(Contract DE-ASQ2-77CS-34512; DE-AC03-86CS-30218)

Avail: Issuing Activity

The results of an experimental study designed to validate the dynamic distributed parameter model used in investigating the control of pump cycling in solar heating and cooling systems and the more general problem of liquid flow control in solar collector loops are given. The validation experiments consisted of first measuring the thermal time constants and transit times of the solar collector loop components. These time constants together with other system parameters and measured climatic data were used to predict the controller performance via the computer simulation model developed. The results of this simulation were compared to those obtained experimentally. The three experiments analyzed showed that the computer simulation was able to predict the controller performance well within the accuracy of the measured data. R.J.F.

N82-30651 Drexel Univ., Philadelphia, Pa.

COMPUTER SIMULATION FOR EVALUATING CONTROL STRATEGIES

S. J. SOKOLOWSKI (U.S. Army, Ft. Monmouth, N.J.), M. J. FISHER (U.S. Army, Ft. Monmouth, N.J.), P. R. HERCZFELD, R. FISCHL, and R. WOLFSON (Middlebury College, Vt.) *In* ASME Solar Eng., 1981 p 367-376 1981 refs

(Contract DE-ASQ2-77C5-34512; DE-AC03-86CS-30318)

Avail: Issuing Activity

A computer simulation code which accurately simulates the operation of solar energy systems under different control strategies such as either the on/off controller or the proportional flow controller is given. The salient feature of this simulation code is its accuracy since it continually updates a set of samples of the solution of the partial differential equation which represents the dynamic behavior of the solar system components. This approach avoids the simulation errors introduced by such methods as the finite differencing scheme which seem to influence the simulation results. The accuracy of the computer simulation was tested against both analytic expressions for the solar energy system performance and against experimental data. As an example of the utility of this simulation code, a comparison between the performance of on-off and proportional flow controls for different pump functions is given. R.J.F.

N82-30652 California Univ., San Diego, La Jolla. Energy Center.

ON ELIMINATING PEAK LOAD AUXILIARY ENERGY CONSUMPTION IN PASSIVE SOLAR RESIDENCES DURING WINTER

A. V. SEBALD and D. MUNOZ (Inst. Tecnológico Regional de Tijuana, Baja Calif., Mexico) *In* ASME Solar Eng., 1981 p 377-388 1981 refs

(Contract DE-AC04-79AL-10891)

Avail: Issuing Activity

The tradeoffs in properly controlled passive solar buildings when peak auxiliary energy consumption is to be avoided are examined. Computerized simulation analysis is used to determine how total backup consumption depends on the choice of peak load blackout periods, what comfort penalties arise, where off-peak energy should be introduced into the house, and the effects of imprecise short-term weather forecasts. R.J.F.

N82-30653 Michigan Technological Univ., Houghton. Dept. of Mechanical Engineering-Engineering Mechanics.

DATA DEPENDENT SYSTEMS APPROACH TO SOLAR ENERGY SIMULATION INPUTS

S. M. PANDIT and K. P. RAJURKAR *In* ASME Solar Eng., 1981 p 389-398 1981 refs

Avail: Issuing Activity

An application of a recently developed methodology called data dependent systems (DDS) to modeling and analysis of solar insolation data is discussed. It is shown to be capable of combining the advantages of deterministic as well as stochastic models. Illustrative DDS models for Madison, Wisconsin data provide a comprehensive quantitative analysis of all the dynamic patterns, including some very minute ones. The model characteristics reveal the relation of these patterns to the direct and diffuse insolation as well as constant and variable weather dynamics. Major dynamic patterns are successfully reproduced in the data simulated with the help of only a few parameters and a random number generator. The relation of the dynamic patterns with a physical model is developed to show that a more realistic estimate of the extinction coefficient is obtained from the DDS models. R.J.F.

N82-30657 Midwest Research Inst., Golden, Colo. Building Systems Development Branch.

SPECTRAL ANALYSIS OF AMBIENT WEATHER PATTERNS

J. V. ANDERSON and K. SUBBARAO *In* ASME Solar Eng., 1981 p 424-430 1981 refs

Avail: Issuing Activity

A Fourier spectral analysis of ambient weather data, consisting of global and direct solar radiation, dry and wet bulb temperatures, and wind speed, is given. By analyzing the heating and cooling seasons independently, seasonal variations are isolated and a cleaner spectrum emerges. This represents an improvement over previous work in this area, in which data for the entire year were analyzed together. As a demonstration of the efficacy of this method, synthetic data constructed with a small number of parameters are used in typical simulations, and the results are compared with those obtained with the original data. A spectral characterization of fluctuations around the moving average is given, and the changes in the fluctuation from season to season are examined. Author

N82-30658 Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.

THE ECONOMIC FEASIBILITY OF FLAT-PLATE SOLAR HOT WATER SYSTEMS: RETROFIT APPLICATIONS FOR VIRGINIA PUBLIC BUILDINGS

R. R. SOMERS, II, A. C. PRITCHARD, M. R. SEXTON, M. C. HOFFMAN (Syska and Hennessy, Inc., Washington, D.C.), and L. S. FLETCHER (Texas A & M Univ., College Station) *In* ASME Solar Eng., 1981 p 431-438 1981 refs

Avail: Issuing Activity

The results of an economic feasibility study of 177 public buildings in the Commonwealth of Virginia to determine if active flat-plate solar collector systems could economically augment or replace existing hot water heating installations are presented. The buildings which were examined included schools, hospitals, local government buildings, and public care facilities. Data concerning each facility's annual hot water requirements, 1978-79 energy costs, operating schedule, and location were evaluated using a computer program that could calculate the monthly and annual solar contribution to the hot water load for a given collector area. The program then performed a life-cycle costing of the solar system. A search technique was used in conjunction with these evaluations to determine two specific solar collector areas for each facility. The first collector area was elected by maximizing the present worth of the net savings over the life of the solar installation. This was designated the optimum collector area. The second collector area (the maximum area) was determined by maximizing the amount of solar energy that could be utilized without increasing the annual hot water system costs. The results indicate that there is a significant potential to use solar energy to provide hot water for many Virginia public buildings. R.J.F.

N82-30659 Science Applications, Inc., McLean, Va. Solar Technology Div.

THERMAL AND ECONOMIC ASSESSMENT OF HOT SIDE SENSIBLE HEAT AND COLD SIDE PHASE CHANGE STORAGE COMBINATION FOR ABSORPTION SOLAR COOLING SYSTEM

M. K. CHOI and J. H. MOREHOUSE *In* ASME Solar Eng., 1981 p 439-448 1981 refs Sponsored in part by Midwest Research Inst.

Avail: Issuing Activity

An analysis of a solar assisted absorption cooling system which employs a combination of phase change on the cold side and sensible heat storage on the hot side of the cooling machine for small commercial buildings is given. The year-round thermal performance of this system for space cooling were determined by simulation and compared against conventional cooling systems in three geographic locations: Phoenix, Arizona; Miami, Florida and Washington, D.C. The results indicate that the hot-cold storage combination has a considerable amount of energy and economical savings over hot side sensible heat storage. Using the hot-cold storage combination, the optimum collector areas for Washington, D.C., Phoenix and Miami are 355 m squared, 250 m squared and 495 m squared, respectively. Compared against conventional vapor compression chiller, the net solar fractions are 61, 67 and 69 percent, respectively. R.J.F.

N82-30660 Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering and Applied Mechanics.

A GENERALIZED ANALYSIS OF SOLAR SPACE HEATING

J. A. CLARK *In* ASME Solar Eng., 1981 p 449-457 1981 refs

Avail: Issuing Activity

A life-cycle model is developed for solar space heating within the United States. The model consists of an analytical relationship among five dimensionless parameters that include all pertinent technical, climatological, solar, operating and economic factors that influence the performance of a solar space heating system. An important optimum condition presented is the break-even metered cost of conventional fuel at which the cost of the solar system is equal to that of a conventional heating system. The effect of Federal (1980) and State (1979) income tax credits on these costs is determined. A parameter that includes both solar availability and solar system utilization is derived and plotted on a map of the U.S. This parameter shows the most favorable present locations for solar space heating application to be in the Central and Mountain States. The data employed are related to the rehabilitated solar data recently made available by the National Climatic Center. R.J.F.

N82-30661 University of Central Florida, Orlando. Dept. of Engineering.

ECONOMICS OF SOLAR ENERGY: SHORT TERM COSTING

H. KLEE *In* ASME Solar Eng., 1981 p 458-464 1981 refs

Avail: Issuing Activity

The solar economics based on life cycle costs are refuted as both imaginary and irrelevant. It is argued that predicting rates of inflation and fuel escalation, expected life, maintenance costs, and legislation over the next ten to twenty years is pure guesswork. Furthermore, given the high mobility level of the U.S. population, the average consumer is skeptical of long run arguments which will pay returns only to the next owners. In the short term cost analysis, the house is sold prior to the end of the expected life of the system. The cash flow of the seller and buyer are considered. All the relevant factors, including the federal tax credit and the added value of the house because of the solar system are included. M.G.

02 SOLAR ENERGY

N82-30662 Mueller Associates, Inc., Baltimore, Md.
AN ECONOMIC COMPARISON OF ACTIVE SOLAR ENERGY AND CONVENTIONAL FUELS FOR WATER AND SPACE HEATING

J. G. SHINGLETON and T. A. KING *In ASME Solar Eng.*, 1981 p 465-474 1981 Sponsored by DOE. Prepared in cooperation with Argonne National Lab., Ill.)

Avail: Issuing Activity

The economic considerations involved in the decision to buy a solar energy system are discussed. In addition, a realistic evaluation is presented of the current cost effectiveness of solar water and space heating systems in all regions of the country and under various economic conditions based on the best available information. A reference long term economic scenario and several typical systems were used as the basis for the analyses. The sensitivity of the results to differences from the reference case is described. A series of reports produced for the U.S. Department of Energy is summarized. All results are not provided for each application type against each type of conventional fuel. However, sufficient results are presented to obtain an understanding of the extent to which solar water and space heating applications compete with conventional fuels. M.G.

N82-30663 Booz-Allen and Hamilton, Inc., Washington, D. C.
EFFECTS OF THE PROVISIONS OF THE CORPORATE AND PERSONAL INCOME TAX CODES ON SOLAR INVESTMENT DECISIONS

M. R. SEDMAK *In ASME Solar Eng.*, 1981 p 475-484 1981 refs

Avail: Issuing Activity

The effects of the provisions of the existing corporate and personal income tax codes on solar investment decisions are analyzed. It is shown that the provisions of a tax code do not discriminate against investment in solar technologies if the present value of depreciation and interest expense tax deductions over the relevant decision period is equal to the present value of actual capital expenses. However, on the basis of a quantitative analyses, it is concluded that the existing corporate income tax code does discriminate against solar investments for the majority of corporations, although the 25 percent tax credit available to businesses for solar investments is sufficient to alleviate the distortion in most cases. In contrast, the provisions of the existing personal income tax code favor solar investments over investments in less capital intensive energy generating units, as the interest paid on loans used to finance solar investments made by individuals is tax deductible, while conventional fuel expenses are not deductible. M.G.

N82-30664 Department of Energy, Washington, D. C.
A COMPARISON OF FUEL SAVINGS IN THE RESIDENTIAL AND COMMERCIAL SECTORS GENERATED BY THE INSTALLATION OF SOLAR HEATING AND COOLING SYSTEMS UNDER THREE TAX CREDIT SCENARIOS

R. MODEN *In ASME Solar Eng.*, 1981 p 485-493 1981 refs

Avail: Issuing Activity

An analysis of expected energy savings between 1977 and 1980 under three different solar tax credit scenarios is presented. The results were obtained through the solar heating and cooling of buildings (SHACOB) commercialization model. This simulation provides projected savings of conventional fuels through the installation of solar heating and cooling systems on buildings in the residential and commercial sectors. The three scenarios analyzed considered the tax credits contained in the Windfall Profits Tax of April 1980, the National Tax Act of November 1978, and a case where no tax credit is in effect. M.G.

N82-30665 Midwest Research Inst., Golden, Colo. Solar Energy Program Branch.

SOLAR THERMAL COST GOALS

R. B. EDELSTEIN *In ASME Solar Eng.*, 1981 p 495-502 1981 refs

Avail: Issuing Activity

The development of cost goals for the DOE solar thermal program by the solar thermal cost goals committee (STCGC) is described. The objective of the STCGC is to determine a consistent set of time-related cost and performance goals for concentrating collector systems based on market value and intermediate goals based on attainable cost levels. Accomplishments thus far include: definition on cost goals and their function in program planning, delineation of competing energy systems costs, development of a breakeven costing methodology for assessing market value, determination of attainable costs for solar thermal systems, setting financial and economic parameters, and calculation of market value as a function of each competing fuel type, application, and region. Author

N82-30666 Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

SIMULATION AND ECONOMIC ANALYSIS OF A LIQUID-BASED SOLAR SYSTEM WITH A DIRECT-CONTACT LIQUID-LIQUID HEAT EXCHANGER, IN COMPARISON TO A SYSTEM WITH A CONVENTIONAL HEAT EXCHANGER

P. BROTHERS and S. KARAKI *In ASME Solar Eng.*, 1981 p 503-508 1981 refs

Avail: Issuing Activity

Using a solar computer simulation package called TRNSYS, simulations of the direct contact liquid-liquid heat exchanger (DCLLHE) solar system and a system with conventional shell-and-tube heat exchanger were developed, based in part on performance measurements of the actual systems. The two systems were simulated over a full year on an hour-by-hour basis at five locations; Boston, Massachusetts, Charleston, South Carolina, Dodge City, Kansas, Madison, Wisconsin, and Phoenix, Arizona. Typically the direct-contact system supplies slightly more heat for domestic hot water and space heating in all locations and about 5 percentage points more cooling as compared to the conventional system. Using a common set of economic parameters and the appropriate federal and state income tax credits, as well as property tax legislation for solar systems in the corresponding states, the results of the study indicate for heating-only systems, the DCLLHE system has a slight life-cycle cost disadvantage compared to the conventional system. For combined solar heating and cooling systems, the DCLLHE has a slight life-cycle cost advantage which varies with location and amounts to one to three percent difference from the conventional system. M.G.

N82-30667 Tulane Univ., New Orleans, La. Dept. of Mechanical Engineering.

ECONOMIC ANALYSIS OF SOLAR BUILDING COMPONENTS

K. E. HASSAN (Al-Fateh Univ., Tripoli, Libya) *In ASME Solar Eng.*, 1981 p 509-514 1981 refs

Avail: Issuing Activity

The problem of the economic choice of building materials and air conditioning equipment, solar and conventional, is dealt with. The formulation is particularly suitable for buildings with combined passive and positive indoor temperature control. The heat fluxes through the various components of the building are the thermal criteria used. The various costs are analyzed and separated into fixed (or capital) costs, and operating costs which constitute the total annual cost. This latter cost is the objective function to be minimized to give the optimum design. The problem is formulated in a most general dimensionless form. It is simplified by neglecting the effect on the total annual cost of the difference between the peak and average heat fluxes, which is negligible in most cases. The simplified relation is solved in closed form to optimize a single layer or two layers of a composite building component. An example of the results is presented graphically. Author

N82-30669 Drexel Univ., Philadelphia, Pa. Dept. of Electrical and Computer Engineering.

OPERATING A DISTRIBUTED PHOTOVOLTAIC POWER GENERATION SYSTEM AT A RESIDENTIAL SITE

T. F. HALPIN, R. FISCHL, and P. R. HERCZFELD *In ASME Solar Eng.*, 1981 p 523-531 1981 refs Sponsored in part by the Middle Atlantic Committee on Power Engineering Education

Avail: Issuing Activity

A method and an inexpensive experiment for designing a photovoltaic electric power generating system located at a residential or commercial user's site which complements the utility's electric supply and is designed to be cost effective for the utility as well as the user are described. The integrated solar-utility electric (ISUE) energy system consists of a solar cell array, battery storage, and a load management strategy. The design is based on probabilistic performance indices which measure the probability of solar energy utilization and the probability of using utility power during peak periods. Experimental data on the effect of solar cell array size and energy management strategies on these performance indices were obtained using an inexpensive ISUE simulator which was installed at a residence. The results give the tradeoffs required in the design and the operating problem encountered when installing such a photovoltaic ISUE system.

M.G.

N82-30671 Ford Aerospace and Communications Corp., Newport Beach, Calif. Aeronutronic Div.

BUFFER THERMAL ENERGY STORAGE FOR A SOLAR THERMAL POWERED 1-MW SUB E ELECTRICAL PLANT

R. E. POLZIEN *In ASME Solar Eng.*, 1981 p 541-548 1981 refs

Avail: Issuing Activity

The application of a latent heat thermal energy buffer storage (TEBS) subsystem to the small community solar thermal power experiment (SCSE) is discussed. The SCSE is a 1-MW sub e solar thermal electric plant consisting of multiple paraboloidal concentrators with an organic Rankine cycle power conversion unit mounted at the focus of each concentrator. Objective of the TEBS is to minimize plant shutdowns during intermittent cloud coverage thereby improving life expectancy of major subsystems. An SCSE plant performance model is used with time varying insolation to show that 70 to 80 percent of the potential engine shutdowns may be averted with the TEBS system. Parametric variation of engine life dependency on start/stop cycles shows the potential for a 4 percent reduction in levelized bus bar energy cost using TEBS.

M.G.

N82-30672 Ford Aerospace and Communications Corp., Newport Beach, Calif. Aeronutronic Div.

ECONOMIC ANALYSIS OF A DISH-RANKINE SOLAR THERMAL POWER SYSTEM

R. L. PONS and R. E. IRWIN *In ASME Solar Eng.*, 1981 p 549-556 1981 refs

Avail: Issuing Activity

An analysis of the performance and costs of a first generation dish Rankine solar thermal power system for small community and industrial applications is presented. The system is of the point-focusing distributed receiver type, with distributed generation and employs multiple paraboloidal concentrators with organic Rankine cycle power conversion systems at the focus of each dish. Projected life cycle energy costs for a fully developed and mass produced system are shown to be competitive with costs projected in the near future for electricity generated by more conventional means. It is shown that: (1) the method of rating plant power output has a minor influence on life cycle energy cost, (2) optimum dish size is greater than 12m, (3) energy cost is virtually independent of plant size above 1 MW sub e and (4) dish spacing and geometric arrangement can be optimized to reduce energy cost.

M.G.

N82-30673 Lincoln Lab., Mass. Inst. of Tech., Lexington.

PERFORMANCE OF A COMBINED PHOTOVOLTAIC/THERMAL, FLAT-PLATE, LIQUID COLLECTOR

W. A. AIELLO and P. RAGHURAMAN *In ASME Solar Eng.*, 1981 p 557-564 1981 refs Sponsored in part by DOE

Avail: Issuing Activity

A combined photovoltaic/thermal, flat-plate, liquid collector, where the liquid circulates both below and above the photovoltaic cells (the primary energy-absorbing surface), was designed and tested according to ASHRAE 93-77 specifications to yield collector thermal and electrical efficiencies. A one-dimensional thermal analysis predicts the test results accurately. On the strength of the test and analytical results, design recommendations are made to maximize the total energy extracted from the collectors. M.G.

N82-30674 Alabama Univ., Huntsville. Solar Energy Center.

TESTING AND EVALUATION OF BTU METERS USED FOR MEASURING SOLAR SYSTEM PERFORMANCE

G. R. GUINN and L. L. HUMMER *In ASME Solar Eng.*, 1981 p 565-571 1981 refs

Avail: Issuing Activity

The operational experience and calibration results of three makes of meters which are widely used as primary instrumentation on active solar energy systems are described. Btu (heat) meters are widely utilized as a utility metering device and as a low cost instrument for evaluating performance of solar energy systems. Approximately 35 Btu meters were tested prior to installation in active solar DWH systems under evaluation. It is indicated that the meter are capable to measure water volume and Btu's at flow rates typically found in solar systems. E.A.K.

N82-30676 Tennessee Valley Authority, Chattanooga. Technical Support Section.

RESULTS OF ASHRAE 95 THERMAL TESTING OF 32 RESIDENTIAL SOLAR WATER HEATING SYSTEMS

G. T. CHINERY and F. C. WESSLING, JR. *In ASME Solar Eng.*, 1981 p 581-588 1981 refs

Avail: Issuing Activity

Thermal testing for 32 residential solar water heating systems that are presented with system descriptions and a review of the test methodology. The tested systems included drain back, drain down, closed loop and air designs and utilized water, glycol/water mixtures, silicone oil and air heat transfer fluids. Systems tested included one and two tank designs. Collectors comprised of selective and nonselective surfaces. The system energy multipliers ranged from 0.96 to 3.6 and calculated fractional energy savings ranged from 17% to 78%. E.A.K.

N82-30677 Utah Univ., Salt Lake City.

TESTING OF AIR-FLOW WINDOWS FOR EVALUATION AND APPLICATION

R. F. BOEHM and K. BRANDLE *In ASME Solar Eng.*, 1981 p 589-596 1981 refs Prepared in cooperation with California Univ., Berkeley. Lawrence Berkeley Lab. Sponsored in part by DOE and HUD

Avail: Issuing Activity

The performance of air flow windows was assessed and compared to a conventional window of current design. Tests are quite representative of actual application conditions in a variety of vertical orientations. The actual application condition requirement necessitated some approximations to the energy measurements which are not found in guarded hot box or calorimeter kinds of approaches to performance evaluations. The testing technique and required approximations are described. A possible type of solar residential application is also described. E.A.K.

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N82-30680 California State Univ., Sacramento. Dept. of Physics.

COOLING PERFORMANCE DATA AND ANALYSIS FOR THREE PASSIVE/HYBRID HOMES IN DAVIS, CALIFORNIA

S. MAHAJAN, C. NEWCOMB, M. SHEA, D. WOODFORD, E. HODAPP, and W. ARMES *In ASME Solar Eng.*, 1981 p 616-625 1981 refs

Avail: Issuing Activity

Three passive/hybrid homes in California, were monitored continuously during the summer of 1979. Two of the houses, are purely passive type, with water columns and concrete floors providing the thermal mass. The third house is a hybrid type. It transfers energy by forced air flow to a rock bed under the slab floor. All three houses are cooled by cooldown of building mass by night ventilation. Hourly data on air temperature, globe temperature, thermal mass temperatures and ambient air temperature were collected. The strip chart data were transferred to magnetic tapes for digital analysis. Thermal performance simulations for all three houses were made by computer codes. The experimentally measured air and thermal mass temperatures, and auxiliary cooling energy used are compared with the computer code predictions. E.A.K.

N82-30681 Delaware Univ., Newark. Inst. of Energy Conversion.

MEASUREMENT OF THE HEAT TRANSFER RATE FOR THERMAL ENERGY STORAGE MASSES IN DIRECT GAIN PASSIVE SOLAR HEATING SYSTEMS

S. F. FAUNCE and R. K. RICKERT (West Chester State College, Pa.) *In ASME Solar Eng.*, 1981 p 626-631 1981 refs

Avail: Issuing Activity

The measurement of heat transfer and the amount of thermal energy stored in thermal mass used in a passive solar heating system is described. A thermal flux meter measured the rate of heat transfer. A time relationship for the solar energy absorbed and discharged by the mass was obtained. Different orientations of the irradiated surface which consisted of different materials such as brick, concrete and phase change materials were measured. Measurements for various mass composites give values of heat transfer for absorptive of the solar irradiated surface for horizontally oriented masses and for the same masses in a vertical position. E.A.K.

N82-30682 Babcock and Wilcox Co., Barberton, Ohio. Fossil Power Generation Div.

THERMAL ANALYSIS OF A SOLAR ADVANCED WATER/STEAM RECEIVER

L. T. YEH and M. WIENER *In ASME Solar Eng.*, 1981 p 632-641 1981 refs Sponsored in part by Sandia Labs. (Contract AT(29-1)-789)

Avail: Issuing Activity

A conceptual design for a 100 MWe solar advanced water/steam receiver that is cost effective and will perform within a practical and reliable power generation system was developed. The design requirements and the basic features of a novel receiver are described. The methods used to estimate the receiver's thermal losses and thermal efficiency are described. The receiver is external with screen tubes using a forced recirculation system. Effects due to changing conditions, such as ambient temperature and wind speed, and changes of solar incident power are presented. The maximum tube metal temperature and the safety factor which is the ratio of maximum allowable heat flux to the actual heat flux absorbed are computed. E.A.K.

N82-30683* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE APPLICATION OF SIMULATION MODELING TO THE COST AND PERFORMANCE RANKING OF SOLAR THERMAL POWER PLANTS

L. S. ROSENBERG, W. R. REVERE, and M. K. SELCUK *In ASME Solar Eng.*, 1981 p 642-653 1981 refs Sponsored in part by DOE in agreement with NASA

Avail: Issuing Activity CSCL 10B

Small solar thermal power systems (up to 10 MWe in size) were tested. The solar thermal power plant ranking study was performed to aid in experiment activity and support decisions for the selection of the most appropriate technological approach. The cost and performance were determined for insolation conditions by utilizing the Solar Energy Simulation computer code (SESII). This model optimizes the size of the collector field and energy storage subsystem for given engine generator and energy transport characteristics. The development of the simulation tool, its operation, and the results achieved from the analysis are discussed. E.A.K.

N82-30684* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HEAT ENGINE DEVELOPMENT FOR SOLAR THERMAL POWER SYSTEMS

H. Q. PHAM and L. D. JAFFE *In ASME Solar Eng.*, 1981 p 654-659 1981 refs Sponsored in part by DOE in Agreement with NASA

Avail: Issuing Activity CSCL 10B

The parabolic dish solar collector systems for converting sunlight to electrical power through a heat engine will, require a small heat engine of high performance long lifetime to be competitive with conventional power systems. The most promising engine candidates are Stirling, high temperature Brayton, and combined cycle. Engines available in the current market today do not meet these requirements. The development of Stirling and high temperature Brayton for automotive applications was studied which utilizes much of the technology developed in this automotive program for solar power engines. The technical status of the engine candidates is reviewed and the components that may additional development to meet solar thermal system requirements are identified. E.A.K.

N82-30685 Montreal Univ. (Quebec). Dept. of Mechanical and Engineering.

OPTIMIZING THE PERFORMANCE OF A SOLAR LIQUID PISTON PUMP

C. L. MURPHY *In ASME Solar Eng.*, 1981 p 660-666 1981 refs Sponsored in part by a grant from NSERC

Utilization of solar energy for pumping water for irrigation or storage is discussed. Oscillations of a Freon 113 liquid column are generated in a working tube when a continuous flow of hot water, and cooling water, are supplied to heated and cooling coils located in the tube. The oscillations are converted into a pump (SLPP) model exhibited self starting, stable operation over a wide range of conditions, provides the inlet hot water heat source and inlet cooling water heat sink are above and below the critical values for stalling at a given pump head. The operation of the SLPP model, is primarily affected by the heating coil position within the working tube, and the geometries of the inlet and outlet water tubes. E.A.K.

N82-30687 Sandia Labs., Albuquerque, N. Mex. Fluid Mechanics and Heat Transfer Div.

SIMULATOR OF LARGE THERMAL ENERGY SYSTEMS (SOLTES)

N. R. GRANDJEAN and M. E. FEWELL *In ASME Solar Eng.*, 1981 p 675-678 1981 refs (Contract DE-AC04-76DP-00789)

Avail: Issuing Activity

SOLTES simulates the steady-state response of thermal energy systems to time-varying data such as weather and loads. Thermal energy system models of individual components and simple and

complex systems can easily be modularly constructed from a library of routines. These routines mathematically model solar collectors, pumps, switches, thermal energy storage, thermal boilers, auxiliary boilers, heat exchangers, extraction turbines, extraction turbine/generators, condensers, regenerative heaters, air conditioners, process vapor, etc.; SOLTES also allows user-supplied routines. Model construction is a natural extension of the system analyst's schematic. A pre-processor aids the user in constructing and editing system models and automatically constructs a SOLTES program that uses only those routines in the system model; thus, computer core requirements are minimized. N.W.

N82-30688 California Univ., Livermore. Lawrence Livermore Lab.

THE ROLE OF FINANCING IN THE MARKETABILITY OF CAPITAL INTENSIVE SOLAR TECHNOLOGIES FOR INDUSTRY

W. C. DICKINSON *In ASME Solar Eng.*, 1981 p 679-687 1981 refs

Avail: Issuing Activity

Three methods of financing large, capital-intensive, industrial solar systems are examined: conventional end-user financing; conventional lease financing; and the solar management company/limited partnership (SMC). The primary disadvantage of the first method is the large capital investment required of the end-user. The availability of investment capital is limited and other investment priorities usually are dominant. In the latter two methods the end-user is not required to provide any front-end capital. The SMC structure appears particularly attractive in that the end-user pays only for solar energy delivered to the process and is not required to operate and maintain the system. Author

N82-30689 Arizona Univ., Tucson. Dept. of Nuclear and Energy Engineering.

DESIGN AND ECONOMIC ANALYSIS FOR SOLAR PROCESS HEAT

G. MIGNON, L. COMPOY, F. LUTTMANN, and R. FAZZOLARE *In ASME Solar Eng.*, 1981 p 688-693 1981 refs Sponsored in part by Arizona Solar Energy Research Commission

Avail: Issuing Activity

A general methodology for the analysis of solar industrial process heat design is described. In the analysis a number of factors must be considered such as climate, plant location and environment, displaced fuel, process demand and schedule, equipment and component alternatives, and system cost. The system parameters are optimized for an assumed set of economic conditions. The results of the analysis are: technical and economic feasibility indicators, collector field design, thermal storage size, pumping and heat exchanger requirements. Author

N82-30690 Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

THE VALUE OF THERMAL STORAGE IN SOLAR IPH SYSTEMS

S. M. HÖCK and M. E. KARPUK *In ASME Solar Eng.*, 1981 p 696-701 1981 refs

Avail: Issuing Activity

The value of thermal storage for three solar industrial process heat systems was determined for storage capacities of 3 to 4000 hours. The dominant source of storage value is backup fuel savings with additional value derived from increased capital equipment utilization and elimination. A computer simulation was used to model the operation of the solar IPH system and predict the amount of fuel saved by heat delivered from storage. Sensitivity of storage value to process temperature, collector cost, load profile, insolation and storage efficiency have been calculated. Storage values ranged from near zero to as high as \$42 per Kw-hr of storage capacity. Author

N82-30691 Los Alamos Scientific Lab., N. Mex.

CONCENTRATING SOLAR COLLECTOR SYSTEM FOR THE EVAPORATION OF LOW-LEVEL RADIOACTIVE WASTE WATER

S. C. DIAMOND and C. C. CAPPIELLO *In ASME Solar Eng.*, 1981 p 702-707 1981 refs

Avail: Issuing Activity

Performance optimization of collector array size and configuration, storage medium and capacity, system operation, and control schemes are done using the active solar system simulator in the DOE-2 building energy analysis computer program. Results of this optimization are reported. Author

N82-30692 ECA, Inc., Woodridge, Ill.

CALCIUM CARBONATE SCALING IN SOLAR COLLECTORS

I. SINGH, C. F. CHENG, and R. M. WOLOSEWICZ (Argonne National Lab.) *In ASME Solar Eng.*, 1981 p 708-711 1981 refs

Sponsored in part by DOE

Avail: Issuing Activity

Water samples collected from five U.S. Department of Energy sponsored solar energy systems and eight water samples of varying degrees of hardness were assessed for tendency to form calcium carbonate scale on solar collector surfaces. A two-step approach is recommended for estimating scaling potential based on water analysis: (1) calculate the Palin Index, and (2) if the index shows a potential for scaling, confirm this result by using the method developed at Argonne National Laboratory based on the Caldwell-Lawrence approach. Water treatments for preventing scaling also are discussed. Author

N82-30694 Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

WIND LOADING ON TRACKING AND FIELD MOUNTED SOLAR COLLECTORS

L. M. MURPHY *In ASME Solar Eng.*, 1981 p 719-727 1981 refs

Sponsored in part by DOE

Avail: Issuing Activity

Current design and testing procedures for wind loading are discussed. The test results corresponding to numerous wind tests on heliostats, parabolic troughs, parabolic dishes, and field mounted photovoltaic arrays are discussed and the applicability of the findings across the various technologies is assessed. Author

N82-30695 ECA, Inc., Woodridge, Ill. Alternative Energy Technologies.

CORROSION PROBLEMS ASSOCIATED WITH SOLAR FLUID AND COMPONENTS

C. F. CHENG, C. P. CHEN, and R. M. WOLOSEWICZ (Argonne National Lab., Ill.) *In ASME Solar Eng.*, 1981 p 728-738 1981 refs

Avail: Issuing Activity

Corrosion and materials problems encountered at three commercial solar demonstration sites are discussed, including analyses of failed outer/inner glass cover plates, absorber panels/tubes, collector outlet tubes, interconnecting hoses, heat exchangers, and storage tanks. In addition, preliminary results are reported of laboratory tests on the corrosion of carbon steel, copper, and aluminum in inhibited propylene-glycol solutions at temperatures typical of stagnant-full conditions (352 F or 178 C). Author

N82-30696 Rensselaer Polytechnic Inst., Troy, N. Y.

COMPUTER SIMULATION OF A PASSIVE SOLAR ASSISTED HEAT PUMP

D. KINLOCK, N. HINESEY, and J. TICHY *In ASME Solar Eng.*, 1981 p 739-745 1981 refs

Avail: Issuing Activity

The Passive Solar Assisted Heat Pump (PSAHP) consists of the outdoor heat exchanger of a conventional air-to-air heat pump enclosed in an attached passive solar greenhouse. A computer simulation of this concept was developed to determine if it worked to optimize the design and to check the effect of various parameters on system operation. An hour-by-hour simulation using weather

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data for the albany, New York area was used, as typical of the severe Northeast U.S. climate region. The optimum design offered a 24% electric energy savings over a regular heat pump. Author

N82-30697 Midwest Energy Inst., Kansas City, Mo.
THERMAL PERFORMANCE OF LOW-COST RETROFITTED SOLAR SPACE HEATING SYSTEM

J. SLOTE *In ASME Solar Eng.*, 1981 p 746-754 1981 refs
Avail: Issuing Activity

The thermal performance of 10 similar low cost, shop built, south wall, active air solar space heating systems is evaluated for 10 days of the 1979 to 80 heating season. The design of the system is outlined. In addition, the equipment and procedures used to monitor the system are detailed, and several practical problems encountered designs of the individual systems, with the consistent features of the more successful systems receiving special attention. J.D.

N82-30698 Argonne National Lab., Ill.
RELIABILITY ASSESSMENT OF SOLAR DOMESTIC HOT WATER SYSTEMS

P. Y. WANG and R. M. WOLOSEWICZ *In ASME Solar Eng.*, 1981 p 755-761 1981 refs
Avail: Issuing Activity

Reliability and mean time between failure studies of six generic solar domestic hot water systems are presented. Failure rate data for system components were obtained from product literature or from consumer product industries. Reliability block diagrams are employed for the analyses, and exponential distribution functions are assumed for individual components. Since some components do not operate continuously, a duty-cycle factor is developed and defined as the ratio of operating time to total mission time. To accommodate systems experiencing different duty cycles, an averaged duty cycle is introduced to estimate mean lives. Large variations in system reliability and mean life were found and result from wide failure rate bands for some of the components. Author

N82-30699 Vitro Labs., Silver Spring, Md.
VALIDATION OF REMOTELY SENSED DATA FROM A LARGE NETWORK OF SOLAR HEATING AND COOLING INSTALLATIONS

C. J. KELLY, JR. *In ASME Solar Eng.*, 1981 p 762-769 1981 refs
Avail: Issuing Activity

Methods for ensuring that data reported by telephone from widely separated solar heating and cooling installations are accurate and reliable are discussed. These methods are divided into two phases—data screening and performance factor validation. Performance factors are the numerical results of performance evaluations of the individual installations. Data screening consists of determining that the gathered data are reasonable with regard to magnitude, rate of change and relationship to other sensor outputs. Performance factor validation consists of constructing energy balances using different groups of sensors or analysis techniques and comparing the results. This validation does not verify individual sensor accuracy but rather confirms the energy flow calculations to standards which may vary to each system. Using these methods, inaccurate or inoperable sensors can be discovered with a high degree of confidence. These validation methods are described and use of them on data gathered from a large scale data network is detailed with examples of the types of anomalies discovered. J.D.

N82-30701*# Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering.

AN EBIC STUDY OF DISLOCATION NETWORKS IN UNPROCESSED AND UNPROCESSED WEB SILICON RIBBON
F. S. FIELDLER (Hewlett-Packard Co., Covallis, Oreg.) and D. AST May 1982 30 p refs Sponsored in part by DOE (Contract JPL-956046)
(NASA-CR-169213; NAS 1.26:169213; JPL-9950-687; DOE/JPL-956046-8272; REPT-2) Avail: NTIS HC A03/MF A01 CSCL 10A

Experimental techniques for the preparation of electron beam induced current samples of Web-dentritic silicon are described. Both as grown and processed material were investigated. High density dislocation networks were found close to twin planes in the bulk of the material. The electrical activity of these networks is reduced in processed material. S.L.

N82-30702*# Science Applications, Inc., La Jolla, Calif.
SOLAR THERMAL BENEFITS STUDY. TASK 1: UTILITY CASE STUDIES

S. YOUNG Mar. 1982 95 p refs Prepared for JPL (NASA-CR-169245; NAS 1.26:169245) Avail: NTIS HC A05/MF A01 CSCL 10A

Metrodology, solar systems, utility systems, fuel and economic assumptions, solar system benefits, and remaining work are summarized with charts and tables. N.W.

N82-30703*# Springborn Labs., Inc., Enfield, Conn.
INVESTIGATION OF TEST METHODS, MATERIAL PROPERTIES, AND PROCESSES FOR SOLAR CELL ENCAPSULANTS
Quarterly Progress Report

P. B. WILLIS Apr. 1982 69 p
(Contract JPL-954527)
(NASA-CR-169239; DOE/JPL-954527-82/22; NAS 1.26:169239; QPR-23) Avail: NTIS HC A04/MF A01 CSCL 10A

Technical investigations concerned the development of advanced cure chemistries for lamination type pottants; the continued evaluation of soil resistant surface treatments, and the results of an accelerated aging test program for the comparison of material stabilities. New compounds were evaluated for efficiency in curing both ethylene/vinyl acetate and ethylene/methyl acrylate pottants intended for vacuum bag lamination of solar cells. One compound in particular, designated Lupersol - TBEC (Lucidol Division of Pennwalt Corp.) was found to be unusually effective in promoting the rapid cure of both these materials. Formulation of these resins with TBEC resulted in compositions of very high gel content, lower temperatures of activation, and much lower cure times, even in the ethylene/methyl acrylate polymer that is more difficult to cure. It is expected that TBEC modified pottant formulations may permit the lamination/encapsulation step to be operated at lower temperatures, higher speed, higher throughput and a much wider tolerance for intentional or accidental variations in the cure schedule. An experimental program continued to determine the effectiveness of soil resistant coatings. Author

N82-30706*# Spire Corp., Bedford, Mass.
DEVELOPMENT OF A LARGE AREA SPACE SOLAR CELL ASSEMBLY Final Report, Jul. 1981 - Mar. 1982

M. B. SPITZER May 1982 65 p refs
(Contract NAS3-22236)
(NASA-CR-167929; NAS 1.26:167929; FR-10081) Avail: NTIS HC A04/MF A01 CSCL 10A

The development of a large area high efficiency solar cell assembly is described. The assembly consists of an ion implanted silicon solar cell and glass cover. The important attributes of fabrication are the use of a back surface field which is compatible with a back surface reflector, and integration of coverglass application and cell fabrications. Cell development experiments concerned optimization of ion implantation processing of 2 ohm-cm boron-doped silicon. Process parameters were selected based on these experiments and cells with area of 34.3 sq cm were fabricated. The average AMO efficiency of the twenty-five best cells was 13.9% and the best cell had an efficiency of 14.4%. An important

innovation in cell encapsulation was also developed. In this technique, the coverglass is applied before the cell is sawed to final size. The coverglass and cell are then sawed as a unit. In this way, the cost of the coverglass is reduced, since the tolerance on glass size is relaxed, and costly coverglass/cell alignment procedures are eliminated. Adhesive investigated were EVA, FEP-Teflon sheet and DC 93-500. Details of processing and results are reported. B.W.

N82-30707*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A SIMPLE MODEL OF PROTON DAMAGE IN GAAS SOLAR CELLS

J. W. WILSON, G. H. WALKER, and R. A. OUTLAW Jun. 1982 18 p refs
(NASA-TM-84495; NAS 1.15:84495) Avail: NTIS HC A02/MF A01 CSDL 10A

A simple proton damage model for GaAs solar cells is derived and compared to experimental values of change in short circuit currents. The recombination cross section associated with the defects was determined from the experimental comparison to be approximately 1.2×10^{-13} cm in fair agreement with values determined from the deep level transient spectroscopy technique. Author

N82-30724# SRI International Corp., Arlington, Va.
ASSESSMENT OF SOME ENERGY TECHNOLOGIES ASSOCIATED WITH SOLAR ENERGY

H. D. ABARBANEL, K. M. CASE, S. M. FLATTE, W. A. NIERENBERG, and K. M. WATSON Oct. 1981 57 p refs
(AD-A114924; SRI-JSR-81-26) Avail: NTIS HC A04/MF A01 CSDL 10A

In this report we present our study of three alternative energy generation concepts which employ solar energy in some part of the system. We will discuss these subjects: Salinity Gradient Solar Ponds, Osmotic Membrane Power Generation, and Thermochemical Storage and Transport. The treatment of these items is not uniform. The report will emphasize the ponds, briefly dwell on Osmotic Membranes and only touch on the third topic. This, in fact, reflects the assessment of the potential of the three concepts. GRA

N82-30725# Army Armament Research and Development Command, Dover, N. J. Larger Caliber Weapon Systems Lab.
SOLAR ENERGY APPLICATIONS AT ARMY AMMUNITION PLANTS

A. P. LOWRY and S. M. MOY Jun. 1982 46 p refs
(AD-A115464; AD-E400841; ARLCD-TR-81038) Avail: NTIS HC A03/MF A01 CSDL 10B

The Army Ammunition Plants use significant quantities of fossil fuels. To reduce dependence on these scarce, costly, and non-renewable fuels, a study was conducted to investigate potential solar energy applications at the AAPs. Solar energy is a low-level energy source which is best applied to low temperature applications. It can be used at the AAPs to preheat boiler feedwater, provide hot air for dry-houses, provide domestic hot water and heat for administration buildings, and provide hot water for manufacturing processes such as metal cleaning, phosphating, and X-ray film processing. Use of the flat plate collectors, evacuated tube collectors, or solar ponds with the possible addition of a heat pump, offers reasonably economical means of applying solar technology to AAP needs. GRA

N82-30727# Army Engineer District, St. Louis, Mo. Mechanical Electrical Section.

PERFORMANCE TEST: OKAW BLUFF BATHHOUSE SOLAR HOT WATER SYSTEM Final Report

M. MERTENS and A. H. P. SWIFT Jun. 1982 13 p
(AD-A115529) Avail: NTIS HC A02/MF A01 CSDL 13A

This report presents data collected during testing at Okaw Bluff Bathhouse during July, 1980 and uses this data to evaluate the economic and energy conservation benefits of using solar hot

water heating systems at recreational bath facilities.

Author (GRA)

N82-30728# Technical Univ. of Denmark, Copenhagen. Lab. for Varmeisolering.

INCIDENT SOLAR RADIATION AND SOLAR HEATING SYSTEMS - MEASURED AND CALCULATED

H. LAWAETZ Oct. 1980 208 p refs In DANISH
(DE82-900603; DTH-LV-MEDD-106) Avail: NTIS (US Sales Only) HC A10/MF A01; DOE Depository Libraries

The solar gain at the surface of the Earth is measured. Formula expressions to calculate the incident angles of the direct solar radiation on a given surface are developed. Measuring equipment for continuous measurements of the solar radiation on seven surfaces is described. From the measurements of the solar radiation and from the other meteorological weather observations, a calculation method for the determination of the diffuse sky radiation on arbitrary surfaces from horizontally measured radiation was made. The yearly solar gain in Denmark is discussed, and with the use of a method for selecting a reference year such one is selected from meteorological weather observations, and the distribution of the solar gain during the year is drawn. A mathematical model of a solar collector is examined. For some given solar collector designs and weather conditions it is demonstrated that the solar collector output calculated with the described model is in accordance with more complicated models. DOE

N82-30730# Lincoln Lab., Mass. Inst. of Tech., Lexington.

DATA REPORT FOR THE NORTHEAST RESIDENTIAL EXPERIMENT STATION, AUGUST 1981

M. C. RUSSELL, P. RAGHURAMAN, and P. C. MAHONEY Oct. 1981 13 p

(Contract DE-AC02-76ET-20279)
(DE82-003348; DOE/ET-20279/164) Avail: NTIS HC A02/MF A01

The physical performance data for the month of August 1981 obtained from photovoltaic energy systems under test at the Northeast Residential Experiment Station in Concord, Massachusetts are given. DOE

N82-30731# Lincoln Lab., Mass. Inst. of Tech., Lexington.

DATA REPORT FOR THE NORTHEAST RESIDENTIAL EXPERIMENT STATION, JULY 1981

M. C. RUSSELL, P. RAGHURAMAN, and P. C. MAHONEY Sep. 1981 14 p

(Contract DE-AC02-76ET-20279)
(DE82-001878; DOE/ET-20279/161) Avail: NTIS HC A02/MF A01

The residential experiments stations were designed to develop residential photovoltaic systems and to gather and disseminate performance data for the photovoltaic community, cognizant institutions and, ultimately, the public. Physical performance data obtained from photovoltaic energy systems under test at the Northeast residential experiment station in Concord, Massachusetts are tabulated. DOE

N82-30734# California Univ., Livermore. Lawrence Livermore Lab.

PULSED-LASER TECHNIQUES FOR TRANSIENT MEASUREMENTS AT SEMICONDUCTOR PHOTOELECTROCHEMICAL SOLAR CELLS

J. H. RICHARDSON, S. P. PERONE, S. B. MONACO, L. L. STEINMETZ, and J. E. HARRAR Oct. 1981 23 p refs
Presented at the Electrochem. Soc. Conf., Denver, 12-16 Oct. 1981

(Contract W-7405-ENG-48)
(DE82-003056; UCRL-85823; CONF-811013-8) Avail: NTIS HC A02/MF A01

Pulsed laser excitation sources provide a convenient means of initiating and probing photophysical and photochemical processes at the semiconductor electrode electrolyte interface. Both time resolved optical and electrochemical measurements are used to

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characterize the dynamics of intra-electrode charge separation and interfacial charge transfer as a function of applied bias, solution composition, and electrode physical properties. The philosophy behind this approach to transient measurements will be illustrated with recent experimental results involving single crystal and polycrystalline electrodes. DOE

N82-30735# Science Applications, Inc., McLean, Va. Solar Technology Div.

EVALUATION OF THERMAL-STORAGE CONCEPTS FOR SOLAR COOLING APPLICATIONS

P. J. HUGHES, J. H. MOREHOUSE, M. K. CHOI, N. M. WHITE, and W. B. SCHOLTEN Oct. 1981 85 p refs
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-004035; SERI/TR-09083-1) Avail: NTIS HC A05/MF A01

Various configuration concepts for utilizing thermal energy storage to improve the thermal and economic performance of solar cooling systems for buildings were analyzed. The storage concepts evaluated provide short-term thermal storage via the bulk containment of water or salt hydrates. The evaluations were made for both residential-size cooling systems (3-ton) and small commercial-size cooling systems (25-ton). The residential analysis considers energy requirements for space heating, space cooling and water heating, while the commercial building analysis is based only on energy requirements for space cooling. The commercial building analysis considered a total of 10 different thermal storage/solar systems, 5 each for absorption and Rankine chiller concepts. The residential analysis considered 4 thermal storage/solar systems, all utilizing an absorption chiller. The trade-offs considered include: cold-side versus hot-side storage, single vs multiple stage storage, and phase-change vs sensible heat storage. DOE

N82-30737# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ECONOMIC ASSESSMENTS OF INTERMITTENT, GRID-CONNECTED SOLAR ELECTRIC TECHNOLOGIES, A REVIEW OF METHODS

T. FLAIM, T. J. CONSIDINE, R. WITHOLDER, and M. EDESESS Sep. 1981 146 p refs
(Contract EG-77-C-01-4042; DE-AC02-77CH-00178)
(DE82-002083; SERI/TR-353-474) Avail: NTIS HC A07/MF A01

The methods that were used for economic assessments of intermittent solar technologies in applications that are connected to conventional utility systems are reviewed. Factors to be considered when assessing intermittent technologies are identified and methods that have been used in technology assessment are reviewed. The tradeoffs among methods are qualitatively assessed relative to ease of use and accuracy of results. The best available methods are identified for use when maximum accuracy is desired. Data problems, deficiencies in existing techniques, and unresolved methodological issues are analyzed. Input assumptions and economic figures of merit are also evaluated. E.A.K.

N82-30740# Pennsylvania State Univ., University Park. Materials Research Lab.

PHOTOVOLTAIC AND STRUCTURAL PROPERTIES OF A-SI:H THIN FILMS Annual Technical Report, 1 Jun. 1980 - 31 May 1981

R. MESSIER and I. S. T. TSONG Oct. 1981 142 p refs
(DE82-002697; SERI/TR-9227-1-T2) Avail: NTIS HC A07/MF A01

Growth mechanisms important in determining the composition, structure, and semiconducting properties of a-Si:H produced by sputtering of Si in an inert gas/H₂ plasma were studied. These growth processes were investigated by systematically varying critical external deposition parameters and by observing resultant changes in the plasma-film environment and in film microstructure and properties. Film microstructure, is reduced or eliminated when growth occurs under conditions of negative substrate bias and induced inert gas ion monohydride configuration for H bonded to

Si. The beneficial consequences of depositional bombardment are offset by bombardment produced, atomic scale defects. The hydrogen partial pressure in the plasma directly controls the amount of hydrogen in the film. It is found that a minimum of 5 to 15 atomic % H is apparently essential for defect minimization; an elevated substrate temperature has only a small effect on microstructure and hydrogen bonding configuration, but is crucial in reducing the density of intrinsic and bombardment related gap states. GRA

N82-30748# Sandia Labs., Albuquerque, N. Mex. CARRIER SIGNAL TECHNOLOGY APPLIED TO SOLAR COLLECTOR FIELD CONTROL

R. L. ALVIS 1981 16 p refs Presented at the 4th Ann. Tech. Conf. of the ASME Solar Energy Div., Albuquerque, N. Mex., 26 Apr. 1981
(Contract DE-AC04-76DP-00789)
(DE82-001775; SAND-81-2045C; CONF-8104112-1) Avail: NTIS HC A02/MF A01

The development and operational performance are described of a control system designed specifically for solar distributed collector field systems. Carrier technology is employed to eliminate costly field constructed control wiring and allows the control system quality to be controlled at system suppliers' plants. Prototype hardware has been built and tested in the field with excellent operating results. DOE

N82-30749# Sandia Labs., Albuquerque, N. Mex. PV System Definition Div.

ASSESSMENT OF THE FEASIBILITY OF THE WIDESPREAD PHOTOVOLTAIC RETROFITS

J. L. JACKSON 1981 14 p refs Presented at the Univ. of Mo. Dept. of Nat. Resources Conf. on Energy, Rolla, 6 Nov. 1981
(Contract DE-AC04-76DP-00789)
(DE82-003051; SAND-81-1147C; CONF-811137-1) Avail: NTIS HC A02/MF A01

Some of the economic implications of retrofits and retrofit designs which might be employed are considered. Residential and commercial retrofits may represent a significant national market for photovoltaic (PV) systems. Techniques for estimating the photovoltaic retrofits market and present preliminary conclusions about physical market size are discussed. Possible institutional barriers to widespread retrofits are reviewed. GRA

N82-30750# Sandia Labs., Albuquerque, N. Mex. Theoretical Div.

USER'S GUIDE TO HELIOS: A COMPUTER PROGRAM FOR MODELING THE OPTICAL BEHAVIOR OF REFLECTING SOLAR CONCENTRATORS. PART 3: APPENDICES CONCERNING HELIOS-CODE DETAILS

C. N. VITTITOE and F. BISS Sep. 1981 89 p refs
(Contract DE-AC04-76DP-00789)
(DE82-003077; SAND-81-1562) Avail: NTIS HC A05/MF A01

HELIOS is a flexible computer code for evaluating designs for central-receiver, parabolic-dish, and other reflecting solar-energy collector systems; for safety calculations on the threat to personnel and to the facility itself; for determination of how various input parameters alter the power collected; for design trade-offs; and for heliostat evaluations. Input variables include atmospheric transmission effects; reflector shape, surface, and suntracking errors; focusing and alignment strategies; receiver design; placement positions of the tower and mirrors; time-of-day and day-of-year for the calculation. Part III is a series of appendices giving code details for subroutine and function descriptions, how common blocks are used, sample jobstreams, and magnetic tape use within the code. DOE

N82-30752# Sandia Labs., Albuquerque, N. Mex.
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION
 EXPERIMENT OPERATIONAL PERFORMANCE EXECUTIVE
 SUMMARY. VOLUME 2 FOR MT. LAGUNA RADAR STATION,
 MT. LAGUNA, CALIF.**

Oct. 1981 7 p Prepared in cooperation with Boeing Computer Services Co., Seattle
 (Contract DE-AC04-76DP-00789)
 (DE82-003682; SAND-81-7104-VOL-2) Avail: NTIS HC A02/MF A01

For the month of August 1981, the daily and monthly electricity production, daily and monthly insolation, monthly average photovoltaic array efficiency, power conditioner efficiency, photovoltaic system efficiency, and capacity factor are given for a photovoltaic power supply for a California radar base. DOE

N82-30753# Sandia Labs., Albuquerque, N. Mex.
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION
 EXPERIMENT OPERATIONAL PERFORMANCE REPORT.
 VOLUME 4 FOR LOVINGTON SQUARE SHOPPING CENTER,
 LOVINGTON, N. MEX.**

Oct. 1981 18 p Prepared in cooperation with Boeing Computer Services, Co., Seattle 4 Vol.
 (Contract DE-AC04-76DP-000789)
 (DE82-003080; SAND-81-7985/4) Avail: NTIS HC A02/MF A01

For the month of August 1981, performance data are given for a photovoltaic power supply at a New Mexico shopping center. Data include: daily and monthly electricity production, daily and monthly insolation data, daily and monthly array efficiency, graphs of energy production vs. power level, array field voltage, cell temperature, and hour of the day, daily photovoltaic system availability, heating and cooling degree days, average ambient temperature, average wind speed for the month, cell temperature, ambient temperature, wind speed and insolation graphed vs. hour of the day, and wind direction distribution. DOE

N82-30756# Sandia Labs., Livermore, Calif.
HELIOSTAT COST-ANALYSIS TOOL

L. D. BRANDT and R. E. CHANG Oct. 1981 52 p refs
 (Contract DE-AC04-76DP-00789)
 (DE82-003879; SAND-81-8031) Avail: NTIS HC A04/MF A01

A heliostat cost analysis tool (HELSTAT) that processes manufacturing transportation, and installation cost data was developed which provides a consistent structure for cost analyses. The HELSTAT calculates a representation product price based on direct input data and various economic, financial, and accounting assumptions. The characteristics of this tool and its initial application in the evaluation of second generation heliostat cost estimates are discussed. A set of nominal economic and financial parameters is also suggested. GRA

N82-30763# Metallgesellschaft, A.G., Frankfurt am Main (West Germany).

**DEVELOPMENT OF INDUSTRIAL PRODUCTION PROCESSES
 FOR COMPONENTS OF SOLAR HEATING SYSTEMS,
 ESPECIALLY SOLAR COLLECTORS Final Report, Aug. 1981**

M. MOELLER Bonn Bundesministerium fuer Forschung und Technologie Apr. 1982 120 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
 (BMFT-FB-T-82-059; ISSN-0340-7608) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 25

Work in preparation for the manufacturing on an industrial scale of solar collectors as well as components for solar heating systems with long service life is described. A suitable selective coating with excellent optical properties for Al absorber panels was developed. Reliable knowledge was acquired on the compatibility of different materials with aqueous and synthetic heat transfer fluids in recirculating solar collector systems. The temperature distribution in the collector was calculated and served as a basis for the design of the transparent cover. The development of sealing compounds with permanent elasticity at constant temperatures up to 120 C make it possible to construct hermetically sealed collector

housings. Testing of systems is completed and efficient solar collectors are now on the market. Author (ESA)

N82-30794*# National Academy of Sciences - National Research Council, Washington, D. C. Committee on Solar-Terrestrial Research (CSTR).

SOLAR-TERRESTRIAL RESEARCH FOR THE 1980'S Final Report

Oct. 1981 159 p Sponsored in part by NASA
 (Contract NSF ATM-79-20060; NA79RA-C-00121)
 (NASA-CR-169258; NAS 1.26:169258; PB82-162371) Avail:
 NTIS HC A08/MF A01 CSCL 04A

The solar-terrestrial system is described. Techniques for observations involving all relevant platforms: spacecraft, the Earth's surface, aircraft, balloons, and rockets are proposed. The need for interagency coordination of programs, efficient data management, theoretical studies and modeling, the continuity of long time series observations, and innovative instrument design is emphasized. Examples of the practical impact of interactions between solar terrestrial phenomena and the environment, including technological systems are presented. GRA

N82-31109*# Ball State Univ., Muncie, Ind. Dept. of Physics and Astronomy.

**SOLAR CONCENTRATION PROPERTIES OF FLAT FRESNEL
 LENSES WITH LARGE F-NUMBERS Final Report**

R. M. COSBY Mar. 1978 35 p refs
 (Contract NCA8-129)

(NASA-CR-162050; NAS 1.26:162050) Avail: NTIS HC A03/MF A01 CSCL 20F

The solar concentration performances of flat, line-focusing sun-tracking Fresnel lenses with selected f-numbers between 0.9 and 2.0 were analyzed. Lens transmittance was found to have a weak dependence on f-number, with a 2% increase occurring as the f-number is increased from 0.9 to 2.0. The geometric concentration ratio for perfectly tracking lenses peaked for an f-number near 1.35. Intensity profiles were more uniform over the image extent for large f-number lenses when compared to the f/0.9 lens results. Substantial decreases in geometri concentration ratios were observed for transverse tracking errors equal to or below 1 degree for all f-number lenses. With respect to tracking errors, the solar performance is optimum for f-numbers between 1.25 and 1.5. Author

N82-31348*# Lockheed Missiles and Space Co., Sunnyvale, Calif. 22b

**MULTI-100 KW: PLANAR LOW COST SOLAR ARRAY
 DEVELOPMENT Final Review Report**

Jun. 1982 45 p

(Contract NAS8-32981)

(NASA-CR-162067; NAS 1.26:162067) Avail: NTIS HC A03/MF A01

The development of a 100 kW planar low cost solar array is presented. Tasks are defined, objectives are stated, and test results are given. A study of alternate contact configuration concluded that gridded back contact cells sharply reduced solar absorptance, that copper contacts will require a developmental program before interface can be achieved, and that gridded back contact cells using Ti-Pd-Ag as the contact materials appear to be the most cost-effective design. R.J.F.

N82-31349*# Lockheed Missiles and Space Co., Sunnyvale, Calif.

**MULTI-100 KW: PLANAR LOW COST SOLAR ARRAY
 DEVELOPMENT Final Report, 1 Sep. 1981 - 31 Jul. 1982**

Jun. 1982 76 p Original contains color illustrations

(Contract NAS8-32981)

(NASA-CR-162068; LMSC-D843500; NAS 1.26:162068) Avail:
 NTIS HC A05/MF A01 CSCL 22B

The applicability of selected low cost options to solar array blanket design was studied by fabricating representative modules and submitting them to thermal cycle environment. Large area (5.9 x 5.9 cm) solar cells of 3 varieties were purchased: (1) Standard

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wraparound, (2) Copper contacts substituted for the conventional Titanium-Palladium-Silver, and (3) Standard wraparound except with gridded back contact instead of continuous metallization. The baseline cell was purchased to compare fabrication cost and to serve as a control cell during test evaluation of the other two cells. All cells were assembled into either substrate modules where the cell is individually filtered and welded to an integrated Kapton-copper circuit or into a superstrate configuration with 4 cells jointly adhered to a single sheet of microsheet and then welded to the integrated Kapton-copper circuit. Cell quality, particularly in the metallization of contacts, was less than desired. Problems were encountered with copper metallization in laying down a barrier metal which would ohmically bond to the silicon. The cells received were shunted (sintered) or with low contact pull strength (non-sintered), thus leading to the decision to solder rather than weld the copper cells to the Kapton substrate. R.J.F.

N82-31634# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

EFFECTS OF AIR MASS AND INTEGRATION METHODS ON RESULTS FOR OPTICAL PROPERTY MEASUREMENTS OF SOLAR COVER PLATE AND ABSORBER MATERIALS

W. E. ROBERTS, L. W. MASTERS, and E. J. CLARK Jan. 1982 48 p refs Sponsored in part by NBS and DOE (PB82-165184; NBSIR-81-2448) Avail: NTIS HC A03/MF A01 CSCL 09E

Methods of calculating the transmittance of cover plate materials and the reflectance of absorber materials are compared. Optical data were obtained for both aged and unaged test specimens using an integrating sphere spectrophotometer. The data were integrated using both the weighted and selected ordinate methods in ASTM E 424, Method A, at air mass 2.0, and the selected ordinate method at air mass 1.5 and 1.0. The solar reflectance and solar transmittance values calculated using the various methods are presented and the impact of the data in terms of possible revisions to ASTM E 424 is discussed. GRA

N82-31764* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

HIGH VOLTAGE PLANAR MULTI-JUNCTION SOLAR CELL Patent

J. C. EVANS, JR., A. T. CHAI, and C. P. GORADIA, inventors (to NASA) 24 Dec. 1980 6 p Filed 24 Dec. 1980 Supersedes N81-16528 (19 - 07, p 0927) (NASA-CASE-LEW-13400-1; US-PATENT-4,341,918; US-PATENT-APPL-SN-219677; US-PATENT-CLASS-136-249; US-PATENT-CLASS-357-30) Avail: US Patent and Trademark Office CSCL 10A

A high voltage multijunction solar cell is provided wherein a plurality of discrete voltage generating regions or unit cells are formed in a single generally planar semiconductor body. The unit cells are comprised of doped regions of opposite conductivity type separated by a gap or undiffused region. Metal contacts connect adjacent cells together in series so that the output voltages of the individual cells are additive. In some embodiments, doped field regions separated by a overlie the unit cells but the cells may be formed in both faces of the wafer.

Official Gazette of the U.S. patent and Trademark Office

N82-31771*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

EXPERIMENTAL EVALUATION OF THE BATTELLE ACCELERATED TEST DESIGN FOR THE SOLAR ARRAY AT MEAD, NEBRASKA

P. O. FRICKLAND and J. REPAR 6 Apr. 1982 46 p refs (Contract NAS7-100; NAS7-100DE-AI01-76ET-20356; DE-AI01-76ET-20356; NAS7-100; NAS7-100DE-AI01-76ET-20356) (NASA-CR-169281; JPL-PUB-82-52; DOE/JPL-10-12-73; NAS 1.26:169281) Avail: NTIS HC A03/MF A01 CSCL 10B

A previously developed test design for accelerated aging of photovoltaic modules was experimentally evaluated. The studies included a review of relevant field experience, environmental chamber cycling of full size modules, and electrical and physical

evaluation of the effects of accelerated aging during and after the tests. The test results indicated that thermally induced fatigue of the interconnects was the primary mode of module failure as measured by normalized power output. No chemical change in the silicone encapsulant was detectable after 360 test cycles. Author

N82-31773*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOVOLTAIC MODULE ENCAPSULATION DESIGN AND MATERIALS SELECTION, VOLUME 1

E. CUDDIHY, W. CARROLL, C. COULBERT, A. GUPTA, and R. H. LIANG 1 Jun. 1982 166 p refs (Contract NAS7-100; DE-AI01-76ET-20356; JPL PROJ. 5101-177) (NASA-CR-169265; JPL-PUBL-81-102-VOL-1; DOE/JPL-10-12-60-VOL-1; NAS 1.26:169265) Avail: NTIS HC A08/MF A01 CSCL 10B

Encapsulation material system requirements, material selection criteria, and the status and properties of encapsulation materials and processes available are presented. Technical and economic goals established for photovoltaic modules and encapsulation systems and their status are described. Available encapsulation technology and data are presented to facilitate design and material selection for silicon flat plate photovoltaic modules, using the best materials available and processes optimized for specific power applications and geographic sites. The operational and environmental loads that encapsulation system functional requirements and candidate design concepts and materials that are identified to have the best potential to meet the cost and performance goals for the flat plate solar array project are described. Available data on encapsulant material properties, fabrication processing, and module life and durability characteristics are presented. E.A.K.

N82-31774*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

PHOTOTHERMAL CHARACTERIZATION OF ENCAPSULANT MATERIALS FOR PHOTOVOLTAIC MODULES

R. H. LIANG, A. GUPTA, and S. DISTEFANO 1 Jun. 1982 77 p refs (Contract NAS7-100; DE-AI01-76ET-20356; JPL PROJ. 5101-210) (NASA-CR-169267; JPL-PUBL-82-42; NAS 1.26:169267) Avail: NTIS HC A05/MF A01 CSCL 10A

A photothermal test matrix and a low cost testing apparatus for encapsulant materials of photovoltaic modules were defined. Photothermal studies were conducted to screen and rank existing as well as future encapsulant candidate materials and/or material formulations in terms of their long term physicochemical stability under accelerated photothermal aging conditions. Photothermal characterization of six candidate pottant materials and six candidate outer cover materials were carried out. Principal products of photothermal degradation are identified. Certain critical properties are also monitored as a function of photothermal aging. E.A.K.

N82-31775*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

AN INVESTIGATION OF THE EFFECT OF WIND COOLING ON PHOTOVOLTAIC ARRAYS

L. WEN Mar. 1982 50 p refs (Contract NAS7-100; DE-AI01-76ET-20356; JPL PROJ. 5101-201) (NASA-CR-169263; JPL-PUBL-82-28; DOE/JPL-10-12-69; NAS 1.26:169263) Avail: NTIS HC A03/MF A01 CSCL 10A

Convective cooling of photovoltaic modules for different wind conditions, including steady state controlled testing in a solar simulator and natural test environments in a field was investigated. Analytical thermal models of different module designs were used to correlate experimental data. The applicability of existing heat transfer correlations is confirmed. Reasonable agreement is obtained by applying a power law wind profile. E.A.K.

N82-31777*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ON THE CAUSE OF THE FLAT-SPOT PHENOMENON OBSERVED IN SILICON SOLAR CELLS AT LOW TEMPERATURES AND LOW INTENSITIES

V. G. WEIZER, J. D. BRODER, H. W. BRANDHORST, JR., and A. F. FORESTIERI 1982 14 p refs Presented at the 3rd European Symp. on Photovoltaic Generators in Space, Bath, England, 4-6 May, 1982; sponsored by RAE, U.K. Dept. of Industry and ESA.

(NASA-TM-82903; E-1286; NAS 1.15:82903) Avail: NTIS HC A02/MF A01 CSDL 10A

A model is presented that explains the 'flat-spot' (FS) power loss phenomenon observed in silicon solar cells operating deep space (low temperature, low intensity) conditions. Evidence is presented suggesting that the effect is due to localized metallurgical interactions between the silicon substrate and the contact metallization. These reactions are shown to result in localized regions in which the PN junction is destroyed and replaced with a metal-semiconductor-like interface. The effects of thermal treatment, crystallographic orientation, junction depth, and metallization are presented along with a method of preventing the effect through the suppression of vacancy formation at the free surface of the contact metallization. Preliminary data indicating the effectiveness of a TiN diffusion barrier in preventing the effect are also given. Author

N82-31781# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

LABORATORY EXPERIMENTS ON HEAT AND MASS EXTRACTION FROM SOLAR PONDS Quarterly Report, 1 Jul. 1981 - 30 Sep. 1981

F. ZANGRANDO Jan. 1982 20 p refs (Contract DE-AC02-77CH-00178)

(DE82-007770; SERI/PR-252-1461; QR-2) Avail: NTIS HC A02/MF A01

The physical parameters that govern the flow and the related thermal field in the solar pond are defined, and simplified analytical models of the process are presented. Experimental goals to be pursued are determined and a preliminary design is presented for the experimental facility to be constructed. DOE

N82-31782# Sandia Labs., Albuquerque, N. Mex. **INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT. VOLUME 5: FOR MT. LAGUNA RADAR STATION, MT. LAGUNA, CALIFORNIA**

Dec. 1981 23 p refs

(Contract DE-AC04-76DP-00789)

(DE82-010949; SAND-81-7090/5) Avail: NTIS HC A02/MF A01

For the month of November, 1981, performance data are given for a photovoltaic power supply at a California radar station. Data given include: daily and monthly electric energy production; daily and monthly solar energy incident; daily and monthly array efficiency; electric energy production vs. power level, voltage, cell temperature, and hour of the day; power conditioning system input, output, and efficiency; daily and monthly electric energy provided by the photovoltaic system to the load; photovoltaic system efficiency; capacity factor; system availability; heating and cooling degree days; daily and hourly insolation, ambient temperature, and wind speed; wind direction distribution; hourly cell temperature; number of freeze-thaw cycles; and system efficiency. Also included is a brief narrative section to provide information not easily included in the computer-generated modules. DOE

N82-31783# General Electric Co., Philadelphia, Pa. Advanced Energy Programs Dept.

DESIGN OF A PHOTOVOLTAIC SYSTEM FOR A PASSIVE DESIGN NORTHEAST ALL-ELECTRIC RESIDENCE

E. M. MEHALICK, G. F. TULLY, J. JOHNSON, J. PARKER, and R. FELICE Jan. 1982 174 p refs

(Contract DE-AC04-76DP-00789)

(DE82-010859; SAND-80-7171) Avail: NTIS HC A08/MF A01

A photovoltaic system was developed and integrated into a passively designed, low energy consuming home suitable for the Northeast region of the country. The selected array size is 4.1 kW and covers 51 square meters of roof area. The design addresses the residential market segment of low energy consuming houses with limited roof area availability for photovoltaic arrays. A direct mount, next generation, larger sized, photovoltaic shingle module is used to reduce installation costs over earlier generation shingle modules. A 4 kW line-commutated inverter is used in the power conversion subsystem, since it is representative of currently available equipment. The complete system and house design are described, including all the pertinent installation and construction drawings. Specific performance results are presented for the Boston and Madison region. The system design presented, coupled with previously completed designs, provide a set of design options expected to be available to residential homeowners in the mid 1980's. DOE

N82-31784# General Electric Co., Schenectady, N. Y. Corporate Research and Development.

POLKA DOT SOLAR CELL Final Report, 1 Apr. 1980 - 29 May 1981

1981 40 p refs

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)

(DE82-006856; SERI/TR-9010-2-T1) Avail: NTIS HC A03/MF A01

Polka dot solar cells are discussed. A model was developed for thick epitaxial layer front junctions with moderate doping levels. The dependence of surface recombination velocity on doping is briefly discussed and epitaxial emitter cell fabrication by solution growth of Si from Sn is described. Two electron beam methods were used to determine the minority carrier diffusion lengths in the epitaxial layers. Arsenic diffusion from Sn-As sources is examined. Some possible modifications to the polka dot cell process are described. DOE

N82-31785# Photowatt International, Inc., Tempe, Ariz. **FEASIBILITY STUDY OF MICROWAVE APPLICATION FOR SOLAR CELL FABRICATION Final Report**

S. CHITRE and M. C. KEELING Jan. 1982 69 p refs

(Contract DE-AC02-77CH-00178)

(DE82-010121; SERI/TR-8041-16-T2) Avail: NTIS HC A04/MF A01

The application of microwave energy in heating for junction formation, back surface field formation, metallization sintering and combinations of these operations was studied. During the initial phases, the product produced did not confirm to the theoretical predictions. As a result, a mathematical model was generated and a computer analysis made. The initial expectations are outlined, and the model and results of the computer analysis are reported. Two generations of equipment were designed and a third generation conceptualized. The first instrument (single mode, single pass) was not capable of uniformly heating wafers above 6000 C. This was rectified in the second instrument which utilized amixed mode, multiple pass cavity. A discussion of the results of experiments on sintering, diffusion, and simultaneous front and back surface junction formation is presented with a tabular summary. The overall results were positive with particularly encouraging results on the front junction formation. In spite of a very low factor (0.67), the efficiency of the cells averaged 9.8% with a maximum of 10.7%. DOE

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N82-31797# Midwest Research Inst., Golden, Colo.
DECISION CRITERIA OF POTENTIAL SOLAR IPH ADAPTERS
E. PERWIN, A. LEVINE, G. MIKASA, R. J. NOUN, and D. SCHALLER Dec. 1981 58 p refs
(Contract DE-AC02-77CH-00178)
(DE82-007002; SERI/TR-663-1032) Avail: NTIS HC A04/MF A01

If national programs are to be effective in the research and development of viable renewable resource technologies for the industrial sector, understanding industry's decision criteria will be important. The results of a preliminary investigation of the decision criteria of potential and actual users of solar industrial process heat systems are presented. Detailed interviews were completed with decision-makers from ten manufacturing firms. Based on economic theory, it was assumed that corporate decision-makers assess the expected cost, revenue, and uncertainty of competing investment opportunities. These decision criteria are composed of factors that are financial, technical, and institutional. Clearly, the firms interviewed were more concerned with costs than any other category of decision criteria. Most of the firms also believed that there was less uncertainty with competing investments than with current solar technology. Based on this preliminary investigation, a more extensive survey of industrial firms is suggested to determine a more comprehensive list of significant decision criteria. DOE

N82-31798# Brookhaven National Lab., Upton, N. Y. Biomedical and Environmental Assessment Div.
HEALTH RISKS OF PHOTOVOLTAIC ENERGY TECHNOLOGIES

P. D. MOSKOWITZ, L. D. HAMILTON, S. C. MORRIS, K. M. NOVAK, C. V. ROBINSON, and M. D. ROWE 1981 6 p refs Presented at the Intern. Symp. on Health Impacts of Different Sources of Energy, Nashville, Jun. 1981
(Contract DE-AC02-76CH-00016)
(DE82-011527; BNL-30745; CONF-810652-8) Avail: NTIS HC A02/MF A01

Health risks of photovoltaic energy technologies arise from mining, processing and refining of raw materials, and fabrication, installation, operation, and disposal of devices used to convert sunlight into useful energy. Using an accounting approach, public and occupational health risks are examined for four different photovoltaic cell alternatives: silicon single-crystal cells produced by an ingot process; silicon metal/insulator/semiconductor cells produced by ribbon growing; cadmium sulfide backwall cells produced by spray deposition; and gallium arsenide cells produced by modified ingot-growing. These alternatives cover a range of manufacturing options (e.g., ingot versus spray deposition) and materials (silicon versus arsenic) which might be used in future commercialization efforts. Most occupational mortality and morbidity effects probably relate to industrial risks similar to those encountered in the day-to-day operation of any industrial operation. Material supply, installation, and operation appear to contribute substantial portions of the damage. DOE

N82-31801# Booz-Allen and Hamilton, Inc., Bethesda, Md. Energy and Environment Div.
PASSIVE ACTIVE CONSERVATION EVALUATOR, PACE USER'S MANUAL

Jun. 1981 216 p Prepared for Midwest Research Inst., Golden, Colo.
(Contract DE-AC02-77CH-00178; EG-77-C-01-40442)
(DE82-010686; SERI/TR-98252-1) Avail: NTIS HC A10/MF A01

The use is described of the PACE computer program, developed as an analysis tool for the study of the economics and financing of active and passive solar energy systems. The program permits analysis of space and water heating systems based on active system algorithms and the solar load ratio passive system algorithms. Several types of analyses and reports are described which the model is capable of producing. Instructions are provided for using the model. The reports available from the program are described in detail. User reference data are included. DOE

N82-31802# Booz-Allen and Hamilton, Inc., Bethesda, Md. Energy and Environment Div.
PASSIVE ACTIVE CONSERVATION EVALUATOR. PACE PROGRAMMER'S MANUAL

Nov. 1981 380 p Prepared for Midwest Research Inst., Golden, Colo.
(Contract DE-AC02-77HC-00178; EG-77-C-01-4042)
(DE82-010722; SERI/TR-98252-2) Avail: NTIS HC A17/MF A01

The program features, programming conventions, and algorithms of the PACE computer program are described. This manual is intended to aid programmers in installing and modifying the program. Written descriptions of program routines, a listing of the program and its data base, a section on programming conventions, an explanation of the algorithms within the program, and advice on installation of PACE are included. DOE

N82-31803# Boeing Computer Services, Inc., Seattle, Wash.
INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT. VOLUME 6: FOR NEWMAN POWER STATION, EL PASO, TEXAS

Dec. 1981 24 p 6 Vol.
(Contract DE-AC04-76DP-00789)
(DE82-010946; SAND-81-7086/6) Avail: NTIS HC A02/MF A01

For the month of November, 1981, performance data are given for the photovoltaic power supply at a Texas utility. Data given include: daily and monthly electrical energy produced; daily and monthly incident solar energy; daily and monthly array efficiency; electrical energy produced versus power level, voltage, cell temperature, and hour of the day; daily and monthly energy delivered from the photovoltaic system to the load; daily system availability; heating and cooling degree days; monthly and hourly ambient temperature, wind speed and insolation; and wind direction distribution. Some site events are reported, and a brief narrative section is included to provide information not easily included in the computer generated modules. DOE

N82-31804# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
EVALUATION AND MARKET TESTING OF CORNING CODE 7809 THIN SOLAR GLASS

R. T. COYLE and R. LIVINGSTON Dec. 1981 30 p refs
(Contract DE-AC02-77CH-0017; EG-77-C-01-4042)
(DE82-010750; SERI/TR-733-1230) Avail: NTIS HC A03/MF A01

A thin, flat glass, 7809 was developed for an advanced solar energy reflector. The melting properties of 7809 glass, and the forming of thin sheets of this glass by the fusion process were tested. Glass manufactured in this experiment was distributed to 17 participants in a program developed to evaluate the glass in concentrating collector applications. A multilaboratory effort was organized to measure the physical properties of the glass. The 7809 glass exhibited good melting properties, had 91.7% transmittance, and had outstanding durability and fracture properties. DOE

N82-31813# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

STATE-OF-THE-ART REVIEW OF LOW-COST COLLECTOR TECHNOLOGIES Final Report

W. A. TOLBERT Jun. 1981 13 p refs Prepared in cooperation with Air Force Engineering and Services Center, Golden, Colo.
(Contract DE-AC02-77CH-00178)
(DE82-009325; DOE/SSO-4042/2) Avail: NTIS HC A02/MF A01

A brief but concise review is provided of low-cost solar collector technologies and their potential for application within the military. Low-cost, light-weight concepts for flat-plate collectors, parabolic trough collectors, heliostats and parabolic dish collectors are covered. In addition, several criteria are evaluated with respect to low-cost collector technologies. These include reliability, maintainability, survivability, motility/erectibility, environmental

impact and economics. Research and development requirements and ongoing activities are also summarized. DOE

N82-31814# Cornell Univ., Ithaca, N. Y. Dept. of Consumer Economics and Housing.

ECONOMIC ANALYSIS OF A PASSIVE SOLAR MULTIPLE FAMILY DWELLING FOR UPSTATE NEW YORK Thesis

J. LAQUATRA, JR. Feb. 1982 153 p refs

(Contract W-7405-ENG-36)

(DE82-009486; LA-9212-T) Avail: NTIS HC A08/MF A01

The economic feasibility of passive solar energy as applied to a multiple family dwelling in three upstate New York cities, Buffalo, Rochester, and Syracuse was studied. Specifically, two passive solar applications, a Trombe wall and direct gain system, for a nine unit structure were analyzed through the use of a solar economic performance code. City specific data, including climatological information, building construction costs, utility rates, and property taxes were used, as were various economic parameters to reflect economic conditions in general and specifically those of the solar systems' owners. DOE

N82-31815# Brookhaven National Lab., Upton, N. Y.

USE OF GROUND COUPLED TANKS IN SOLAR ASSISTED HEAT PUMP SYSTEMS. 1: COMPARISON OF EXPERIMENTAL AND COMPUTER MODEL RESULTS

P. D. METZ 1982 10 p refs Presented at the ASME Solar Energy Div. 4th Ann. Tech. Conf., Albuquerque, N. Mex., Apr. 1982

(Contract DE-AC02-76CH-00016)

(DE82-009928; BNL-30913; CONF-820410-9) Avail: NTIS HC A02/MF A01

Ground coupling (the use of the Earth as a heat source sink or storage element) for solar assisted heat pump systems was studied. Four buried tank experiments were operated between December, 1978 and March 1981 in order to determine the feasibility of ground coupled tanks in these systems. Heat was added to or removed from the tanks according to a weekly schedule derived from computer simulations of solar heat pump systems in the local (New York) climate. Each tank was operated according to a different control strategy. Experimental results from these tank experiments for this period are presented and these results are compared to those generated by a computer model. The model is found to be valid, for the most part, using undisturbed soil thermal properties which provide the best fit to the data most of the time. Its results are very sensitive to soil thermal conductivity during periods of large heat addition to the tanks. A ground coupled tank is found to be desirable in series solar assisted heat pump systems. However, no important carry over of summer collected heat to winter was observed. DOE

N82-31832# California Univ., Los Angeles.

ENVIRONMENTAL EFFECTS OF SOLAR THERMAL POWER SYSTEMS: EXPERIMENTS ON RESTORATION OF DISTURBED DESERT LAND BY MEANS OF REVEGETATION Progress Report, FY 1981

E. M. ROMNEY, R. B. HUNTER, and A. WALLACE Oct. 1981 18 p refs

(Contract DE-AM03-76SF-00012)

(DE82-006231; UCLA-12-1312) Avail: NTIS HC A02/MF A01

Cost effective methods of restoring native vegetation on disturbed Mojave Desert land were developed. Techniques for producing transplanting stocks of native shrub species were emphasized and different ways to protect and encourage regrowth from crown and root sprouting and new seedling establishment were investigated. Improved transplanting methods were developed. Vegetation management and recovery are required at sites disturbed for solar thermal power system installations. DOE

N82-31844# Brookhaven National Lab., Upton, N. Y. Div. of Energy and Economic Analysis.

INFLUENCE OF SOLAR ENERGY DEPLOYMENT ON LONG-RANGE TRANSPORT AIR POLLUTION

F. W. LIPPERT and L. I. KLEINMAN Jul. 1981 35 p refs

(Contract DE-AC02-76CH-00016)

(DE82-011329; BNL-51350) Avail: NTIS HC A03/MF A01

An analysis of the effects on ambient sulfur oxides of wide-spread deployment of various solar energy technologies by the year 2000 has been made, using the BNL long-range transport model AIRSOX. The solar energy deployment scenario was based on the Domestic Policy Review (National Energy Plan II), as supplied by the MITRE Corporation as part of the Technology Assessment of Solar Energy (TASE) project. The resulting changes in SO/sub x/ are in general quite modest (less than 10%), which is a direct result of the modest changes in SO2 emissions resulting from solar energy use. The changes over time from 1975 to 2000 are in general more important, and imply that a solar energy scenario specifically intended to optimize air quality might result in larger benefits. DOE

N82-32250# Department of Energy, Washington, D. C. Office of Energy Research.

SUMMARIES OF FY 1981 ENGINEERING RESEARCH

Feb. 1982 45 p

(DE82-008344; DOE/ER-0121) Avail: NTIS HC A03/MF A01

This report documents the Basic Energy Sciences (BES) Engineering Research program for fiscal year 1981; it provides a summary for each of the 39 program projects in addition to a brief program overview. The report is intended to provide staff of congressional committees, other executive departments, and other DOE offices with substantive program information so as to facilitate governmental overview and coordination of federal research programs. Of equal importance, its availability facilitates communication of program information to interested research engineers and scientists. DOE

N82-32350*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SOME DESIGN CONSIDERATIONS FOR SOLAR-POWERED AIRCRAFT

W. H. PHILLIPS Jun. 1980 60 p refs

(NASA-TP-1675; L-13562; NAS 1.60:1675) Avail: NTIS HC

A04/MF A01 CSCL 01C

Performance and operating characteristics are presented for a solar powered aircraft intended to remain aloft for long periods. The critical technologies which limit the performance are identified. By using the techniques presented, the effects of variation in the system parameters are studied. Practical design consideration are discussed. S.L.

N82-32563# National Science Foundation, Washington, D.C. Environment, Energy and Resources Group.

FEDERAL ROLE IN THE COMMERCIALIZATION OF ACTIVE SOLAR HEATING AND COOLING TECHNOLOGY: PAPERS FOR AND A SUMMARY OF A WORKSHOP

1981 225 p refs Workshop held in Washington, D.C., 18-19 Sep. 1980

(PB82-173402; NSF/PRA-81021) Avail: NTIS HC A10/MF A01

CSCL 13A

Active solar heating and cooling technology and prospects for commercial applications is assessed. Decision factors affecting commercialization emphasize land use controls and solar access issues; barriers and conditions which appear to retard commercial viability and social technology; government intervention to accelerate implementation; criteria to allocate resources among alternate incentive programs; analysis of solar incentives; and frustrations, concerns, and insights of a pioneer in solar technology. GRA

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N82-32841* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PHOTOCAPACITIVE IMAGE CONVERTER Patent

W. E. MILLER, A. SHER, and Y. H. TSUO, inventors (to NASA) 25 May 1982 7 p Filed 20 Jun. 1980 Supersedes N80-28635 (18 - 19, p 2562)

(NASA-CASE-LAR-12513-1; US-PATENT-4,331,873;

US-PATENT-APPL-SN-161256; US-PATENT-CLASS-250-330;

US-PATENT-CLASS-250-370) Avail: US Patent and Trademark Office CSCL 10A

An apparatus for converting a radiant energy image into corresponding electrical signals including an image converter is described. The image converter includes a substrate of semiconductor material, an insulating layer on the front surface of the substrate, and an electrical contact on the back surface of the substrate. A first series of parallel transparent conductive stripes is on the insulating layer with a processing circuit connected to each of the conductive stripes for detecting the modulated voltages generated thereon. In a first embodiment of the invention, a modulated light stripe perpendicular to the conductive stripes scans the image converter. In a second embodiment a second insulating layer is deposited over the conductive stripes and a second series of parallel transparent conductive stripes perpendicular to the first series is on the second insulating layer. A different frequency current signal is applied to each of the second series of conductive stripes and a modulated image is applied to the image converter.

Official Gazette of the U.S. Patent and Trademark Office

N82-32842# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

MATERIALS TECHNOLOGY ASSESSMENT OF HIGH TEMPERATURE SOLAR RECEIVERS FOR FUELS AND CHEMICALS PRODUCTION

T. N. TIEGS Jul. 1981 25 p refs

(Contract W-7405-ENG-26)

(ORNL/TM-7802) Avail: NTIS HC A02/MF A01

Current interest in using solar thermal energy to produce fuels and chemicals has prompted an assessment of materials technology for five proposed designs of solar receivers. The principal process of interest is water splitting. Reaction schemes considered involve the high temperature decomposition of sulfuric acid, and silicon carbide is the structural ceramic material usually considered most resistant to the conditions of this reaction. Hence we have assessed the fabricability of the designs from SiC for that reaction system, even though most designs envision use with air, helium, or nitrogen as a heat transfer medium. Honeycomb and hemispherical dome receivers have been fabricated from SiC. A receiver using planar coiled tubes has been fabricated from cordierite but not from SiC. Fabrication has not been demonstrated for helical coil and long tube designs. The last three of these should be fabricable with up to two years development. All lack the ultimate test: operational experience. The need for reliable seals is common to all designs. Metallic gaskets are subject to corrosion, and ceramic and mechanical seals have not been demonstrated for the anticipated thermal cycling. Author

N82-32847*# Science Applications, Inc., McLean, Va. SOLAR THERMAL PLANT IMPACT ANALYSIS AND REQUIREMENTS DEFINITION STUDY Final Report

5 Feb. 1982 522 p refs Prepared for JPL

(Contract JPL-955238)

(NASA-CR-169310; JPL-9950-716; NAS 1.26:169310) Avail:

NTIS HC A22/MF A01 CSCL 10A

The technology and economics of solar thermal electric systems (STES) for electric power production is discussed. The impacts of and requirements for solar thermal electric power systems were evaluated. Author

N82-32850*# Spectrolab, Inc., Sylmar, Calif.

DESIGN, ANALYSIS AND TEST VERIFICATION OF ADVANCED ENCAPSULATION SYSTEMS, PHASE 2 PROGRAM RESULTS Periodic Report, period ending 1 Oct. 1981

A. GARCIA, C. MINNING, R. T. BREEN, J. F. COAKLEY, L. B. DUNCAN, D. M. GLLASPY, R. H. KIEWERT, F. G. MCKINNEY, W. E. TAYLOR, and L. E. VAUGHN Jun. 1982 210 p refs Sponsored in part by DOE Prepared for JPL Prepared in cooperation with Hughes Aircraft Co.

(Contract JPL-955567)

(NASA-CR-169300; DOE/JPL-955567-82/8-SUPPL;

JPL-9950-720-SUPPL; NAS 1.26:169300) Avail: NTIS HC

A10/MF A01 CSCL 10A

Optical, electrical isolation, thermal structural, structural deflection, and thermal tests are reported. The utility of the optical, series capacitance, and structural deflection models was verified.

Author

N82-32852*# Benham Group, Oklahoma City, Okla.

LAND AVAILABILITY AND LAND VALUE ASSESSMENT FOR SOLAR PONDS IN THE UNITED STATES

May 1982 359 p refs Prepared for JPL

(Contract NAS7-100; JPL-955978)

(NASA-CR-169198; JPL-9950-723; NAS 1.26:169198) Avail:

NTIS HC A16/MF A01 CSCL 10A

The land availability and land values for solar ponds in the United States as they concern the residential, commercial, and institutional land use categories were investigated. Solar ponds were identified as efficient and economical means for collecting and storing direct and diffuse solar energy. Innovative methodologies were applied to arrive at regional projections regarding the amount of land that might potentially be available for retrofit or future solar pond applications. Regional land values were also documented and analyzed. Author

N82-32853*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DETERMINATION OF OPTIMUM SUNLIGHT CONCENTRATION LEVEL IN SPACE FOR 3-4 CASCADE SOLAR CELLS

H. B. CURTIS 1982 14 p refs Presented at the 3rd European Symp. on Photovoltaic Generators in Space, Bath, Engl., 4-6 May 1982; sponsored by RAE and ESA

(NASA-TM-82899; E-1282; NAS 1.15:82899) Avail: NTIS HC

A02/MF A01 CSCL 10A

The optimum range of concentration in space for III-V cascade cells has been calculated using a realistic solar cell diode equation. Temperature was varied with concentration using several models and ranged from 55 deg at one sun to between 80 deg and 200 deg C at 100 suns. A variety of series resistance and internal resistances were used. Coefficients of the diffusion and recombination terms are strongly temperature dependent. The study indicates that the maximum efficiency of 30 percent occurs in the 50 to 100 X sun concentration range provided series resistance is below 0.015 ohm sq cm and cell temperature is about 80 C at 100 suns. Author

N82-32854*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

LARGE AREA LOW-COST SPACE SOLAR CELL DEVELOPMENT

C. R. BARAONA and J. L. CIONI (NASA. Johnson Space Center, Houston, Tex.) 1982 9 p refs Presented at the 3rd European Symp. on Photovoltaic Generators in Space, Bath, Engl., 4-6 May, 1982; sponsored by RAE and ESA

(NASA-TM-82902; E-1285; NAS 1.15:82902) Avail: NTIS HC

A02/MF A01 CSCL 10A

A development program to produce large-area (5.9 x 5.9 cm) space quality silicon solar cells with a cost goal of 30 \$/watt is described. Five cell types under investigation include wraparound dielectric, mechanical wraparound and conventional contact configurations with combinations of 2 or 10 ohm-cm resistivity, back surface reflectors and/or fields, and diffused or ion implanted junctions. A single step process to cut cell and cover-glass

simultaneously is being developed. A description of cell developments by Applied Solar Energy Corp., Spectrolab and Spire is included. Results are given for cell and array tests, performed by Lockheed, TRW and NASA. Future large solar arrays that might use cells of this type are discussed. Author

N82-32855*# PRC Systems Sciences Co., Tucson, Ariz.
GALLIUM ARSENIDE SOLAR ARRAY SUBSYSTEM STUDY Final Report, Jan. 1981 - Feb. 1982
 F. Q. MILLER Feb. 1982 221 p refs
 (Contract NAS3-22667)
 (NASA-CR-167869; NAS 1.26:167869) Avail: NTIS HC A10/MF A01 CSCL 10A

The effects on life cycle costs of a number of technology areas are examined for a gallium arsenide space solar array. Four specific configurations were addressed: (1) a 250 KWe LEO mission - planer array; (2) a 250 KWe LEO mission - with concentration; (3) a 50 KWe GEO mission planer array; (4) a 50 KWe GEO mission - with concentration. For each configuration, a baseline system conceptual design was developed and the life cycle costs estimated in detail. The baseline system requirements and design technologies were 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 costs. Author

N82-32857# Texas Univ., Arlington. Dept. of Mechanical Engineering.
SOLAR PHOTOVOLTAIC/THERMAL RESIDENTIAL EXPERIMENT, PHASE 2 Final Report
 S. T. KUGLE, J. R. LEITH, and M. S. SVANE Aug. 1981 74 p refs
 (Contract DE-AC02-76ET-20279)
 (COO-4577-10) Avail: NTIS HC A04/MF A01

Performance and operation of photovoltaic and thermal solar heating and cooling systems were evaluated in order to assess the feasibility of hybrid photovoltaic/thermal collectors. Experiments were carried out at an instrumented single-family dwelling/research facility at the University of Texas at Arlington. The cooling load was the dominant comfort consideration, since the climate at the research site (in north central Texas) is generally regarded as humid subtropical with hot summers. Several solar-assisted heating and cooling configurations were considered for a basic system comprised of the photovoltaic and thermal collectors, a thermal storage tank, and a two-speed heat pump. The photovoltaic array, with an area of 109 sq. m was part of a utility-interactive ('line-stuffing') power system. Average solar-to-dc conversion efficiency of the array was 4.7%. Efficiency of the thermal collectors, with an area of 48.4 sq. m, was 5 to 20% and was dependent upon the difference between the glycol-water collector loop and thermal storage tank temperatures. Design objectives and operational strategies for hybrid photovoltaic/thermal collector systems were developed. Author

N82-32862*# Texas Research and Engineering Inst., Inc., Port Neches.
SILICON PRODUCTION PROCESS EVALUATIONS Final Report, 18 May 1981 - 30 Jul. 1982
 30 Jul. 1982 177 p refs Sponsored in part by DOE Prepared for JPL
 (Contract JPL-956045)
 (NASA-CR-169163; DOE/JPL-956045-82/5; NAS 1.26:169163)
 Avail: NTIS HC A09/MF A01 CSCL 10A

Chemical engineering analyses involving the preliminary process design of a plant (1,000 metric tons/year capacity) to produce silicon via the technology under consideration were accomplished. Major activities in the chemical engineering analyses included base case conditions, reaction chemistry, process flowsheet, material balance, energy balance, property data, equipment design, major equipment list, production labor and forward for economic analysis. The process design package provided detailed data for raw materials, utilities, major process equipment and production labor

requirements necessary for polysilicon production in each process. Author

N82-32864*# Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering.
AN EBIC STUDY OF HEM POLYCRYSTALLINE SILICON
 T. KOCH (Hewlett-Packard Co.) and D. AST 27 May 1982 29 p refs Sponsored in part by DOE Prepared for JPL
 (Contract JPL-956046)
 (NASA-CR-169296; DOE/JPL-956046-82/4; NAS 1.26:169196)
 Avail: NTIS HC A03/MF A01 CSCL 10A

Low-cost silicon for solar cells grown by the heat exchanger method (HEM) was studied in the electron beam induced current (EBIC) mode of a scanning electron microscope (SEM). Comparisons were made between the defects observed optically and the recombination centers visible in EBIC. Much of the HEM material was single crystalline, but structural defects were found from areas near the corners of the grown material. Most of these defects consisted of linear twin boundaries and grain boundaries. The electrical activity of these boundaries was dependent on symmetry of the boundaries. Symmetric twin boundaries did not exhibit recombination activity while unsymmetric twin boundaries were electrically active. Author

N82-32865# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
TEST STATION FOR SOLAR COLLECTORS IN LOW AND HIGH TEMPERATURE RANGE
 J. ANHALT and J. M. V. MARTINS Jul. 1982 15 p refs
 Presented at the 1st Latin Am. Congr. on Heat and Mass Transfer
 (INPE-2457-PRE/152) Avail: NTIS HC A02/MF A01

A collector test field was established. With the four installed test loops it is possible to test different kinds of solar collectors and collector banks in a temperature range from 30 C up to 250 C with a maximum power of 20 kW. The measurement equipment including a solar meteorological stations meets all requirements to carry out collector test according to international standards. Three types of collector banks, flat-plate, booster mirror collectors and parabolic trough collectors with approximately 20 sq m aperture area each are installed and under short and long term test. For typical applications, e.g. process heat in the range of 120 C up to 200 C, special experiments with outlet temperatures at fixed levels were performed. Author

N82-32870# Technical Univ. of Denmark, Lyngby. Lab. for Varmeisolering.
TWO SOLAR HEATING SYSTEMS FOR WATER HEATING. A DESCRIPTION AND EVALUATION AFTER 4-MONTHS OPERATIONS
 K. ELLEHAUGE, L. S. JORGENSEN, M. LANGE, S. E. MIKKELSEN, and C. NIELSEN Dec. 1980 55 p In DANISH
 (DE82-900831; DTH-LV-MEDD-104; ESR-12) Avail: NTIS (US Sales Only) HC A04/MF A01; DOE Depository Libraries

Efficiency and reliability of two different solar heating systems were imperfections. The heating systems, planned for a 4 person family, consisted of 5.4 m² solar collector and 300 l storage tank with heat exchanger in the bottom. Insulation, yield, and decreased oil use are evaluated. DOE

N82-32871# Houston Univ., Tex.
SOLAR PRODUCTION OF ELEMENTAL PHOSPHORUS Final Report
 T. P. WHALEY, B. D. YUDOW, and J. D. SCHREIBER Nov. 1981 71 p refs Prepared in cooperation with Inst. of Gas Technology
 (Contract DE-AC03-80SF-11422)
 (DE82-010118; DOE/SF-11422/T1) Avail: NTIS HC A04/MF A01

A project is described which was to determine the technical feasibility of using a solar furnace to produce elemental phosphorus and to provide guidelines for future reactor designs. A laboratory program showed that elemental phosphorus may be produced by

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heating an intimate mixture of phosphate rock, silica, and carbon black to 13000 to 15000 C and sweeping the phosphorus vapors from the reactor with argon. Phosphorus vapors are bubbled through a copper sulfate solution to minimize any potential exposure of personnel. Four successful solar furnace runs at the White Sands Solar Facility are reported. The design and testing of the solar receiver/reactor are discussed. DOE

N82-32872# Technical Research Centre of Finland, Espoo.
PROPERTIES OF SOLAR AND WARM AIR HEATING SYSTEMS AND ENERGY SAVING PROSPECTS COMPARED WITH ELECTRICAL HEATING

T. KALEMA 1980 63 p refs In FINNISH; ENGLISH summary
(DE82-901526; VTT-LVI-50) Avail: NTIS (US Sales Only) HC A04/MF A01; DOE Depository Libraries

The operation of a solar and warm air heating system and of direct electrical heating was studied in two similar apartments during one year. The goal was to find out the properties of solar and warm air heating system in practice, and particularly the amount of energy obtained from the collector. In addition, attempts were made to estimate the energy saving prospects of the system compared with electrical heating by measurements in two similar apartments. DOE

N82-32877# New Mexico State Univ., Las Cruces. Solar Energy Inst.

DATA REPORT FOR THE SOUTHWEST RESIDENTIAL EXPERIMENT STATION, OCTOBER 1981

J. F. SCHAEFER, O. Y. HAI, G. HOCKING, and C. WHITAKER
16 Nov. 1982 22 p Prepared in cooperation with MIT
(Contract DE-AC02-76ET-20279)
(DE82-010854; DOE/ET-20279/167) Avail: NTIS HC A02/MF A01

Residential photovoltaic systems (PV) were developed to gather and disseminate performance data for the photovoltaic community and cognizant institutions. Each prototype system consists of a roof mounted PV array, sized to meet at least 50% of the annual electric demand of an energy conserving house, and an enclosed structure to house the remainder of the PV system equipment, test instrumentation, and work space. The arrays provide dc energy, which is converted to ac energy by power conditioning equipment to service all of the usual loads of the residence. One month of performance data obtained from the eight SW RES Prototype Systems are presented. DOE

N82-32879# Southern Solar Energy Center Planning Project, Atlanta, Ga.

FUNDAMENTALS OF SOLAR ACCESS

M. LEVIN 1 Apr. 1981 22 p refs Presented at the Alabama Solar Access Conf., 1 Apr. 1981; sponsored by the Alabama Dept. of Energy and at the Solar Symp. for Local Officials, 5 May 1981; sponsored by the National League of Cities, the National Association of County Officials and the US Conf. of Mayors and at the Symp. on Legal Issues in Building Codes Administration, 7 May 1981; sponsored by the National Conference of States on Building Codes and Standards
(Contract DE-AC02-79CS-30166)

(DE82-009481; SSEC/SP-33233) Avail: NTIS HC A02/MF A01

Aspects of solar access are examined. The following topics are discussed: solar geometry, topography, orientation, trees and vegetation, design options, and legal questions. DOE

N82-32881# Florida Solar Energy Center, Cape Canaveral.

SOLAR COLLECTOR TEST REPORT

W. E. STONEY, comp. Jun. 1981 63 p
(Contract DE-AC02-79CS-30166)

(DE82-009467; SSEC/TP-12226) Avail: NTIS HC A04/MF A01

The commercial readiness and potential of an all plastic solar hot water collector were evaluated. The collector is described and data are given for the efficiency curve, incident angle modifier, raw test data, and static tests. The design demonstrates that a thin film plastic absorber can be built to produce performance at

least equal to the mid range of conventional copper or aluminum absorbers and that production costs could be at least half that of currently available collectors. DOE

N82-32886# Sandia Labs., Albuquerque, N. Mex.
INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENTAL OPERATIONAL PERFORMANCE, EXECUTIVE SUMMARY. VOLUME 3. BERVERLY HIGH SCHOOL, BEVERLY, MASSACHUSETTS

Jan. 1982 17 p Prepared in cooperation with Boeing Computer Services, Inc., Seattle
(Contract DE-AC04-76DP-00789)
(DE82-009297; SAND-81-7102-VOL-3) Avail: NTIS HC A02/MF A01

Performance data for the months of November and December, 1981 are given for a utility connected 100 kW solar photovoltaic flat panel power system at a Massachusetts school building. Data given include monthly and daily energy produced, monthly and daily solar energy incident on the collectors, monthly array efficiency, monthly power conditioner efficiency, monthly system efficiency, monthly capacity factor, and monthly average insolation. Also included are a plot of data acquisition mode and recording interval for each day of each month, and a malfunction report regarding the data acquisition system. DOE

N82-32890# Messerschmitt-Boelkow-Blom G.m.b.H., Ottobrunn (West Germany). Unternehmensbereich Raumfahrt.

THE GERMAN CONTRIBUTION TO THE 1 MW (EL) SOLAR TOWER POWER PLANT OF THE EUROPEAN COMMUNITY: EURELIOS, PHASE C Final Report, Mar. 1981

J. HOFMANN and E. SCHOBBER Bonn Bundesministerium fuer Forschung und Technologie Apr. 1982 54 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-82-047; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 11,40

The installation and acceptance of a heliostat field are described. System engineering of the whole plant is discussed and start-up, initiated by stepwise experimentation and operation of the subsystems, is treated. The complete system was operated, first under simulated conditions, then in solar operational mode. Results, obtained over a period of several months, prove the functional integrity of the heliostat field under quasi operational conditions. Author (ESA)

N82-33828# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DESIGN DESCRIPTION OF THE TANGAYE VILLAGE PHOTOVOLTAIC POWER SYSTEM

J. E. MARTZ and A. F. RATAJCZAK Jun. 1982 113 p refs
(NASA-TM-82917; E-1305; NAS 1.15:82917) Avail: NTIS HC A06/MF A01 CSCL 10A

The engineering design of a stand alone photovoltaic (PV) powered grain mill and water pump for the village of Tangaye, Upper Volta is described. The socioeconomic effects of reducing the time required by women in rural areas for drawing water and grinding grain were studied. The suitability of photovoltaic technology for use in rural areas by people of limited technical training was demonstrated. The PV system consists of a 1.8-kW (peak) solar cell array, 540 ampere hours of battery storage, instrumentation, automatic controls, and a data collection and storage system. The PV system is situated near an improved village well and supplies d.c. power to a grain mill and a water pump. The array is located in a fenced area and the mill, battery, instruments, controls, and data system are in a mill building. A water storage tank is located near the well. The system employs automatic controls which provide battery charge regulation and system over and under voltage protection. This report includes descriptions of the engineering design of the system and of the load that it serves; a discussion of PV array and battery sizing methodology; descriptions of the mechanical and electrical designs including the array, battery, controls, and instrumentation; and a

discussion of the safety features. The system became operational on March 1, 1979. Author

N82-33838# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

DEVELOPMENT OF A DIRECT-ABSORPTION HIGH-TEMPERATURE GAS RECEIVER

A. J. HUNT Aug. 1981 7 p refs Presented at the Intern. Solar Energy Soc. Congr., Brighton, England, 23-28 Aug. 1981 (Contract W-7405-ENG-48)

(DE82-010168; LBL-13234; CONF-810865-12) Avail: NTIS HC A02/MF A01

The development of a high temperature solar thermal gas receiver using direct absorption of concentrated sunlight by a suspension of small carbon particles is described. The small particle heat exchange receiver (SPHER) can be used to power a Brayton cycle engine, supply industrial process heat or heat a gas to provide energy for a chemical reaction. The advantages are: simplicity, low pressure loss, light weight, and high optical efficiency. The experimental and theoretical progress in the design of a 30 kW thermal test receiver is discussed. DOE

N82-33842# Westinghouse Research and Development Center, Pittsburgh, Pa.

DEVELOPMENT OF COPPER SULFIDE/CADMIUM SULFIDE THIN-FILM SOLAR CELLS

J. R. SZEDON, W. J. BITER, and H. C. DICKEY Mar. 1982 52 p refs

(Contract DE-AC02-77CH-00178)

(DE82-009398; SERI/PR-8143-1-T6) Avail: NTIS HC A04/MF A01

Unencapsulated thin film solar cells of the Cu₂S/CdS type were aged in controlled flowing gas ambients to characterize changes in their photovoltaic properties. Severe degradation which occurs in wet O₂ ambients at room temperature may account for the large short circuit current losses reported earlier. Limited loss in J/sub sc/ occurs at RT in dry oxygen. No loss is attributed to moisture in Ar or N₂ ambients for exposure times greater than approx. 2 hrs. Direct measurements of optical absorption in the front Cu₂S layer facilitated by an intergral CdS/Cu₂S detector on the back surface. Several techniques for making such a detector are demonstrated. GRA

N82-33844# Southern Solar Energy Center Planning Project, Atlanta, Ga.

SOLAR-HEATED MUNICIPAL SWIMMING POOLS, A CASE STUDY: DADE COUNTY, FLORIDA

M. LEVIN Sep. 1981 11 p refs

(Contract DE-AC02-79CS-30166)

(DE82-009475; SSEC/SP-32266) Avail: NTIS HC A02/MF A01

The installation of a solar energy system to heat the water in the swimming pool in one of Dade County, Florida's major parks is described. The mechanics of solar heated swimming pools are explained. The solar heating system consists of 216 unglazed polypropylene tube collectors, a differential thermostat, and the distribution system. The systems performance and economics as well as future plants are discussed. DOE

N82-33845# Institute of Public Administration, Washington, D.C. **AN ASSESSMENT OF THE FIELD STATUS OF ACTIVE SOLAR SYSTEMS**

Feb. 1982 87 p

(Contract DE-AC03-80SF-11485)

(DE82-011939; DOE/SF-11485/1) Avail: NTIS HC A05/MF A01

Findings and recommendations by experts from basic data gathered through first hand interviews with over 150 solar industry people in various parts of the country are assessed. Domestic hot water systems are emphasized. The following topics are included: industry description, product problems and marketing. DOE 1

N82-33846# Sandia Labs., Albuquerque, N. Mex.

INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE. VOLUME 6: NEWMAN POWER STATION, EL PASO, TEXAS

Jan. 1982 11 p

(Contract DE-AC04-76DP-00789)

(DE82-008483; SAND-81-7100-6) Avail: NTIS HC A02/MF A01

Performance data for the month of December 1981 for a 20 kW peak photovoltaic flat panel power system for an uninterruptable power supply load at an El Paso, Texas utility are given. Data include monthly total and daily insolation, monthly total and daily electrical energy, and array efficiency. Also plotted are the data acquisition mode and recording intervals for each day of the month. Three site events (maintenance and system problems) are summarized, and missing data from December 25 through December 30 are explained. DOE

N82-33852# California Univ., Berkeley. Energy and Environment Div.

TECHNOLOGY ASSESSMENT OF SOLAR-ENERGY SYSTEMS. PART 1: AN ANALYSIS OF LIFE-CYCLE COSTS OF SOLAR FACILITIES. PART 2: MINERALS CRITICAL TO THE DEVELOPMENT OF FUTURE ENERGY TECHNOLOGIES IN HIGH AND LOW SOLAR SCENARIOS

J. SATHAYE and H. RUDERMAN Sep. 1981 49 p refs

(Contract DE-AC03-76SF-00098)

(DE82-012339; LBL-13324) Avail: NTIS HC A03/MF A01

Solar and renewable technologies account for most of the increase in material requirements for energy technologies. The analysis identified 20 minerals where domestic reserves are inadequate to meet the demand. Domestic mine capacity is inadequate for 23 minerals. However, the world wide mine production capacity is adequate to meet the US demand for all the minerals. Energy related demand can therefore provide a potential market for some of these 23 minerals provided the US has deposits that can be exploited at worldwide competitive prices. For some critical and strategic minerals such as chromium the US demand peaks during a time period different than the period during which world demand peaks. The time period differences will help smooth market fluctuations and reduce the US vulnerability. Alternative technology designs can help mitigate diverse supply disruptions or sharp price increases. Alternatives may not always be available for a specific strategic and critical mineral. Each mineral may have to be analyzed and evaluated on its own merits before comparative options can be completely analyzed. DOE

N82-33858# Sandia Labs., Albuquerque, N. Mex.

INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE. VOLUME 8: NEWMAN POWER STATION, EL PASO, TEXAS Executive Summary

Mar. 1982 9 p

(Contract DE-AC04-76DP-00789)

(DE82-014247; SAND-81-7100/8) Avail: NTIS HC A02/MF A01

Performance data for 20 kWp photovoltaic flat panel power system for an uninterruptable power supply load (computer) are summarized. Data given include: (1) daily and monthly electrical energy produced; (2) daily and monthly incident solar energy; (3) array efficiency; (4) capacity factor; and (5) the data acquisition mode and recording interval plot. DOE

N82-33859# Massachusetts Inst. of Tech., Cambridge. Energy Lab.

HOMEOSTATIC CONTROL: ECONOMIC INTEGRATION OF SOLAR TECHNOLOGIES INTO ELECTRIC POWER OPERATIONS AND PLANNING

R. D. TABORS Jul. 1981 25 p refs

(Contract DE-AM01-76EI-02295)

(DE82-013631; MIT-EL-81-028) Avail: NTIS HC A02/MF A01

The economic issues associated with the interface of new energy technologies and the electric utility grid are discussed. The concept of homeostatic control is introduced and the use of such an economic concept applied to the introduction of

02 SOLAR ENERGY

nondispatchable technologies into the existing utility system is examined. The transition and potential impact of a homeostatic control system working with the existing electric utility system is treated. DOE

N82-33861# Boeing Aerospace Co., Seattle, Wash.
HIGH-ASPECT-RATIO SILICON-CELL METALLIZATION Final Technical Status Report

Jan. 1982 42 p
(Contract DE-AC04-76DP-00789)
(DE82-011687; SAND-81-7033) Avail: NTIS HC A03/MF A01

Two features of the silicon concentrator solar cell are addressed which affect output at high concentration levels. The first is the development of narrow but high electroplated grid lines with improved conductivity. The object is a reduction in cell series resistance without increase in shadowing. This goal is accomplished by electroplating through a thick photo resist mask to produce lines .7 mil wide by .7 mil high. Advance pulse plating techniques are combined with pure silver plating baths to produce a deposit conductivity equal to the bulk silver conductivity. The second feature is a double diffused selectivity textured front surface. This development employs a deep diffusion in the silicon under the grid lines. Only the non-grid line open area is selectively texture etched, removing the deep junction. This open textured area is then given a second shallow diffusion for optimum cell efficiency. This selective procedure maintains the original highly polished wafer surface under the grid lines so that high resolution narrow grid lines are possible. DOE

N82-33864# Electric Power Research Inst., Palo Alto, Calif.
Residential and Commercial Applications Program.
SOLAR-HEATING AND -COOLING RESEARCH PROJECTS: A SUMMARY

N. LANSING Feb. 1982 50 p
(DE82-903152; EPRI-EM-2272-SR) Avail: NTIS HC A03/MF A01

In addition to outlining solar heating and cooling experimental projects, the major features of the solar systems are described. Also included are relatively detailed descriptions of the performance-monitoring equipment. These projects provide a basis for verification of analytic work aimed at determining the preferred solar system for any given utility service area, that is, the system that provides the lowest total cost to the consumer and to the utility. DOE

N82-33865# Department of Energy, Washington, D. C.
INTERNATIONAL ENERGY AGENCY INSTRUMENTED FACILITIES SURVEY FOR SOLAR ASSISTED LOW ENERGY DWELLINGS

Feb. 1982 144 p Prepared in cooperation with Burt, Hill, Kosar, Rittlemann, and Associates
(DE82-015158; DOE/NBM-2015158) Avail: NTIS HC A07/MF A01

The instrumentation of 38 active and passive solar projects in 9 countries (Denmark, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, United States, and West Germany) are outlined. Surveys are presented and the data are rearranged to compare answers from similar survey questions for each of the projects. Building, solar system and instrumentation descriptions and meteorological, solar system and building system instrumentation capabilities are addressed. DOE

N82-33866# Massachusetts Inst. of Tech., Cambridge. Energy Lab.

RESIDENTIAL PHOTOVOLTAIC WORTH: A SUMMARY ASSESSMENT OF THE MIT ENERGY LABORATORY

T. L. DINWOODIE Jan. 1982 50 p refs
(Contract DE-AM01-76EI-02295)
(DE82-010867; MIT-EL-82-005) Avail: NTIS HC A04/MF A01

The role and significance of worth analysis in photovoltaic and similar program development is reviewed. Photovoltaic development is divided into three time frames: 1974 to 1982; 1982 to 1990; and 1990 to 2000. Several studies performed from 1974

to data are described in terms of their response to the evolving questions of photovoltaic economic worth. Several trends are discussed that should play a more or less direct role in the ultimate acceptance of photovoltaic technology from 1982 to 1990. The significant parameters affecting photovoltaic economics are defined and results of studies establishing allowable costs and investment figures of merit are presented. Photovoltaic investment worth on a US regional basis is analyzed. Alternative residential photovoltaic configurations are characterized and assessed. Studies that examined photovoltaics and storage, PV/Thermal combined collector systems, and the difference between photovoltaic retrofit and new construction applications are summarized. DOE

N82-33867# EIC, Inc., Newton, Mass.
PREPARATION AND CHARACTERIZATION OF AMORPHOUS ZNAS FOR USE IN SOLAR CELLS Final Report, 15 Jul. 1980 - 14 Jan. 1981

R. D. RAUH, T. L. ROSE, and A. N. SCOVILLE Mar. 1982 31 p refs
(Contract DE-AC02-77CH-00178)
(DE82-014516; SERI/TR-9243-1-T1) Avail: NTIS HC A03/MF A01

Amorphous zinc arsenide films were prepared by flash evaporation and RF sputtering from both ZnAs₂ and Zn₃As₂ polycrystalline material in addition to the conventional evaporation method used previously. Neither of the two methods resulted in improved control of the stoichiometry. The ratio of As to Zn, however, usually was between the values of 0.6 and 2.0 of the two stoichiometric crystalline compounds. Annealing of the films tended to change the stoichiometry towards an As/Zn ratio of 0.7 which is the value in the thermally more stable Zn₃As₂ compound. Physical deterioration of the films, however, was not observed until the temperature exceeded 3500 C. The optical band gap was determined from the absorption spectrum for a number of films with different stoichiometries. Although there was a slight trend towards higher band gap as the arsenic concentration increased, the dependence was not statistically significant. Similar results were obtained from measurement of some action spectra of the films using an electrochemical cell arrangement. The band gap is assigned a value of 1.3 + or - 0.2V for the stoichiometric range of ZnAs_{0.6} to ZnAs₂ 1. DOE

N82-33868# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DATA REPORT FOR THE NORTHWEST RESIDENTIAL EXPERIMENT STATION, DECEMBER 1981

M. C. RUSSELL, P. BAGHURAMAN, and P. C. MAHONEY Apr. 1982 18 p refs
(Contract DE-AC02-76ET-20279)
(DE82-016027; DOE/ET-20279/192) Avail: NTIS HC A02/MF A01

One month of physical data obtained at the Northeast Residential Experiment Station in Concord, Massachusetts for state-of-the-art photovoltaic systems is presented. Included is a summary of meteorological information, electric energy used and produced, solar cell array and power conditioning unit data, and photovoltaic system-utility energy flow. The data are also tabulated hour-by-hour for an averaged day of the month, and a monthly load duration curve is given for each of the loads being monitored. Five prototype systems are under test, each consisting of a roof-mounted solar cell array, sized to meet at least 50% of the annual electrical demand of an energy-conserving house, and an enclosed structure to house the remainder of the system equipment, test instrumentation, and work space. The systems are grid-connected. Data are also provided for a full-sized photovoltaic residence in Carlisle, Massachusetts. The methods of data analysis and reduction are discussed. DOE

N82-33878# Institute of Public Administration, Washington, D.C.
ASSESSMENT OF THE FIELD STATUS OF ACTIVE SOLAR SYSTEMS. VOLUME 2: APPENDICES Final Report

Jan. 1982 209 p refs
 (Contract DE-AC03-80SF-11485)
 (DE82-016032; DOE/SF-11485/T1-VOL-2) Avail: NTIS HC A10/MF A01

The range of materials and corrosion problems, either encountered or anticipated, in current systems are reviewed critically with emphasis on materials degradation under the special and demanding conditions of solar heating as opposed to normal domestic hot water and space heating systems. A selected bibliography of available relevant reports and studies is included.

GRA

N82-33879# Boeing Computer Services, Inc., Seattle, Wash.
INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT. VOLUME 4: BEVERLY HIGH SCHOOL, BEVERLY, MASS.

Jan. 1982 44 p
 (Contract DE-AC04-76DP-00789)
 (DE82-008622; SAND-81-7088/4) Avail: NTIS HC A03/MF A01

Performance data are presented for the months of November and December, 1981 for a photovoltaic power supply at a Massachusetts school building. The data include: monthly and daily electrical energy produced; monthly and daily solar energy received; monthly and daily array efficiency; energy produced as a function of power level, voltage, cell temperature, and hour of the day; input, output, and efficiency of two power conditioner units and for the total power conditioning system; energy supplied by the photovoltaic system to the load during each day and month; photovoltaic system efficiency; capacity factor; daily system availability; monthly and hourly insolation; heating and cooling degree days; number of freeze-thaw cycles per month; monthly and hourly ambient temperature; monthly and hourly wind speed; wind direction distribution; hourly cell temperature; and data acquisition mode and recording interval plot.

DOE

N82-33880# Franklin Research Center, Philadelphia, Pa.
ENERGY-CONSERVING PASSIVE SOLAR MULTI-FAMILY RETROFIT PROJECTS. CYCLE 5, CATEGORY 1: HUD SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

1981 100 p refs Sponsored in part by DOE
 (Contract HUD-H-2377)
 (PB82-180944; HUD-0002338) Avail: NTIS HC A05/MF A01
 CSCL 13A

A total of 14 passive solar retrofit buildings are described. The concept of passive solar energy and the various types of passive systems found in the Cycle 5 projects are discussed. Each of the 14 solar designs is described, and some of the key points raised in the discussion of passive concepts are illustrated. Each project description cites the location of the passive solar home and presents the following information: grantee/builder, designer, solar designer, price, number of units, net heated area, heat load, degree days, solar fraction of the total heat load, and auxiliary heat required. Project descriptions also include data on recognition factors (the five passive elements necessary for a complete passive system), the type of auxiliary heating system used in the building, the solar water heating system (if any), and the passive cooling techniques used (if any).

GRA

N82-33883# National Bureau of Standards, Washington, D.C.
 National Engineering Lab.

RESIDENTIAL SOLAR DATA CENTER: DATA RESOURCES AND REPORTS Final Report, Sep. 1979 - Sep. 1981

P. M. CHRISTOPHER and A. O. HOUSER Oct. 1981 67 p refs
 (Contract IAA-H-5481)

(PB82-180845; NBSIR-81-2369) Avail: NTIS HC A04/MF A01
 CSCL 10A

The Residential Solar Data Center (SDC) was responsible for the establishment and operation of a computerized data base containing non-instrumented residential data collected from the

DoE/HUD Solar Heating and Cooling Demonstration Program. This document includes a summary of the history and background of the SDC and its role in the demonstration program, a list of the final computer reports which are available, sample pages of representative reports, and a description of the data files which comprised the solar data base.

Author

N82-33886# Center for Renewable Resources, Washington, D.C.

COMPETITION IN THE PHOTOVOLTAICS INDUSTRY: A QUESTION OF BALANCE Final Report

B. STAMBLER 1 Feb. 1981 227 p refs
 (Contract SB-81-975)

(PB82-171570) Avail: NTIS HC A11/MF A01 CSCL 05C

The photovoltaics industry is profiled and the potential for competition as the industry matures is analyzed. Problems associated with small business' involvement are discussed and the effects of government programs on competition are examined.

GRA

N82-33887# Economic Research Service, Washington, D. C.
 National Economics Div.

SOLAR- AND WIND-POWERED IRRIGATION SYSTEMS

R. V. ENOCHIAN Feb. 1982 34 p refs
 (PB82-177486; AER-482) Avail: NTIS HC A03/MF A01 CSCL 02C

Five different direct solar and wind energy systems are technically feasible for powering irrigation pumps. However, with projected rates of fossil fuel costs, only two may produce significant unsubsidized energy for irrigation pumping before the turn of the century. These are photovoltaic systems with nonconcentrating collectors (providing that projected costs of manufacturing solar cells prove correct); and wind systems, especially in remote areas where adequate wind is available.

Author (GRA)

03

HYDROGEN

Includes hydrogen production, storage, and distribution.

A82-38431

INTERFACIAL OXIDE LAYER MECHANISMS IN THE GENERATION OF ELECTRICITY AND HYDROGEN BY SOLAR PHOTOELECTROCHEMICAL CELLS

D. C. CARD and H. C. CARD (Manitoba, University, Winnipeg, Canada) Solar Energy, vol. 28, no. 6, 1982, p. 451-460. Natural Sciences and Engineering Research Council refs
 (Contract NSERC-G-0442; NSERC-A-1330)

An analytic model for the semiconductor-electrolyte interface in a photoelectrochemical cell is presented. Attention is given to the semiconductor-oxide-electrolyte junction, considering only n-type semiconductors with electrons as majority carriers and photocurrent being due to holes. The majority carrier current is described in terms of its relationships to the photovoltage, to the photovoltage with energy separation between the semiconductor conduction band edge energy at the surface and the energy of the maximum oxidized state density at redox levels in the electrolyte, and to the photovoltage with a spread in the redox state density. The oxide layer on the semiconductor surface is regarded as thin enough to permit electrons from the conduction or valence band of the semiconductor to tunnel into the redox states of the electrolyte. Conversion efficiency is concluded to increase with the presence of the oxide layer, caused by a decrease in the majority carrier current for a given photovoltage.

M.S.K.

03 HYDROGEN

A82-39845

CHEMICAL CONTROL OF RECOMBINATION AT GRAIN BOUNDARIES AND LIQUID INTERFACES - ELECTRICAL POWER AND HYDROGEN GENERATING PHOTOELECTROCHEMICAL CELLS

A. HELLER (Bell Telephone Laboratories, Inc., Murray Hill, NJ) *Journal of Vacuum Science and Technology*, vol. 21, July-Aug. 1982, p. 559-561. refs

Recombination of carriers at a surface or at a grain boundary of a semiconductor is associated with the presence of chemical bonds that are weaker than those in the bulk. Upon strengthening these bonds, by reacting the interface with a strongly bound impurity, the rate of recombination is drastically reduced. For example, a 1000-fold increase in EBIC charge collection efficiency for the polycrystalline p-InP/Ti Schottky junction and a corresponding increase in the efficiency of the photoelectrochemical cell polycrystalline p-InP/VC13-VC12-HCl/C are observed when silver is chemisorbed on the semiconductor grain boundaries. Chemical control of carrier recombination at semiconductor solution interfaces and grain boundaries results in 12% efficient monocrystalline and 8% efficient thin film polycrystalline solar cells, that generate either electrical power or hydrogen. (Author)

A82-39907

PROPERTIES AND APPLICATIONS OF METAL HYDRIDES IN ENERGY CONVERSION SYSTEMS

H. WENZL (Kernforschungsanlage Juelich GmbH, Institut fuer Festkoerperforschung, Juelich, West Germany) *International Metals Reviews*, vol. 27, no. 3, 1982, p. 140-168. refs

Structural, thermodynamic, and kinetic properties and phase diagrams of hydrogen in metals and alloys are presented in relation to materials development for the 'hydrogen energy technology'. Among the materials considered special attention is paid to the hydrides of Li, Mg, Y, V, Nb, U, TiFe, and LaNi5. It is shown how these materials are utilized for the production of hydrogen by water splitting, stationary and mobile storage, heat pumps and heat storage, heat engines, fusion-reactor technology, and hydrogen-isotope separation. (Author)

A82-41401

LONG-TERM TESTING AND STABILITY OF CAN15 ALLOY FOR A HYDROGEN STORAGE APPLICATION

M. S. BAWA and E. A. ZIEM (Texas Instruments Inc., Dallas, TX) *International Journal of Hydrogen Energy*, vol. 7, no. 10, 1982, p. 775-781.

(Contract DE-AC01-79ER-10000)

CaNi5 alloy, in a long term test in excess of 5000 charge/discharge cycles, demonstrated good stability. The hydrogen absorption was in the 20-40 C range at hydrogen pressures of 1.07-1.35 atm. The hydrogen desorption in the 50-60 C range was at 1.14-2.36 atm. A hydrogen working capacity under the above test conditions of about 0.8% by weight was obtained. (Author)

A82-41402

HYDROGEN ABSORPTION IN BERYLLIUM-SUBSTITUTED Mg2Ni

D. LUPU, A. BIRIS, and E. INDREA (Institute of Isotopic and Molecular Technology, Cluj, Rumania) *International Journal of Hydrogen Energy*, vol. 7, no. 10, 1982, p. 783-785. refs

The alloys Mg2Ni(1-x)Be(x) (x = 0.15 and 0.25) retain the Mg2Ni structure, showing a lattice dilation proportional to the beryllium content. The pressure-composition isotherms are reported for the dissociation of hydrided samples. The results suggest that there are two type of interstices able to absorb up to 4 H atoms per formula unit. The heats of formation obtained from the van't Hoff relationship show an increased stability for the hydrides of the beryllium-substituted alloys compared to the pure Mg2Ni. The results suggest that the electronic factors are more important for hydride stability than variations in the unit cell volume. (Author)

A82-41404

CATALYTIC COMBUSTION OF HYDROGEN. IV - FABRICATION OF PROTOTYPE CATALYTIC HEATERS AND THEIR OPERATING PROPERTIES

M. HARUTA and H. SANO (Osaka, Government Industrial Research Institute, Ikeda, Japan) *International Journal of Hydrogen Energy*, vol. 7, no. 10, 1982, p. 801-807. refs

A82-41405

A LIQUID HYDROGEN CAR WITH A TWO-STROKE DIRECT INJECTION ENGINE AND LH2-PUMP

S. FURUHAMA and Y. KOBAYASHI (Musashi Institute of Technology, Tokyo, Japan) *International Journal of Hydrogen Energy*, vol. 7, no. 10, 1982, p. 809-820. refs

Objectives for the practical application of hydrogen fuel to cars are (1) engine-output increase, suppression of abnormal combustion and NO(x) reduction; (2) the development of a low cost liquid hydrogen (LH2) tank having high thermal insulation; and (3) the development of a method to supply fuel from the LH2 tank to the engine. A hydrogen car system consisting of a LH2-tank and LH2 pump-injector for high pressure and low temperature hydrogen gas injection into a two-stroke engine has been developed that is capable of meeting all the above-mentioned requirements except (2). The system was then applied to a minicar equipped with a 0.55 l engine. The performance of the car has demonstrated the above-mentioned capabilities in the engine dynamometer and road tests. (Author)

A82-43613

THE HYDROGEN-FUELED ENGINE [VODORODNYI DVIGATEL']

V. I. KHYROV and B. E. LAVROV (Alma-Ata, Izdatel'stvo Nauka, 1981. 112 p. In Russian. refs

The use of hydrogen as a fuel in a piston engine is examined with reference to results of theoretical studies on the hydrogen engine cycle and extensive experimental data on the operation of hydrogen-fueled engines. Special properties of hydrogen engines are discussed, and a set of requirements is formulated for the design and performance characteristics of these engines. The past history of hydrogen-fueled engines is briefly reviewed, as is the potential of hydrogen power V.L.

A82-45138

P-INP PHOTOCATHODES, SOLAR TO HYDROGEN CONVERSION AND IMPROVEMENT OF POLYCRYSTALLINE FILMS BY REACTING SILVER WITH THE GRAIN BOUNDARIES

A. HELLER, R. G. VADIMSKY, W. D. JOHNSTON, JR., K. E. STREGE, H. J. LEAMY, and B. MILLER (Bell Telephone Laboratories, Inc., Murray Hill, NJ) In: *Photovoltaic Specialists Conference*, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 1422-1427. refs

A82-47997

HIGH TEMPERATURE SOLAR THERMOCHEMICAL PROCESSING - HYDROGEN AND SULFUR FROM HYDROGEN SULFIDE

J. E. NORING and E. A. FLETCHER (Minnesota, University, Minneapolis, MN) *Energy (UK)*, vol. 7, Aug. 1982, p. 651-666. Research supported by the Northern States Power Co. refs

Sunlight, concentrated to high intensities, has a rarely recognized potential for adding process heat to reactors at high temperatures. Hydrogen sulfide is a by-product of the sweetening of fossil fuels. In this paper, by way of example, the production of hydrogen and sulfur from hydrogen sulfide is used as a device for showing how solar processing might be considered as a successor to a currently used industrial process, the Claus process. It is concluded that this and other processes should be explored as means of using as well as storing solar energy. (Author)

N82-28788*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

AUTOTHERMAL REFORMING OF SULFUR-FREE AND SULFUR-CONTAINING HYDROCARBON LIQUIDS

In its conversion of Hydrocarbons for Fuel Cell Appl. p 1-74 Oct. 1981

Avail: NTIS HC A07/MF A01 CSCL 10A

The mechanisms by which various fuel component hydrocarbons related to both heavy petroleum and coal-derived liquids are converted to hydrogen without forming carbon were investigated. Reactive differences between paraffins and aromatics in autothermal reforming (ATR) were shown to be responsible for the observed fuel-specific carbon formation characteristics. The types of carbon formed in the reformer were identified by SEM and XRD analyses of catalyst samples and carbon deposits. From tests with both light and heavy paraffins and aromatics, it is concluded that high boiling point hydrocarbons and polynuclear aromatics enhance the propensity for carbon formation. The effects of propylene addition on the ATR performance of benzene are described. In ATR tests with mixtures of paraffins and aromatics, synergistic effects on conversion characteristics were identified. Indications that the sulfur content of the fuel may be the limiting factor for efficient ATR operation were found. The conversion and degradation effects of the sulfur additive (thiophene) were examined. J.D.

N82-28804# California Univ., Livermore. Lawrence Livermore Lab.

ROTARY KILN FOR THE SOLAR DECOMPOSITION OF ZINC SULFATE

P. K. SHELL, W. H. PARRISH, R. RUIZ, and O. H. KRIKORIAN 11 Nov. 1981 31 p refs

(Contract W-7405-ENG-48)

(DE82-004323; UCID-19242) Avail: NTIS HC A03/MF A01

A rotating kiln was built for tests coupling the solar central receiver at White Sands, New Mexico with the zinc Sulfate Subcycle as part of a study on the thermochemical production of hydrogen from water. The kiln was specially designed to help overcome some of the problems associated with using solar energy to heat substances with poor absorptivities and will be used to study the advantages of using solar thermal energy to decompose zinc sulfate. DOE

N82-29484# Brookhaven National Lab., Upton, N. Y. Technology and Data Div.

ANALYSIS OF THE USE OF HYDROGEN AS A SUPPLEMENT TO NATURAL GAS

J. DACIERNO and M. BELLER Sep. 1981 50 p refs

(Contract DE-AC02-76CH-00016)

(DE82-006844; BNL-51442) Avail: NTIS HC A03/MF A01

The concept of hydrogen supplementation of natural gas with the added option of hydrogen separation from mixtures is evaluated. A 1977 study by an Ad Hoc Committee is reevaluated in terms of the present energy situation with emphasis on specific incentives and barriers to the long term implementation of the concept. A systematic analysis of the concept is presented including the selection of a site where the concept could penetrate the existing energy system infrastructure, a survey of the industrial hydrogen market, and an economic analysis to determine the conditions necessary for feasibility. The minutes of a workshop held during the study are appended. DOE

N82-29492# Studsvik Energiteknik A.B., Nykoping (Sweden). Research Center.

ASSESSMENT OF POTENTIAL FUTURE MARKET IN SWEDEN FOR HYDROGEN AS AN ENERGY CARRIER Final Report

G. CARLESON Sep. 1980 382 p refs Sponsored in part by the International Energy Agency

(DE82-900643; NE/EPA-80/4) Avail: NTIS (US Sales Only) HC A17/MF A01; DOE Depository Libraries

Future hydrogen markets during the period 1980-2025 were projected. The probable range of hydrogen production costs were evaluated as well as the expected market shares in competition

with alternative energy carriers. Three different energy scenarios were developed, based on nuclear energy, renewable indigenous energy sources and the present energy picture, respectively. Within each of the three scenarios, an analysis was made of the competitiveness of hydrogen on both the demand and the supply sides of the sectors: chemical industry, steel industry, peak power production, residential and commercial heating, and transportation. Costs were calculated for the production, storage and transmission of hydrogen. Health, environmental and societal implications were taken into consideration. The results were used to estimate the market penetration of hydrogen. DOE

N82-30713*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

INTEGRATED GASIFIER COMBINED CYCLE POLYGENERATION SYSTEM TO PRODUCE LIQUID HYDROGEN

R. K. BURNS, P. J. STAIGER, and R. M. DONOVAN Jul. 1982

37 p refs

(NASA-TM-82921; E-1308; NAS 1.15:82921) Avail: NTIS HC

A03/MF A01 CSCL 10A

An integrated gasifier combined cycle (IGCC) system which simultaneously produces electricity, process steam, and liquid hydrogen was evaluated and compared to IGCC systems which cogenerate electricity and process steam. A number of IGCC plants, all employing a 15 MWe has turbine and producing from 0 to 20 tons per day of liquid hydrogen and from 0 to 20 MWt of process steam were considered. The annual revenue required to own and operate such plants was estimated to be significantly lower than the potential market value of the products. The results indicate a significant potential economic benefit to configuring IGCC systems to produce a clean fuel in addition to electricity and process steam in relatively small industrial applications. Author

N82-31557# Midwest Research Inst., Golden, Colo.

SOLAR DECOMPOSITION OF CADMIUM OXIDE FOR HYDROGEN PRODUCTION Final Subcontract Report

J. D. SCHREIBER, B. D. YUDOW, R. H. CARTY, T. P. WHALEY, and J. B. PANGBORN Nov. 1981 92 p refs

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)

(DE82-011092; SERI/TR-9-8325-1) Avail: NTIS HC A05/MF

A01

The reactor developed for this study performed satisfactorily in establishing the feasibility of cadmium oxide decomposition under the realistic conditions of the solar-furnace environment. The solar-furnace environment is very appropriate for the evaluation of design concepts. However, the solar furnace probably cannot give precise rate data. The flux is too nonuniform, so temperatures of reactant and corresponding reaction rates are also nonuniform. One of the most important results of this project was the recovery of samples from the quench heat exchanger that contained a surprisingly large amount of metallic cadmium. The fact that the sample taken from the quench heat exchanger was metallic in appearance and contained between 67% and 84% metallic cadmium would tend to indicate recombination of cadmium vapor and oxygen can be effectively prevented by the quenching operation. It would also tend to confirm recent studies that show cadmium oxide does not sublime appreciably. DOE

N82-32202# Los Alamos Scientific Lab., N. Mex.

LIQUID-HYDROGEN-FUELED-VEHICLE TESTS: EXECUTIVE SUMMARY

W. F. STEWART 1981 39 p refs Presented at Automotive Tech. Development Contractor Coordination Meeting, Dearborn, Mich., 26 Oct. 1981

(Contract W-7405-ENG-36)

(DE82-002352; LA-UR-81-3194; CONF-811090-1) Avail: NTIS HC A03/MF A01

A baseline liquid hydrogen fueled vehicle and a liquid hydrogen refueling system were completed. The vehicle was refueled at least 60 times with liquid hydrogen using various liquid hydrogen storage Dewars and a semiautomatic refueling station. The engine was operated for 133 h and the car was driven for 3540 km

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(2200 miles) on hydrogen without any major difficulties. The vehicle obtained 2.4 km/L (5.7 miles/gal) of liquid hydrogen or 8.9 km/L (21 miles/gal) of gasoline on an equivalent energy basis for driving in the high altitude Los Alamos, Santa Fe, and Albuquerque areas. Without refueling, the car had a range of about 274 km (170 miles) with the first liquid hydrogen tank and about 362 km (225 miles) with the second tank. DOE

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FUELS AND OTHER SOURCES OF ENERGY

Includes fossil fuels, nuclear fuels, geothermal and ocean thermal energy, tidal energy, and wind energy.

A82-38218

ETHANOL FROM BIOMASS - THE QUEST FOR EFFICIENCY

H. G. DEYOUNG High Technology, vol. 2, Jan.-Feb. 1982, p. 61-64, 66, 67.

Methods for the production of ethanol to be used as an energy source from readily renewable biomass, natural materials based largely on cellulose, are reviewed. Current procedures for ethanol production utilize energy-inefficient processes and costly materials, such as corn, and thus are highly impractical for the large-scale ethanol production which is envisioned as a partial solution for US energy needs. The use of cellulosic raw materials is at the center of present research efforts, but no reliable and high-yielding conversion technique has yet been demonstrated. Methods of ethanol production are discussed and attention is focused on new fermentation technologies which potentially could overcome the problems associated with the use of cellulosic raw materials. For example, a strain of yeast is being developed which has the capability to convert up to twice as much of our agricultural wastes to ethanol than was thought possible just a year ago N.B.

A82-38270

ON ALTERNATIVE ENERGY SOURCES - WAVE POWER AVAILABILITY IN WATER OF FINITE DEPTH

S. BERGAMASCHI and V. COSSALTER (Padova, Università, Padua, Italy) Meccanica, vol. 17, Mar. 1982, p. 44-52. refs

The theory of wave height variation due to refraction and friction at the sea bottom is adopted to estimate the amount of mechanical power available at depths ranging from 5 to 25 m, where it seems reasonable to place devices to capture and convert wave energy. The refraction theory is mathematically modelled and the computer program for the power estimation is presented. The evaluation of the wave power available at a location near the Italian coast on the southern Adriatic is presented as an application, and is found to be 3.9 kW/m at the selected point, compared to 6.4 kW/m for deep water in the southern Adriatic. The methods of analytic and numerical bathymetry are used to arrive at the result. (Author)

A82-40204

RECENT ADVANCES IN DROPLET VAPORIZATION AND COMBUSTION

C. K. LAW (Northwestern University, Evanston, IL) Progress in Energy and Combustion Science, vol. 8, no. 3, 1982, p. 171-201. Research supported by the U.S. Department of Energy and NSF. refs

Recent progress on understanding the fundamental mechanisms governing droplet vaporization and combustion is reviewed. Topics include the classical d-2-Law and its limitations; the major transient processes of droplet heating and fuel vapor accumulation; effects due to variable transport property assumptions; combustion of multicomponent fuels including the miscible fuel blends, immiscible emulsions, and coal-oil mixtures, finite-rate kinetics leading to ignition and extinction; and droplet interaction. Potentially promising research topics are also suggested. (Author)

A82-40481

ENERGY REQUIREMENTS OF WORKERS AT AN OIL FIELD IN WESTERN SIBERIA [POTREBNOSTI V ENERGIU RABOCHIKH-NEFTIANIKOV ZAPADNOI SIBIRI]

G. I. BONDAREV, V. IA. VISSARIONOVA, V. S. DUPIK, T. A. ZEMLIANSKAIA, and S. A. KHOTIMCHENKO (Akademiia Meditsinskikh Nauk SSSR, Moscow, USSR) Voprosy Pitaniia, May-June 1982, p. 18-21. In Russian. refs

A82-41202#

THE MOTION OF PARTICLES INSIDE A DROPLET

J. N. CHUNG (Washington State University, Pullman, WA) ASME, Transactions, Journal of Heat Transfer, vol. 104, Aug. 1982, p. 438-445. refs

(Contract DE-EG22-80PC-30216)

(ASME PAPER 81-WA/HT-45)

Numerical solutions to the differential-integral equations of motion developed for particles translating inside a circulating droplet were obtained, for the case of coal particle motions inside a light hydrocarbon droplet, by means of fourth-order Runge-Kutta methods with step size control according to desired accuracy. The coal particles are found to generally make looping motions due to existing vortex streamlines and to move outward with respect to the vortex center. At high droplet Reynolds numbers, the particles probably accumulate near the droplet surface before substantial evaporation of the droplet can take place, due to a transport time which is two orders of magnitude smaller than the droplet lifetime. At low droplet Reynolds numbers, particles will be evenly distributed, with a slightly higher particle density near the surface. O.C.

A82-41410* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE NEED FOR EXPANDED EXPLORATION OF MATTER-ANTIMATTER ANNIHILATION FOR PROPULSION APPLICATION

P. F. MASSIER (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) British Interplanetary Society, Journal (Interstellar Studies), vol. 35, Sept. 1982, p. 387-390. refs (Contract NAS7-100)

The use of matter-antimatter annihilation as a propulsion application for interstellar travel is discussed. The physical basis for the superior energy release in such a system is summarized, and the problems associated with antimatter production, collection and storage are assessed. Advances in devising a workable propulsion system are reported, and the parameters of an antimatter propulsion system are described. C.D.

A82-42549

ALTERNATIVE ENERGY SOURCES

R. W. TODD (National Centre for Alternative Technology, Powys, Wales) International Journal of Ambient Energy, vol. 3, Apr. 1982, p. 69-80. refs

Renewable energy sources and their potential contribution for solving energy needs are presented. Centralized supply technologies include those alternative fuels derived from biomass using solar energy, (supplying 57% of the energy supply in some countries), and those using directly collected solar energy to manufacture a fuel. Fuel utilization effects can be doubled by using combined heat and power stations, and other major sources include wind, wave, tidal, and solar. In terms of local supply technology, wood burning appliances are becoming more popular, and methane is being used for heating and to fuel spark ignition engines. Geothermal low temperature heating exists worldwide at a capacity of 7.2 GW, supplying heat, particularly in Hungary, parts of the U.S.S.R., and Iceland, and a geothermal research program has been established in the United States. Sweden has a potential hydroelectric capacity of 600 MW, and the United States has a 100 GW capacity. Many of these technologies are already cost effective. R.K.R.

A82-43064#

EFFECT OF WIND LOADING ON THE DESIGN OF A KITE TETHER

S. K. VARMA and J. S. GOELA (Indian Institute of Technology, Kanpur, India) *Journal of Energy*, vol. 6, Sept.-Oct. 1982, p. 342, 343. Ministry of Science and Technology refs (Contract MST-13(19)/79-SERC)

An examination of the effects of wing drag on the static profile and force transmission efficiency of a tether connected to a kite-type wind energy conversion device is presented. Assuming that the velocity and density fields are invariant with height, governing equations are formulated for the system in equilibrium under drag and lift forces, the tether weight, and the system tensions. A force balance is calculated taking into account the wind drag along the tether axis and perpendicular to the tether. The computations consider a Kevlar-29 line and show that predictions made in terms of a catenary model are erroneous in terms of the static behavior of the kite tether. M.S.K.

A82-43079

WIND ENERGY USE - A CONTRIBUTION TO THE LESSENING OF REGIONAL BOTTLENECKS [WINDENERGIENUTZUNG - EIN BEITRAG ZUR MINDERUNG VON REGIONALEN ENGPASSEN]

H. DETTER (Wien, Technische Universitaet, Vienna, Austria) In: Small power plants; Seminar on Small Power Plants - Technology and Cost Effectiveness, Technische Universitaet Wien, Vienna, Austria, January 15, 16, 1981, Reports. Vienna, Technische Universitaet Wien, 1981, p. 135-147. In German. Research supported by the Bundesministerium fuer Wissenschaft und Forschung. refs

The potential for wind energy use in general and in Austria is assessed. The efficiency of this energy form is evaluated, and the possibility of applying it for various Austrian regions is noted. Austrian research activities in the wind energy area are discussed, including the WEK-Seibersdorf 10-kW converter atop a 35 m tower, planned improvements in the latter, and a field test program. C.D.

A82-44671*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

THE LANDSAT-D RESPONSIVENESS TO USER COMMUNITY NEEDS

V. V. SALOMONSON (NASA, Goddard Space Flight Center, Greenbelt, MD) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 6 p. refs (IAF PAPER 82-100)

Initial examinations of the Landsat-4 Multispectral Scanner and Thematic Mapper (TM) imagery indicate that these systems and the ground-based data processing systems are performing well. A combination of the spatial resolution of the multispectral scanner with the four band (0.5-0.6, 0.6-0.7, 0.7-0.8, and 0.8-1.1 microns) multispectral capability provides a useful observation technique for identifying crop type, phenological state of development, and a real condition assessment. Landsat multispectral scanner imagery has become more important in the search for new deposits of oil and mineral resources, and geological applications indicate that image analysis complements geological mapping techniques. Advantages of the TM include more precise measurements of the increased reflectance of vegetation in the green and near infrared. In addition, TM has improved vegetation species differentiation, due to measurements made in new spectral bands. Preliminary TM data analysis reveals that systems have performed to optimum expectations. R.K.R.

A82-45212

THE USES OF SPACE-BASED INFORMATION IN PETROLEUM GEOLOGY [ISPOL'ZOVANIE KOSMICHESKOI INFORMATSII V NEFTIANOI GEOLOGII]

L. G. KIRIUKHIN, (ED.) and S. E. PETROV Moscow, Vsesoiuznyi Nauchno-Issledovatel'skii Geologorazvedochnyi Neftianoi Institut (VNIGNI, Trudy, No. 232), 1981. 153 p. In Russian.

Studies are presented concerning the application of remote sensing data to the investigation of territories which are of interest for petroleum geology. Topics discussed include examinations of the primary geological problems which can be investigated by remote sensing methods, the types of space-based data obtained and the geological information they can provide, basic methods of interpreting satellite pictures, as well as methods for the comprehensive interpretations of geological, geophysical, and space-based data used in compiling specialized maps. In addition, the practical results achieved during investigations of various petroleum-containing regions in the USSR (including the Caspian, North Caucasus, Volga-Ural, Timan-Pechora, and West Siberian regions) are examined. N.B.

A82-45486#

ON THE USE OF SATELLITE DATA TO INFER SURFACE FLUXES AT METEOROLOGICAL SCALES

J. C. PRICE (U.S. Department of Agriculture, Hydrology Laboratory, Beltsville, MD) *Journal of Applied Meteorology*, vol. 21, Aug. 1982, p. 1111-1122. refs

For numerical meteorological prediction, the determination of energy, momentum and moisture fluxes at the earth's surface requires knowledge of surface properties at a very coarse spatial resolution. A procedure is described for estimating the important surface properties through analysis of high spatial resolution visible and thermal infrared data from satellites. An averaging method is then specified for aggregating or parameterizing local estimates of surface properties to a relatively coarse grid spacing. The method considers grid scale fluxes between ground and atmosphere, specifying that parameterized surface values should yield fluxes equal to those produced by integration of the high spatial resolution description of the surface. This allows estimation of latent and sensible heat exchange with the atmosphere at the large scales of general circulation models. The procedure is illustrated by application to a data set from the Heat Capacity Mapping Mission. (Author)

A82-45807

CORRELATION OF MAGNETIC, GRAVITATIONAL AND THERMAL FIELDS OVER CONTINENTS

V. N. LUGOVENKO and V. P. PRONIN (Akademiia Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniia Radiovoln, Akademiagorodok, USSR) *Gerlands Beitrage zur Geophysik*, vol. 91, no. 4, 1982, p. 346-354. refs

The gravitational and magnetic potentials of a common source are functionally connected. The formation of magnetic and density inhomogeneities in the earth's crust is considered. A joint interpretation of magnetic and gravity anomalies and of irregularities of heat flow would be possible under certain assumptions. It has to be assumed that a conduction mechanism is involved in the transportation of heat produced by local sources, and the thermal field must be assumed to be stationary. As a rule, positive heat flow anomalies correspond to negative regional magnetic and gravity anomalies, which can be partially explained by decompensation and demagnetization of the earth's crust and upper mantle as a result of heating. It is pointed out that heat conductivity plays an important role in the formation of the temperature regime. G.R.

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A82-46784

BIOTIC CONTRIBUTIONS TO THE GLOBAL CARBON CYCLE THE ROLE OF REMOTE SENSING

R. A. HOUGHTON and G. M. WOODWELL (Ecosystems Center, Woods Hole, MA) In: Machine processing of remotely sensed data with special emphasis on range, forest, and wetlands assessment; Proceedings of the Seventh International Symposium, West Lafayette, IN, June 23-26, 1981. West Lafayette, IN, Purdue University, 1981, p.593-600. refs

The global CO₂ problem is reviewed. Changes in terrestrial vegetation and soils since 1700 are analyzed on the basis of rates of forest harvest and regrowth, rates of land conversion to agriculture, and changes in biomass and soil carbon that accompany such changes in land use. The results show that: (1) changes in land use have caused a net release of carbon into the atmosphere that, until recently, was greater than the release from combustion of fossil fuels and (2) there is still a large uncertainty in the analysis, mainly because of conflicting reports on the current rate of tropical forest destruction. The kinds of information needed to improve the analysis are outlined. It is suggested that remote sensing of forest transformations by a satellite such as Landsat may reduce the range of uncertainty by a factor of two to four. F.G.M.

A82-47998

ESTIMATION OF POTENTIAL BIOMASS RESOURCE AND BIOGAS PRODUCTION FROM AQUATIC PLANTS IN ARGENTINA

R. E. FITZSIMONS, C. N. LAURINO, and R. H. VALLEJOS (Consejo Nacional de Investigaciones Cientificas y Tecnicas and Universidad Nacional de Rosario, Centro de Estudios Fotosinteticos y Bioquimicos, Rosario, Argentina) Energy (UK), vol. 7, Aug. 1982, p. 681-687. Research supported by the Consejo Nacional de Investigaciones Cientificas y Tecnicas and Agua y Energia. refs

The use of aquatic plants in artificial lakes as a biomass source for biogas and fertilizer production through anaerobic fermentation is evaluated, and the magnitude of this resource and the potential production of biogas and fertilizer are estimated. The specific case considered is the artificial lake that will be created by the construction of Parana Medio Hydroelectric Project on the middle Parana River in Argentina. The growth of the main aquatic plant, water hyacinth, on the middle Parana River has been measured, and its conversion to methane by anaerobic fermentation is determined. It is estimated that gross methane production may be between 1.0-4.1 x 10 to the 9th cu cm/year. The fermentation residue can be used as a soil conditioner, and it is estimated production of the residue may represent between 54,900-221,400 tons of nitrogen/year, a value which is 2-8 times the present nitrogen fertilizer demand in Argentina. N.B.

A82-48000

VOLCANIC ENERGY

W. M. HEFFINGTON (Texas A & M University, College Station, TX) Energy (UK), vol. 7, Aug. 1982, p. 717-719. refs

The quantities and rates of the thermal energy released during selected volcanic eruptions are estimated, and the potential for this type of energy for the production of energy is evaluated. It is shown that the total amounts of energy released during many volcanic eruptions are not so large as to be unmanageable when removed in a controlled manner, over a period of times for use in electric power generation. In addition, it is suggested that the use of volcanoes for energy production might lead to obtaining a measure of control over volcanic destruction. N.B.

N82-28388# Los Alamos Scientific Lab., N. Mex.

CATALYTIC COAL CONVERSION SUPPORT: USE OF LASER FLASH-PYROLYSIS FOR STRUCTURAL ANALYSIS Progress Report, 1 Jan. - 31 Mar. 1980

C. K. ROFER-DEPOORTER, comp., W. J. VERZINO, JR., R. E. HERMES, B. A. NICHOLS, and N. E. VANDERBORGH Oct. 1981 6 p refs

(Contract W-7405-ENG-36)

(DE82-004179; LA-9031-PR) Avail: NTIS HC A02/MF A01

Catalysts for the gasification of coal, because high temperatures are required for useful rates in uncatalyzed gasification were studied. Metal salt and oxide catalysts were investigated to allow gasification to proceed at reasonable rates at lower temperatures. Laser pyrolysis of coal, and examination of the pyrolysis products by a combination of gas chromatography and mass spectroscopy, contributes to understanding the changes that take place in coal upon treatment with catalysts. The products of laser pyrolysis are likely to be more representative of the original structure of the material pyrolyzed and other pyrolysis products. Coals are pulverized and treated with various catalysts, then heat treated in various atmospheres at different temperatures, and the resulting char is pyrolyzed to examine changes that take place during processing. The amounts of H₂, CO, CH₄, H₂O, CO₂, and C₂H₂ in the pyrolysis products varies with varying treatment. Amounts of H₂O and CO generated decrease with increasing processing temperature. With steam processing, greater amounts of CO, CO₂, and H₂O are generated in the pyrolysis. DOE

N82-28390# Los Alamos Scientific Lab., N. Mex.

CATALYTIC COAL CONVERSION SUPPORT: USE OF LASER FLASH-PYROLYSIS FOR STRUCTURAL ANALYSIS Progress Report, 1 Jan. - 31 Mar. 1981

G. A. BENNETT, C. K. ROFER-DEPOORTER, W. J. VERZINO, JR., R. E. HERMES, and L. F. GRITZO Oct. 1981 18 p refs

(Contract W-7405-ENG-36)

(DE82-004180; LA-9034-PR) Avail: NTIS HC A02/MF A01

The apparatus for on-line sampling of gases generated during processing of coal with catalysts was checked out with coal processed without catalysts. Gases monitored by gas chromatography are N₂, O₂, H₂, CH₄, CO, CO₂, C₂H₄, and C₂H₆. Most of the gaseous products are liberated in the first hour of processing. Condensates are also collected for later analysis by GC/MS. Reproducibility of the method is being improved. A method is being developed to compare pyrograms quantitatively. Coals and chars are pyrolyzed for 1.0 s at a laser power of 20 W, with the spot focussed to 2.5 mm as standard conditions. The total abundances of about forty compounds are then tabulated and subjected to a statistical analysis of variance. The compounds include alkanes, alkenes, aromatics, and sulfur, oxygen, and nitrogen compounds. The statistical analysis is now being performed for untreated Fruitland coal, and for Fruitland coal treated with CO₂ at 4000 C and the catalysts NaHCO₃, Na₂CO₃, and K₂CO₃. Extensive transient heat transfer analysis was performed to model the laser pyrolysis event. DOE

N82-28392# California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Molecular Research Div.

CHEMISTRY AND MORPHOLOGY OF COAL LIQUEFACTION Annual Report, 1 Oct. 1980 - 20 Sep. 1981

H. HEINEMANN Sep. 1981 48 p refs

(Contract W-7405-ENG-48)

(DE82-005141; LBL-13318) Avail: NTIS HC A03/MF A01

Progress in coal liquefaction processes is discussed. Six tasks are reported: selective synthesis of gasoline range components from synthesis gas; electron microscopic studies of coal during hydrogenation; catalyzed low temperature hydrogenation of coal; selective hydrogenation, hydrogenolysis, and alkylation of coal and coal liquids by organometallic systems; chemistry of coal solubilization and liquefaction; and coal conversion catalyst deactivation. DOE

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N82-28395# Ames Lab., Iowa.

STUDY OF HYDROGEN IN COALS, POLYMERS, OXIDES, AND MUSCLE WATER BY NUCLEAR MAGNETIC RESONANCE: EXTENSION OF SOLID STATE HIGH RESOLUTION TECHNIQUES Ph.D. Thesis

L. M. RYAN Oct. 1981 242 p refs

(Contract W-7405-ENG-82)

(DE82-005454; IS-T-957) Avail: NTIS HC A11/MF A01

Nuclear magnetic resonance (NMR) spectroscopy of solids was investigated. High resolution solid state ¹³C NMR spectra exhibiting features similar to those observed in liquids are currently achievable using sophisticated pulse techniques. Analogous methods for high resolution ¹H NMR of rigid solids are developed. Applications include characterization of hydrogen aromaticities in fossil fuels, and studies of hydrogen in oxides and bound water in muscle.

DOE

N82-28400# Oak Ridge National Lab., Tenn.

RECENT PROGRESS IN MAJOR COAL LIQUEFACTION FACILITIES: OVERVIEW REPORT NO. 2

K. H. LIN, J. F. FISHER, A. R. IRVINE, and F. M. OHARA, JR.

Dec. 1981 94 p refs

(Contract W-7405-ENG-26)

(DE82-004656; ORNL/TM-8025) Avail: NTIS HC A05/MF A01

Reviews and evaluations of significant developments in four major coal liquefaction projects (SRC-I, SRC-II, EDS and H-Coal) are presented. The main sources of information were (1) progress reports from major coal liquefaction facilities, (2) technical review meeting memos, and (3) SRC-I and SRC-II demonstration plant status review meeting memos. A summary of important developments is presented as the basis for an assessment of the significance of these developments in coal liquefaction, as well as more detailed information to provide a supporting data base for the technical assessment.

DOE

N82-28401# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

PERFORMANCE ASSESSMENT OF MATERIALS AND COMPONENTS OF THE WESTINGHOUSE COAL GASIFICATION PROCESS DEVELOPMENT UNIT

J. P. HAMMOND and J. R. HORTON Dec. 1981 35 p refs

(Contract W-7405-ENG-26)

(DE82-005995; ORNL/TM-8037) Avail: NTIS HC A03/MF A01

A preliminary assessment of the performance of materials and components of the Westinghouse Process Development Unit (PDU) at Waltz Mill, Pennsylvania is given. The assessment was accomplished by evaluating information in the literature and discussing performance problems with the operating personnel of the PDU. The materials and components problems at the Westinghouse plant are not especially pressing from the viewpoint of its successful operation; however, several areas require increased effort for the orderly development of a viable commercial process. Such areas include (1) an efficient waste heat recovery system for the product gas stream, (2) elimination of a solids sticking problem in the off-gas cyclone consistent with high thermal efficiency, (3) a high-temperature solids feeder for recycle char capable of operation at 6500 C, and (4) a fusion-bonded protective ceramic overlay approach to provide long-life service of the combustor feed tube.

DOE

N82-28427# National Coal Board, Leatherhead (England).

IN-BED CORROSION TESTS OF SUPERHEATER ALLOYS IN A 10-SQUARE-FOOT AFBC Final Report

A. G. ROBERTS, R. V. WARDELL, and A. J. MINCHENER Nov.

1981 262 p Sponsored by Electric Power Research Inst.

(Contract EPRI PROJ. 979-2)

(DE82-901346; EPRI-CS-2118) Avail: NTIS HC A12/MF A01

Candidate superheater alloys in the form of tubes and hanger materials were immersed for 1000 to 2000 h in the fluidized bed of a small industrial boiler in which operating conditions were representative of conditions which might be expected in a future commercial power plant. Materials investigated included low medium and high chromium ferritic steels, iron based austenitic

steels, and nickel based alloys. The results (1) indicate that some iron based austenitic steels and high chromium ferritic steels are likely to be suitable for superheater tubes whilst nickel based alloys are not; (2) suggest that some iron based austenitic steels are suitable materials for uncooled hanger components while ferralloy type steels may be suitable for both cooled and uncooled applications; and (3) were not significantly different from those obtained on small rigs over similar periods of operation at similar temperatures.

DOE

N82-28428# Oak Ridge National Lab., Tenn. Chemical Technology Div.

EVALUATION OF POTENTIAL PROCESSES FOR RECOVERY OF METALS FROM COAL ASH. VOLUME 2: LABORATORY DATA AND COST ESTIMATES Final Report

R. M. CANON, T. M. GILLIAM, and J. S. WATSON Nov. 1981

222 p refs

(Contract W-7405-ENG-26; EPRI PROJ. 1404-2)

(DE82-005592; EPRI-CS-1992-VOL-2) Avail: NTIS HC A10/MF

A01

An experimental campaign was carried out to develop process flowsheets for the removal of metals from fly ash and their subsequent separation into saleable products. The capital cost requirements for processing 1 million tons of ash (dry basis) per year were \$42.5 million and \$55 million, respectively, for the two most promising processes, HCl direct acid leach and pressure digestion acid leach. The net yearly cash flow for the HCl direct acid leach process was \$15.2 million, which makes it a viable option. The pressure digestion acid leach process, on the other hand, had a negative cash flow of \$22 million, which makes it unattractive.

DOE

N82-28462# Suntech, Inc., Marcus Hook, Pa.

AN EXPLORATORY RESEARCH AND DEVELOPMENT PROGRAM LEADING TO SPECIFICATIONS FOR AVIATION TURBINE FUEL FROM WHOLE CRUDE SHALE OIL. PART 1: PRELIMINARY PROCESS ANALYSES Interim Report, 2 Jan. - 1 Jul. 1979

H. E. REIF, J. P. SCHWEDOCK, and A. SCHNEIDER Wright-Patterson AFB, Ohio AFWAL Sep. 1981 48 p refs

3 Vol.

(Contract F33615-78-C-2024; AF PROJ. 3048)

(AD-A112681; AFWAL-TR-81-2087-PT-1) Avail: NTIS HC

A03/MF A01 CSCL 21D

Preliminary process analyses of three different technically feasible processing schemes proposed by SUN TECH, INC. for converting 100,000 BPCD of raw Paraho shale oil into military turbine fuels was investigated. Each processing scheme is based on very limited, but pertinent, data generated by SUN TECH plus literature sources. The base processing scheme consists of severe hydrotreating followed by sulfuric acid extraction; the two alternate cases utilize moderate hydrotreating plus extraction for nitrogen removal and hydrocracking. Screening-type process designs and costs estimates were prepared for each case using the economic basis specified. Results indicate that shale oil fuels refineries are more capital intensive than a comparable size petroleum refinery. No attempt was made at optimization.

Author (GRA)

N82-28463# Suntech, Inc., Marcus Hook, Pa.

AN EXPLORATORY RESEARCH AND DEVELOPMENT PROGRAM LEADING TO SPECIFICATIONS FOR AVIATION TURBINE FUEL FROM WHOLE CRUDE SHALE OIL. PART 2: PROCESS VARIABLE ANALYSES AND LABORATORY SAMPLE PRODUCTION Interim Report, 1 Jul. 1979 - 1 Nov. 1980

H. E. REIF, J. P. SCHWEDOCK, and A. SCHNEIDER Wright-Patterson AFB, Ohio AFWAL Sep. 1981 61 p refs

3 Vol.

(Contract F33615-78-C-2024; AF PROJ. 2480)

(AD-A112682; AFWAL-TR-81-2087-PT-2) Avail: NTIS HC

A04/MF A01 CSCL 21D

Pilot plant process data have been incorporated in three design bases for manufacturing military fuels from raw Occidental shale oil. Processing schemes for 90,000 BPCD refineries to maximize

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either JP-4, JP-8 or to produce JP-4 plus other military fuels are presented. The processing sequence comprises moderate severity hydrotreating, fractionation, anhydrous HC1 extraction and hydrocracking. Plant capacities and product yields were not optimized. Investments for the three refinery options considered are 1.5 to 2.0 times as much as a comparable size petroleum fuels refinery. At maximum JP-4 or JP-8 production the yields are about 87 and 53 volume % of total refinery energy input, respectively. Overall, refinery thermal efficiency is $>$ or $=$ 75%. Inspection data are presented for five samples of specification aviation turbine fuels prepared from pilot plant operations. GRA

N82-28464# Suntech, Inc., Marcus Hook, Pa.
AN EXPLORATORY RESEARCH AND DEVELOPMENT PROGRAM LEADING TO SPECIFICATIONS FOR AVIATION TURBINE FUEL FROM WHOLE CRUDE SHALE OIL. PART 3: PRODUCTION OF SPECIFICATION OF JP-4 FUEL FROM GEOKINETICS SHALE OIL Interim Report, 1 Jan. - 1 Apr. 1980

H. E. REIF, J. P. SCHWEDOCK, and A. SCHNEIDER
Wright-Patterson AFB, Ohio AFWAL Oct. 1981 45 p refs
3 Vol.

(Contract F33615-78-C-2024; AF PROJ. 2480)
(AD-A112683; AFWAL-TR-81-2087-PT-3) Avail: NTIS HC
A03/MF A01 CSCL 21D

270 Barrels of specification JP-4 jet fuel were produced by hydrotreating 890 barrels of raw Geokinetics shale oil under severe operating conditions in a continuous process development unit. On a once thru basis the yield of JP-4 off the hydrotreater was about 35 volume % of the feed. Preliminary estimates of plant investments and economics indicate that for the combination severe hydrotreating and hydrocracking, an 85 volume % yield can be attained based on total refinery energy input. Capital investments and manufacturing costs do not appear to be excessive for a shale oil refinery. GRA

N82-28466# SRI International Corp., Menlo Park, Calif.
BASIC STUDY OF FUEL STORAGE STABILITY Interim Report, 1 Mar. - 31 Mar. 1982

F. R. MAYO, S. E. BUTTRILL, JR., B. LAN, and G. A. ST. JOHN
15 Apr. 1982 8 p
(Contract DAAG29-80-C-0122; SRI PROJ. PYU-1924)
(AD-A114127; ARO-17062.2-E; IR-2) Avail: NTIS HC A02/MF
A01 CSCL 21D

The object of this work is to determine the mechanism by which gum and deposits are formed in diesel fuels, and thus how to predict and prevent their formation. We have been following the development of deposit precursors during oxidations of pure hydrocarbons at 130 C by field ionization mass spectrometry (FIMS), and also testing high performance liquid chromatography (HPLC) for the same purposes. HPLC might be a convenient and economical substitute for FIMS. The previous report, Interim Report No. 1 (March 22, 1982), included all useful data on this project since the joint Final Report of October 1, 1981 to NASA-Lewis and ARO. The present report includes data on deposit formation and rates of oxidation of several diesel fuels supplied by the U.S. Army Fuels and Lubricants Research Laboratory at San Antonio, done during the previous year, which have not yet appeared in any written report. Author (GRA)

N82-28468# California Univ., Livermore. Lawrence Livermore Lab.

PLANT DESIGN AND ECONOMIC ANALYSIS FOR SOLAR COAL GASIFICATION

W. R. AIMAN, C. B. THORSNESS, and D. W. GREGG 9 Apr. 1981 20 p refs Presented at the Solar Thermal Test Facilities Users Assoc. Ann. Business and Tech. Meeting, Pasadena, Calif., 20 Apr. 1981

(Contract W-7405-ENG-48)
(DE82-003178; UCRL-85821; CONF-810469-5) Avail: NTIS HC
A02/MF A01

The advantage of the solar coal gasification (SCG) method, compared to a similar Lurgi plant, is conservation of coal; 40%

more product can be produced from a given amount of coal. The primary detriment of SCG is an 8 hr/day operation; which leads to a higher plant investment is twice as important as the cost of the heliostat field. Providing excess heliostat capacity to maximize the output of the processing units probably is economically justified. Operating costs are lower for SCG, but capital costs are higher. In the future, as coal costs increase relative to investment costs, the SCG plant will become more economical than the Lurgi plant. DOE

N82-28470# California Univ., Livermore. Lawrence Livermore Lab.

LABORATORY-SCALE SIMULATION OF UNDERGROUND COAL GASIFICATION: EXPERIMENT AND THEORY

J. R. CREIGHTON and C. B. THORSNESS 28 Aug. 1981 26 p refs Presented at the Western States Sect. Meeting of the Combust. Inst., Tempe, Ariz., 19-20 Oct. 1981

(Contract W-7405-ENG-48)
(DE82-001063; UCRL-86473; CONF-811041-2) Avail: NTIS HC
A03/MF A01

Laboratory-scale experiments simulating underground coal gasification are described. A 1 cm borehole is drilled through a block of coal which is cut to fit in a 55 gallon oil drum. Inlet gas may be air or oxygen/steam mixture at various ratios. The blocks are burned for a period of several hours at a prescribed flow schedule, with appropriate instrumentation. Gas quality is found to be relatively independent of coal type for the range of sub-bituminous coals tested. After the burn the blocks of coal are cut open to examine the cavity. A mathematical modeling effort supports these experiments. The models are restricted to pure carbon, to simplify the chemistry in the model. When plug flow is assumed in the cavity the model predicts reasonable cavity shape downstream, but an incorrect shape upstream. When aerodynamic flow, including viscosity and vortex formation, is calculated in the cavity reasonable cavity shapes are obtained. DOE

N82-28471# Monsanto Research Corp., Miamisburg, Ohio.
IN-SITU COAL GASIFICATION OF BITUMINOUS COALS. A DEVELOPMENT PLAN

R. E. ZIELINSKI and A. K. AGARWAL 1981 18 p refs Presented at the 56th SPE Ann. Tech. Conf. and Exhibition, San Antonio, 5-7 Oct. 1981

(Contract DE-AC04-76DP-00053)
(DE82-002558; MLM-2873-OP; CONF-811023-6) Avail: NTIS
HC A02/MF A01

Underground coal gasification (UCG). A technology that could provide for the economic production of gasoline and SNG in the eastern, high energy use markets and would provide an essentially new energy source to these markets is discussed. The high rank, thin seam, bituminous coals provide an effective target for the development of an economically viable technology for resource recovery. Tests demonstrated the feasibility of gasifying deep, thin seam, swelling bituminous coals. This test provided a 72% energy recovery by utilizing only air injection. DOE

N82-28472# Mobil Research and Development Corp., Princeton, N. J. Central Research Div.

FUNDAMENTAL STUDIES IN THE CONVERSION OF COALS TO FUELS OF INCREASED HYDROGEN CONTENT. VOLUME 1: THE CHEMISTRY AND MECHANISMS OF COAL CONVERSION TO CLEAN FUEL Interim Report, Jun. 1979 - Dec. 1980

F. J. DERBYSHIRE, G. A. ODOERFER, L. R. RUDNICK, P. VARGHESE, and D. D. WHITEHURST Nov. 1981 251 p refs

Sponsored by EPRI
(Contract EPRI PROJ. 1655-1)
(DE82-901287; EPRI-AP-2117-VOL-1) Avail: NTIS HC A12/MF
A01

Coal conversions were examined at a variety of conditions. Reaction products were characterized by numerous techniques to give insight into the compositional changes occurring at short times, the influence of coal and solvent composition, and the extent of solvent coal interactions. Coal dissolution in high boiling solvents

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was investigated in parallel studies using pure model compounds and high boiling coal derived liquids. Procedures were developed to separate coal derived liquids into distillate and nondistillable fractions and to effect further separation on a preparative scale into different chemical classes. Liquid chromatography was used extensively to characterize the solvents and relate their composition to coal conversion. DOE

N82-28473# West Virginia Univ., Morgantown. Dept. of Chemical Engineering.

OPTIMIZATION STUDIES OF VARIOUS COAL CONVERSION SYSTEMS Quarterly Reports, 1 May - 1 Jul. 1981 and 1 Aug. - 31 Oct. 1981

C. Y. WEN, T. TONG, H. M. HUANG, and H. CHEN 1981 27 p refs

(Contract DE-FG22-81PC-40778)

(DE82-005208; DOE/PC-40778/T1; QR-1; QR-2) Avail: NTIS HC A03/MF A01

Two types of coal liquefier reactors are examined for the optimization of coal conversion systems; three-phase fluidized bed and bubble column of lurry reactors. These two reactors have some similarities. Both are three-phase reactors; both deal with mass transfer of gas species of gas species from gas phase into liquid and solid phases; and both involve dissolution of solid phase. The main difference between them is that solid particles have much longer residence time in three-phase fluidized beds than in bubble columns. A literature survey of three-phase fluidization is presented to clarify the hydrodynamic aspect of ebullient bed reactor design. A literature survey of the hydrodynamics of solid-liquid-gas system slurry reactors is also given. DOE

N82-28474# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ALCOHOL FUELS PROGRAM TECHNICAL REVIEW, SUMMER, 1981

1981 97 p refs

(Contract DE-AC02-77CH-00178)

(DE82-006904; DOE/TIC-2006904) Avail: NTIS HC A05/MF A01

Methanol production research activity consists of two elements: development of a pressurized oxygen gasifier and synthesis of catalytic materials to more efficiently convert synthesis gas to methanol and higher alcohols. The experimental apparatus and recent results obtained from the gasifier are reported. The catalysis research is principally directed toward producing novel organometallic compounds for use as a homogeneous catalyst. The utilization research is directed toward the development of novel engine systems that use pure alcohol for fuel. Reforming methanol and ethanol catalytically to produce H₂ and CO gas for use as a fuel offers performance and efficiency advantages over burning alcohol directly as fuel in an engine. An application of this approach is also detailed. The use of fuel cells in transportation is discussed. Alternate electrolyte systems are investigated for the direct and indirect use of alcohols in fuel cells. DOE

N82-28654# Southwest Research Inst., San Antonio, Tex.
EMISSION CHARACTERIZATION OF AN ALCOHOL/DIESEL-PILOT FUELED COMPRESSION IGNITION ENGINE AND ITS HEAVY-DUTY DIESEL COUNTERPART Final Report, Aug. 1980 - Aug. 1981

T. L. ULLMAN and C. T. HARE Aug. 1981 239 p refs

(Contract EPA-68-03-2884)

(PB82-154113; EPA-460/3-81-023) Avail: NTIS HC A11/MF A01 CSCL 21G

Results from emissions testing of a prototype diesel engine, developed by Volvo Truck Corporation of Sweden, which uses pilot injection of diesel fuel for compression ignition of alcohol fuel injection for main combustion are described. In addition to this dual fuel engine, emission testing was also conducted on a heavy-duty diesel engine of similar design. Both engines were tested over the 1979 13-mode FTP, or shorter versions of this modal test, and over the 1984 Transient FTP as well as an experimental bus cycle. The dual-fuel engine was characterized

with methanol, ethanol and ethanol with 30 percent water (wt %). An oxidation catalyst was also used with methanol and ethanol. Emission characterization included regulated emissions (HC, CO, and NOX) along with total particulate, unburned alcohols, individual hydrocarbons, aldehydes, phenols and odor. GRA

N82-28680# Sandia Labs., Albuquerque, N. Mex.

MULTI-FRAC TEST SERIES Final Report

R. A. SCHMIDT, N. R. WARPINSKI, S. J. FINLEY, and R. C.

SHEAR Nov. 1981 188 p refs

(Contract DE-AC04-76DP-00789)

(DE82-004514; SAND-81-1239) Avail: NTIS HC A09/MF A01

A series of five full scale tests performed to evaluate various multi-frac concepts is described. The tests were conducted in horizontal boreholes drilled in ash-fall tuff from a tunnel under 1300 ft of overburden. DOE

N82-28689# Geological Survey, Washington, D. C.

US GEOLOGICAL SURVEY ACTIVITIES, FISCAL YEAR 1981

1981 165 p refs

(CIRC-875) Avail: NTIS HC A08/MF A01

Activities in Alaska, Mount St. Helens, leasing and regulatory procedure, coal, royalty management, water data telemetry, acid rain, hazardous wastes, oil and gas resources, and digital cartography are reviewed. Chemical and nuclear wastes and petroleum exploration in Alaska are discussed. Management issues are addressed. Mapping activities are reported. Water resources, conservation, and earth sciences, are also reviewed. N.W.

N82-28697# RAND Corp., Santa Monica, Calif.

THE EFFECTS OF LEASE SIZE ON YIELDS FROM OIL SHALE SURFACE MINES

R. Y. PEI and D. S. RUBENSON Mar. 1982 36 p refs

Sponsored by DOE

(RAND/N-1798-DOE) Avail: NTIS HC A03/MF A01

The effects of lease size and waste disposal policy on the amount of oil shale that can be recovered from an open pit mine are examined. Process facilities and waste disposal are considered, and the effects of federal leasing policy on the long-term potential of oil shale are assessed. Geometrical analysis of an open pit mine provided an understanding of the relation between lease size and resource recovery. The amount of recoverable oil shale was found to be limited to no more than 20 percent of the resource in place. Author

N82-28751# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

OIL SHALE AND COAL RESEARCH FY 1980 Annual Report, 1980

Mar. 1981 87 p refs

(Contract W-7405-ENG-48)

(DE82-002825; LBL-11989) Avail: NTIS HC A05/MF A01

The environmental consequences of shale oil production is discussed. Solid wastes and water and air pollution are discussed. The characterization, transport, fate, and control of organic, organometallic, and inorganic compounds synthesized or released during retorting are discussed. A number of previously unrecognized or little understood environmental concerns were identified, such as in situ leaching, air emission of toxic trace elements, and aqueous effluent disposal. Individual summaries of various research topics are given under the following headings: characterization studies, partitioning studies, retort abandonment, wastewater treatment studies, and coal research (water). Separate abstracts were prepared for 17 of these 18 papers. DOE

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N82-28757# Murray-North Partners Ltd., Hamilton (New Zealand).

SMALL HYDRO-ELECTRIC RESOURCE ASSESSMENT: HAURAKI AREA Final Report

Apr. 1981 50 p refs Prepared in cooperation with New Zealand Energy Research and Development Committee, Auckland

(DE82-901428; NZERDC-63) (US Sales Only) HC A04/MF A01; DOE Depository Libraries

Hydrological studies were undertaken to provide data for the evaluation and selection of potential hydroelectric sites in the Hauraki area in New Zealand. This involved determining hydrological statistics for a large number of sites. In only a few instances could the results of a continuous flow gauging record be applied directly to a site. For most sites it was necessary to derive long term mean flow data using the water balance relationship, this was in good agreement with the results of flow gaugings where these were available. Streams draining the porous soils of the Mamaku Plateau to the south were an exception, and reliable flow data in this area can only be obtained from flow gaugings. Flow distribution and flow frequency relationships were estimated on a regional basis. The information derived was sufficient to assist in identifying potential hydroelectric sites meriting further investigation. DOE

N82-28760# Oak Ridge Gaseous Diffusion Plant, Tenn. Uranium Resource Evaluation Project.

HYDROGEOCHEMICAL AND STREAM SEDIMENT RECONNAISSANCE BASIC DATA FOR AZTEC QUADRANGLE NEW MEXICO

31 Jul. 1981 203 p refs

(Contract W-7405-ENG-26)

(DE82-000853; GJBX-321-81; K/UR-348) Avail: NTIS HC A10/MF A01

Uranium resources for national energy planning were assessed, and areas favorable for uranium resources were identified. Field and laboratory data are presented for 331 water samples and 1693 sediment samples from the Aztec Quadrangle, New Mexico. Uranium values are reported and samples were collected. DOE

N82-28764# California Univ., Livermore. Lawrence Livermore Lab.

OIL SHALE PROJECT LARGE RETORT RUN SUMMARY RUN L-3

F. J. ACKERMAN, W. A. SANDHOLTZ, J. H. RALEY, J. F. CARLEY, L. J. TRIPP, A. J. ROTHMAN, and J. H. CAMPBELL 23 Nov. 1981 79 p refs

(Contract W-7405-ENG-48)

(DE82-005109; UCID-18595-REV-1) Avail: NTIS HC A05/MF A01

L-3 was a combustion experiment in the 6.0 Mg retort conducted on May 7-12, 1979. Perhaps the most important conclusion is the high yield (83% of FA) that was achieved using a broad particle size distribution (-30.5 cm, +0.001 cm) with 15 to 20% of the shale larger than 15 cm. The nonuniform flow in the retort was closely predicted by the changing shape of the steam front. Steam front measurements made after the run indicated that the flow distribution through the bed was little affected by the retorting and combustion processes. Therefore, use of the steam front as a diagnostic tool for pre-assessing bed characteristics appears promising. The technique of ignition by hot-gas-preheating worked satisfactorily. No oxygen was observed in the exit gas during the entire retort operation. The temperature of the retort front was controlled by the air flux; no run-away temperatures were encountered when making the step grade change from 18-36 gal/ton. DOE

N82-28765# Western Geophysical Co. of America, Houston, Tex. Aero Service Div.

AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY, ROSEBURG QUADRANGLE, OREGON, VOLUME 1 Final Report

Mar. 1981 121 p refs

(Contract DE-AC13-76GJ-01664)

(DE82-005536; GJBX-388-81-VOL-1) Avail: NTIS HC A06/MF A01

Traverse lines were flown in an east-west direction at a line spacing of six (6) miles. Tie lines were flown north-south approximately eighteen (18) miles apart. A total of 16,880.5 line miles of geophysical data were acquired, compiled, and interpreted during the survey, of which 1596 line miles are in this quadrangle. DOE

N82-28787*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

CONVERSION OF HYDROCARBONS FOR FUEL CELL APPLICATIONS. PART 1: AUTOTHERMAL REFORMING OF SULFUR-FREE AND SULFUR-CONTAINING HYDROCARBON LIQUIDS. PART 2: STEAM REFORMING OF N-HEXANE ON PELLET AND MONOLITHIC CATALYST BEDS Final Report

M. FLYTZANI-STEPHANOPOULOS and G. E. VOECKS Oct. 1981 127 p refs

(Contract DE-AI03-79ET-11326-1)

(NASA-CR-169134; JPL-PUB-82-37-PT-1/PT-2; NAS 1.26:169134;

DOE/ET-11326/1-PT-1/PT-2) Avail: NTIS HC A07/MF A01 CSCL 10A

The autothermal reforming process for conversion of various hydrocarbons to hydrogen and the use of monolithic catalyst beds in the steam reforming of n-hexane are described.

N82-28789*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

STEAM REFORMING OF N-HEXANE ON PELLET AND MONOLITHIC CATALYST BEDS. A COMPARATIVE STUDY ON IMPROVEMENTS DUE TO HEAT TRANSFER

In its Conversion of Hydrocarbons for Fuel Cell Appl. p 75-120 Oct. 1981 refs

Avail: NTIS HC A07/MF A01 CSCL 10A

Monolithic catalysts with higher available active surface areas and better thermal conductivity than conventional pellets beds, making possible the steam reforming of fuels heavier than naphtha, were examined. Performance comparisons were made between conventional pellet beds and honeycomb monolith catalysts using n-hexane as the fuel. Metal-supported monoliths were examined. These offer higher structural stability and higher thermal conductivity than ceramic supports. Data from two metal monoliths of different nickel catalyst loadings were compared to pellets under the same operating conditions. Improved heat transfer and better conversion efficiencies were obtained with the monolith having higher catalyst loading. Surface-gas interaction was observed throughout the length of the monoliths. J.D.

N82-28790*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

REQUIREMENTS FOR THE CONCEPTUAL DESIGN OF ADVANCED UNDERGROUND COAL EXTRACTION SYSTEMS

M. D. GANGAL and M. L. LAVIN 15 Dec. 1981 111 p refs Sponsored by NASA

(Contract DE-AI01-76ET-12548)

(NASA-CR-169142; JPL-PUBL-81-70; NAS 1.26:169142) Avail:

NTIS HC A06/MF A01 CSCL 08I

Conceptual design requirements are presented for underground coal mining systems having substantially improved performance in the areas of production cost and miner safety. Mandatory performance levels are also set for miner health, environmental impact, and coal recovery. In addition to mandatory design goals and constraints, a number of desirable system characteristics are identified which must be assessed in terms of their impact on production cost and their compatibility with other system elements. Although developed for the flat lying, moderately thick seams of

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Central Appalachia, these requirements are designed to be easily adaptable to other coals. B.W.

N82-28800# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

PRELIMINARY CONCEPTUAL DESIGN FOR GEOTHERMAL SPACE HEATING CONVERSION OF SCHOOL DISTRICT 50 JOINT FACILITIES AT PAGOSA SPRINGS, COLORADO. GTA REPORT NO. 6

I. A. ENGEN Nov. 1981 30 p refs
(Contract DE-AC07-75ID-01570)

(DE82-005245; EGG-GTH-5599) Avail: NTIS HC A03/MF A01

This feasibility study and preliminary conceptual design effect assesses the conversion of a high school and gym, and a middle school building to geothermal space heating is assessed. A preliminary cost benefit assessment made on the basis of estimated costs for conversion, system maintenance, debt service, resource development, electricity to power pumps, and savings from from reduced natural gas consumption concluded that an economic conversion depended on development of an adequate geothermal resource (approximately 1500F, 400 gpm). Material selection assumed that the geothermal water to the main supply system was isolated to minimize effects of corrosion and deposition, and that system compatible components are used for the building modifications. Asbestos cement distribution pipe, a stainless steel heat exchanger, and stainless steel lined valves were recommended for the supply, heat transfer, and disposal mechanisms, respectively. A comparison of the calculated average gas consumption cost, escalated at 10% per year, with conversion project cost, both in 1977 dollars, showed that the project could be amortized over less than 20 years at current interest rates.

GRA

N82-28801# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

BIOMASS ENERGY CONVERSION IN HAWAII

R. L. RITSCHARD and A. GHIRARDI Jun. 1981 33 p refs

(Contract W-7405-ENG-48)

(DE82-005139; LBL-11902) Avail: NTIS HC A03/MF A01

Materials and processes for producing liquid fuels from biomass are discussed. Direct combustion of biomass is discussed. The use of sugar industry products, tree crops, municipal solid wastes, and other biomass resources is discussed, as well as the environmental impacts of direct combustion systems. DOE

N82-28816# Mid-American Solar Energy Complex, Minneapolis, Minn.

ECONOMIC SUMMARY OF WOODY BIOMASS DIRECT COMBUSTION AND GASIFICATION ALTERNATIVES

Aug. 1981 19 p

(Contract DE-AC02-79CS-30150)

(DE82-003140; MASEC-R-81-065; B-101-6) Avail: NTIS HC A02/MF A01

A base case analysis indicates that acceptable rates of return on investment are possible when utilizing wood as a commercial scale boiler fuel. Principal variables include the availability of cost competitive wood fuel over the term of the loan and overall installed cost for the system. In some cases the cost of coal at the point of end use will be comparable with wood. Hardware costs will determine system economics and applicable air quality standards, or lack thereof, will play an important role. The overall economics of using wood for fuel are extremely site specific. The additional 10 percent energy tax credit greatly enhances the economics of a wood fired system, although system economics are very attractive without this tax incentive. Cost of money does not seem to drastically affect overall system economics. DOE

N82-28824# Oak Ridge National Lab., Tenn.

FOSSIL ENERGY PROGRAM Quarterly Progress Report, period ending 30 Sep. 1981

L. E. MCNEESE Dec. 1981 325 p refs

(Contract W-7405-ENG-26)

(DE82-005947; ORNL-5833) Avail: NTIS HC A14/MF A01

The progress made during the period from July 1 through September 30 for the Oak Ridge National Laboratory research and development projects in support of the increased utilization of coal and other fossil fuels as sources of clean energy is reported. The following topics are discussed: coal conversion development, chemical research and development, materials technology, fossil energy materials program, liquefaction projects, component development, process analysis, environmental control technology, atmospheric fluidized bed combustion, underground coal gasification, coal preparation and waste utilization. DOE

N82-28838# Stuttgart Univ. (West Germany). Inst. fuer Kernenergetik und Energiesysteme.

PRODUCTION OF LIQUID FUELS OUT OF PLANT BIOMASS AND REFUSE: METHODS, COST, POTENTIAL [HERSTELLUNG VON FLUESSIGEN KRAFTSTOFFEN AUS PFLANZLICHEN PRODUKTEN UND MUELL - METHODEN, KOSTEN, POTENTIAL]

B. WOICK and R. FRIEDRICH Sep. 1981 99 p refs in GERMAN; ENGLISH summary

(IKE-K-68; ISBN-0173-6892) Avail: NTIS HC A05/MF A01

Different ways of producing biomass and its conversion into high grade fuel for vehicles are reviewed with particular reference to physical and geographical factors, pertaining in the Federal Republic of Germany (FRG). Even with the potentially small amount of biomass in the FRG, the fueling of diesel engines with rape oil or modified ethanol, which can be obtained from any cellulosic feedstock, seems to pose the fewest difficulties and promises greatest efficiency. However, the amount of fuel produced from biomass can probably only meet a very small percentage of the total amount required. Author (ESA)

N82-28913# Boeing Engineering and Construction Co., Seattle, Wash.

WIND RESOURCE ANALYSIS FOR THE TENNESSEE VALLEY AUTHORITY REGION, VOLUME 1

D. MCGREW, R. NIELSEN, and W. WEISNER Jun. 1981 146 p refs Sponsored in part by Tennessee Valley Authority, Chattanooga 4 Vol.

(Contract DE-AC06-76RL-01830)

(DE82-004927; TVA/OP/ECR-81/71-VOL-1) Avail: NTIS HC A07/MF A01

Background information on the geography, topography, and climate of the region, a summary of the wind resource, and assessments of the wind resource and energy production potential for specific sites in the region are presented. Information on the sources of meteorological data, and on the various types of summary tables and graphs that were produced to assess the wind resource is given. Results of the wind energy assessment for each site are summarized to provide an overview and description of the various features of the regional wind energy resource and the simulated energy production of two wind turbines rated at 2.5 megawatts and 65 kilowatts. Background on how the wind resource is assessed and on how the results of the assessments should be interpreted is given. The accuracy of the analysis, possible future improvements in data collection and recommendations on areas of the region that deserve further exploration are discussed. DOE

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N82-28914# Boeing Engineering and Construction Co., Seattle, Wash.

WIND ENERGY RESOURCE ATLAS. VOLUME 2: TVA POWER SERVICE AREA

D. MCGREW, R. NIELSEN, and W. WEISNER Jun. 1981 865 p refs Sponsored in part by Tennessee Valley Authority, Chattanooga 4 Vol.

(Contract DE-AC06-76RL-01830)

(DE82-004877; TVA/OP/ECR-81/71-VOL-2) Avail: NTIS HC A99/MF A01

Data summaries for Tennessee Valley Authority sites 1 through 20 are given. Each site has 19 graphs and 23 tables showing seasonal and annual variations in such parameters as wind velocity and wind direction. In addition to the graphs and tables, the data for each site are preceded by brief site notes. DOE

N82-28915# Boeing Engineering and Construction Co., Seattle, Wash.

WIND RESOURCE ANALYSIS FOR THE TENNESSEE VALLEY AUTHORITY REGION, VOLUME 3

D. MCGREW, R. NIELSEN, and W. WEISNER Jun. 1981 839 p refs Sponsored in part by Tennessee Valley Authority, Chattanooga 4 Vol.

(Contract DE-AC06-76RL-01830)

(DE82-006196; TVA/OP/ECR-81/71-VOL-3) Avail: NTIS HC A99/MF A01

Data summaries for Tennessee Valley Authority TVA sites 21 through 47 are given. Each site has graphs and tables showing seasonal and annual variations of wind direction and velocity. Sites 32 through 38 have wind run data so only one table showing monthly variations of mean windspeed is given for each site. In addition to the graphs and tables, the data for each site is preceded by brief site notes. DOE

N82-28916# Boeing Engineering and Construction Co., Seattle, Wash.

WIND RESOURCE ANALYSIS FOR THE TENNESSEE VALLEY AUTHORITY REGION, VOLUME 4

D. MCGREW, R. NIELSEN, and W. WIESNER Jun. 1981 838 p refs Sponsored in part by Tennessee Valley Authority, Chattanooga 4 Vol.

(Contract DE-AC06-76RL-01830)

(DE82-005103; TVA/OP/ECR-81/71-VOL-4) Avail: NTIS HC A99/MF A01

Data summaries for Tennessee Valley Authority (TVA) sites 48 to 99, excluding sites 69-72 which were not assigned are given. TVA Sites 48-66 have graphs and tables showing seasonal and annual variations of wind parameters. Sites 67 and 68 only show the mean wind-speed on one summary page. Sites 73 to 99 are forest service sites that only had one observation per day, usually in the afternoon. Since there is no direction associated with the windspeed, there are only two graphs and two tables for each site showing variations of the mean windspeed. In addition to the graphs and tables, the data for each site is preceded by brief site notes. DOE

N82-29282# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio. Aero Propulsion Lab.

AVIATION FUELS-FUTURE OUTLOOK AND IMPACT ON AIRCRAFT FIRE THREAT

A. V. CHURCHILL In AGARD Aircraft Fire Safety 17 p May 1982 refs

Avail: NTIS HC A09/MF A01

The properties of aviation turbine fuels with respect to aircraft fire safety are described. It is indicated that projections of the availability of petroleum crudes specifications for aviation turbine fuels may have to be modified to use fuels produced from shale oil, heavy oils and coal. Projections of the chemical and physical properties of future aviation fuels produced from these alternative sources are discussed and compared with present fuels. Progress on programs to develop fire safe fuels through the use of antimisting additives is also described. E.A.K.

N82-29371* National Aeronautics and Space Administration. Pasadena Office, Calif.

COAL DESULFURIZATION BY AQUEOUS CHLORINATION Patent

J. J. KALVINSKAS (JPL, California Inst. of Tech., Pasadena), N. VASILAKOS (JPL, California Inst. of Tech., Pasadena), W. H. CORCORAN (JPL, California Inst. of Tech., Pasadena), K. GROHMANN (JPL, California Inst. of Tech., Pasadena), and N. K. ROHATGI, inventors (to NASA) (JPL, California Inst. of Tech., Pasadena) 20 Apr. 1982 11 p Filed 12 May 1980 Sponsored by NASA

(NASA-CASE-NPO-14902-1; US-PATENT-4,325,707;

US-PATENT-APPL-SN-156790; US-PATENT-CLASS-44-1SR;

US-PATENT-CLASS-201-17) Avail: US Patent and Trademark Office CSCL 07D

A method of desulfurizing coal is described in which chlorine gas is bubbled through an aqueous slurry of coal at low temperature below 130 degrees C., and at ambient pressure. Chlorinolysis converts both inorganic and organic sulfur components of coal into water soluble compounds which enter the aqueous suspending media. The media is separated after chlorinolysis and the coal dechlorinated at a temperature of from 300 C to 500 C to form a non-caking, low-sulfur coal product.

Official Gazette of U.S. Patent and Trademark Office

N82-29376*# Pennsylvania State Univ., University Park. Fuels and Combustion Lab.

PLANE FLAME FURNACE COMBUSTION TESTS ON JPL DESULFURIZED COAL Final Technical Report

J. J. REUTHER, H. T. KIM, and J. G. H. LIMA 15 May 1982 73 p refs Prepared for JPL

(Contract JPL-956123)

(NASA-CR-169199; NAS 1.26:169199; PSU/FCL-C-82-345)

Avail: NTIS HC A04/MF A01 CSCL 21B

The combustion characteristics of three raw bituminous (PSOC-282 and 276) and subbituminous (PSOC-230) coals, the raw coals partially desulfurized (ca -60%) by JPL chlorinolysis, and the chlorinated coals more completely desulfurized (ca -75%) by JPL hydrodesulfurization were determined. The extent to which the combustion characteristics of the untreated coals were altered upon JPL sulfur removal was examined. Combustion conditions typical of utility boilers were simulated in the plane flame furnace. Upon decreasing the parent coal volatile matter generically by 80% and the sulfur by 75% via the JPL desulfurization process, ignition time was delayed 70 fold, burning velocity was retarded 1.5 fold, and burnout time was prolonged 1.4 fold. Total flame residence time increased 2.3 fold. The JPL desulfurization process appears to show significant promise for producing technologically combustible and clean burning (low SO₃) fuels. J.D.

N82-29385# Advanced Fuel Research, Inc., East Hartford, Conn.

CHARACTERIZATION OF WYOMING SUBBITUMINOUS COALS AND LIQUEFACTION PRODUCTS BY FOURIER TRANSFORM INFRARED SPECTROMETRY Final Report, May 1980 - May 1981

P. R. SOLOMON and R. M. CARANGELO Nov. 1981 146 p refs Sponsored by Electric Power Research Inst.

(Contract EPRI PROJ. 1604-2)

(DE82-901292; EPRI-AP-2115) Avail: NTIS HC A07/MF A01

FTIR analysis were performed on samples of coal to correlate liquefaction yields with coal structure information. Analyses were also performed on recycled solvents to determine whether FTIR spectra may be related to solvent quality. The products of coal liquefaction were examined and compared to the starting material in order to trace the chemistry taking place during the process. To identify and quantify materials being analyzed, a model compound library of molecular species that are important components in coal liquids and recycle solvents was begun. The model compounds were used to develop calibration constants to relate data to the concentration of organic structural components in unknown material. Software was developed to use the library to identify components in a mixture. DOE

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N82-29387# Aerojet Energy Conservation Co., Sacramento, Calif.

COMBUSTION ENHANCEMENT AND POLLUTANT CONTROL RESEARCH WITH ACOUSTICALLY INDUCED MIXING Technical Progress Report, Sep. - Dec. 1981

R. J. FAESER and M. I. RUDNICKI Jan. 1982 29 p refs
(Contract DE-AC22-81PC-40270)
(DE82-007012; DOE/PC-40270/3) Avail: NTIS HC A03/MF A01

The impression of acoustic energy on the combustion zone of pulverized coal furnaces was evaluated. These benefits include the reduction in NO/sub x/ generation, the increase in combustion intensity, and the increase in turndown ratio (maximum flow/minimum flow). The reason for these possible benefits is the increased relative motion of the gas and coal particles and the fine stirring action resulting from high frequency acoustic waves. The fabrication and checkout of the test facility are completed, combustion testing is initiated, and a more efficient location for the acoustic drivers is identified. DOE

N82-29391# Texaco, Inc., Montebello, Calif. Research Lab.
GASIFICATION OF RESIDUAL MATERIALS FROM COAL LIQUEFACTION. TYPE 1 EVALUATION OF H-COAL LIQUEFACTION RESIDUE FROM ILLINOIS NO. 6 COAL AS A FEEDSTOCK FOR THE TEXACO GASIFICATION PROCESSES

A. M. ROBIN Oct. 1981 11 p
(Contract DE-AC01-76ET-10137; EX-76-C-01-2247)
(DE82-003873; DOE/ET-10137/T1; FE-2247-27) Avail: NTIS HC A02/MF A01

A laboratory evaluation of a 20-pound sample of atmospheric tower bottoms from a coal liquefaction pilot plant was completed. The sample, which was obtained from the liquefaction of Illinois No. 6 coal, was judged to be a suitable feedstock for the Texaco synthesis gas generation process. It can be charged directly to the gasifier at a temperature of about 3500 F. Based on these results, operating conditions and yields were estimated for gasifying 1000 pounds per hour of molten undiluted residue at 1200 psig. DOE

N82-29392# Avco-Everett Research Lab., Mass.
PREIGNITION VOLATILE YIELDS AS RELATED TO COAL CHARACTERISTICS Final Technical Report, 15 Sep. 1980 - 15 Nov. 1981

K. G. NEOH, K. ANNAMALAI, and R. E. GANNON Oct. 1981 73 p refs
(Contract DE-AC22-80PC-30290)
(DE82-005706; DOE/PC-30290/T4) Avail: NTIS HC A04/MF A01

Thirteen coals ranging in rank from lignite to anthracite were tested at two temperatures between 15000 K and 25000 K. Results from these coals showed that the volatile yields obtained under high-heating rate and temperatures are generally higher than the proximate yield. A positive correlation between the high-temperature yield and the carbon content in the coal was obtained, and the effect of the maceral content was found to be secondary to the chemical composition. With the exception of the lignite and sub-bituminous coals, the heating value of the volatiles is equal to or higher than that of the original coal. Investigation of particle size effects were carried out on three of the thirteen coals and the results showed particle size effects to be insignificant in the size range tested. Modeling results from the AERL coal combustion code indicate that volatile yield strongly affects burner design. Predictions obtained from the model are consistent with current burner technology and can serve as a basis for design improvements. DOE

N82-29394# United States Steel Corp., Monroeville, Pa. Research Lab.

STUDIES OF FUNDAMENTAL FACTORS CONTROLLING CATALYZATION OF REACTIONS OF GASES WITH CARBONACEOUS SOLIDS Final Report

R. M. FISHER and A. SZIRMAE Aug. 1981 21 p refs
(Contract DE-AC02-77ER-045455; EG-77-C-02-4545)
(DE82-005520; DOE/ER-04545/T1; COO-4545-1) Avail: NTIS HC A02/MF A01

Studies of the effects of catalyst particle size and composition and of reaction temperature on the gasification of graphite in H₂ + 2% H₂O by dispersed metal catalysts produced a comprehensive understanding of the process. The experimental observations suggest that the role of catalysts is to effect dissociation of H₂O. The absorbed H and O adatoms then transfer, that is, spill over, to the carbon surface and combine to form CO and CH₄. Spill-over cannot occur if a thin insulating barrier is present between metal and graphite. Gasification is highly localized around each catalyst particle and results in the formation of surface channels and deep pits on single crystals of graphite due to anisotropy in carbon bonding. Similar, but extremely fine, terrace channeling occurs on the graphite microcrystalline aggregates compressed into planchets. The rate of gasification by Fe over a wide range of particle size (approx. 10 nm to 1 mm) is determined by the total surface area. Thus the simple relation that reaction rate equals wt % catalyst/particle size provides a useful guide to the activity of a particular catalyst powder. Transition metal alloys generally show a reduced level of catalytic activity. Ni-Cu alloys are of interest as they were found to produce a desirable increase in the CH₄/CO ratio of the product gas. Several readily available forms of highly dispersed iron powder could be used as expendable catalyst additives for coal gasification, particularly to enhance in situ (underground) methods. DOE

N82-29395# Utah Univ., Salt Lake City. Dept. of Mining and Fuels Engineering.

CHEMISTRY AND CATALYSIS OF COAL LIQUEFACTION CATALYTIC AND THERMAL UPGRADING OF COAL LIQUID AND HYDROGENATION OF CO TO PRODUCE FUELS Quarterly Progress Report, Jul. - Sep. 1981

W. H. WISER Dec. 1981 73 p refs
(Contract DE-AC22-79ET-14700)
(DE82-006094; DOE/ET-14700/8) Avail: NTIS HC A04/MF A01

The hydrogenation activity of a series of HDS catalysts correlated well with O₂ chemisorption and surface dispersion measured by ESCA; however, the HDS activity showed poor correlation with both techniques. The implication is that hydrogenation most likely takes place at edge sites on the basic MoS₂ crystallites and HDS at different, yet unknown site locations. Chemisorption, X ray diffraction, and ESCA measurements demonstrated that MnO is concentrated on the surface of the basic Fe particles in reduced Fe-Mn Fischer Tropsch catalysts. DOE

N82-29402# California Univ., Livermore. Lawrence Livermore Lab.

SOLVENT EXTRACTION OF METHANE FROM SIMULATED GEOPRESSURED-GEOTHERMAL FLUIDS: SUB-PILOT TEST RESULTS

R. QUONG, H. H. OTSUKI, and F. E. LOCKE 14 Jan. 1982 28 p refs
(Contract W-7405-ENG-48)
(DE82-010992; UCID-19291) Avail: NTIS HC A03/MF A01

The extraction of methane dissolved in 15 wt % sodium solution at 1500 C and 1000 psi was demonstrated using n-hexadecane as the solvent in a sub-pilot scale extraction column operated in a continuous, countercurrent flow mode. Greater than 90% recovery of methane was obtained with solvent/brine mass flow ratios in the range of .040 to .045. The height of an ideal stage in this experimental Elgin-type spray column was estimated to be 1.5 ft. Application of this process on actual geopressured fluids is technically feasible, and when combined with direct drive injection disposal is economically attractive. Design and operation of a

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methane saturated-brine supply system to provide simulated geopressured fluid continuously at 1500 C and 1000 psi are also described. Author

N82-29404# Oak Ridge National Lab., Tenn. Environmental Sciences Div.

FUELS AND CHEMICALS FROM WOODY BIOMASS PROGRAM Quarterly Progress Report for period ending 31 Dec. 1980

J. H. CUSHMAN and J. W. RANNEY Jan. 1982 105 p refs (Contract W-7405-ENG-26) (DE82-010338; ORNL/TM-7952; ORNL-ESD-1827) Avail: NTIS HC A06/MF A01

Progress reports from twenty-two continuing research projects in the program are presented. The projects are in the following major areas: species screening and genetic selection; stand establishment and cultural treatment; and harvest, collection, transportation and storage. DOE

N82-29405# Institute of Gas Technology, Chicago, Ill.

HYDROPROCESSING OF HEAVY OILS Final Technical Report, 4 Sep. 1979 - 3 Nov. 1980

R. M. BOWMAN, B. J. JODY, G. JARVI, and R. F. ZABRANSKY Nov. 1981 66 p (Contract DE-AC03-79SF-10760)

(DE82-011289; DOE/SF-10760/6) Avail: NTIS HC A04/MF A01

Hydroprocessing of No. 4 fuel oil to produce a steam-reforming feed suitable for an integrated fuel cell power generation facility was studied. The program included both a system analysis and experimental hydroprocessing work. The initial phase of the experimental work was designed to determine the feasibility of converting the feed to a product suitable for a conventional steam reformer in a single-stage operation. Three catalysts were tested: American Cyanamid AERO HDS-20A, Shell 324, and a proprietary Union Carbide hydrocracking catalyst. Sustained operation with a significant amount of conversion could not be achieved in this mode of operation with these catalysts. The second phase of the experimental work was designed to investigate a two-stage operation in which the feed was first hydrotreated and then hydrocracked. Shell 324 was used as the hydrotreating catalyst; the Union Carbide catalyst was used in the hydrocracking stage. The results of this study indicate that work on developing a low-pressure (less than 500 psig) hydrocracking catalyst that is sulfur- and nitrogen-resistant should be considered. DOE

N82-29407# Chicago Univ., Ill.

COAL-TRANSFORMATION CHEMISTRY Quarterly Progress Report

L. M. STOCK 1981 45 p refs

(Contract DE-AC22-80PC-30088) (DE82-010100; DOE/PC-30088/7; QPR-7) Avail: NTIS HC A03/MF A01

Illinois No. 6 coal was benzylated selectively on phenolic and carboxylic groups using tetrabutylammonium hydroxide as a base and phase transfer catalyst and benzylbromide as the benzylating agent. Demineralized Illinois No. 6 coal was O-methylated in a similar fashion. Colorado coal was reductively methylated and subsequently methylated using tetrabutylammonium hydroxide. The spectroscopic data for these reactions are presented and interesting features are discussed. Illinois No. 6 coal was reductively ethylated using the Sternberg procedure. Analysis of the carbon NMR of the tetrahydrofuran soluble coal product gives some insight into the nature of carbon-carbon alkylation. Illinois No. 6 coal was trifluoroacetylated with lead (IV) tetrakis(trifluoroacetate) in trifluoroacetic acid at ambient temperature. Trifluoroacetylated coal was hydrolyzed in aqueous medium to give hydroxylated coal. The introduction of hydroxyl groups was confirmed by infrared spectroscopy. Several reactions of this hydroxylated coal were investigated. Tin (IV) chloride was selected to study the influence of Lewis acids on the deuterium hydrogen exchange reactions of diphenylmethane and tetralin-d12 or methylphthalene-d8 at low temperature (3000 C and 2000 C). The effort on donor solvent coal chemistry was directed to investigate the role of pericyclic reactions in the liquefaction process more extensively. Preliminary

results indicate that free radical processes occur preferentially and that pericyclic reactions are unimportant at the threshold reaction temperatures of 400 to 4250 C. DOE

N82-29447# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

EFFECT OF SIMULATED MEDIUM-BTU COAL GASIFIER ATMOSPHERES ON THE BIAxIAL STRESS RUPTURE BEHAVIOR OF FOUR CANDIDATE COAL GASIFIER ALLOYS

R. M. HORTON Dec. 1981 43 p refs

(Contract DE-AC07-76ID-01570)

(DE82-010614; EGG-FM-5657) Avail: NTIS HC A03/MF A01

Four candidate alloys for internal use in coal gasifiers were tested in four simulated coal gasifier atmospheres up to approximately 500 h. It was determined that biaxial stress rupture strength and life were adversely affected. It is found that exposure to these atmospheres at temperatures below 11720 K do not decrease these rupture properties below those measured in air. Only at 12550 K are the rupture properties in the various CGA atmospheres consistently below those measured in air at atmospheric pressure. DOE

N82-29469 British Library Lending Div., Boston Spa (England). **MARKET PROSPECTS AND ECONOMICS OF NUCLEAR GASIFICATION OF COAL TO SYNTHETIC NATURAL GAS**

W. BREYER, D. WIEGAND, K. H. BODE, D. OESTERWIND, and L. SCHRADER 23 Jun. 1982 16 p refs Transl. into ENGLISH from Reaktortagung (West Germany), 1977 p 1011-1014

(BLL-RISLEY-TR-4106-(9091.9F)) Avail: British Library Lending Div., Boston Spa, Engl.

Potential uses of synthetic natural gas (SNG) and nuclear district heating are summarized. Costs and economics of SNG production are considered. Fast reactors development in the U.S.S.R. is reviewed. N.W.

N82-29471 British Library Lending Div., Boston Spa (England). **RESEARCH AND DEVELOPMENT WORK ON THE GASIFICATION OF COAL BY HYDROGENATION WITH NUCLEAR PROCESS HEAT WITHIN THE SCOPE OF THE DESIGN PHASE OF THE PNP-PROJECT**

L. SCHRADER 28 May 1982 87 p Transl. into ENGLISH of rept. T-78-25 Rheinische Braunkohlenwerke AG, Cologne, Dec. 1976

(BLL-TRANS-T5837/BG/MRS14581/82; T-78-25) Avail: British Library Lending Div., Boston Spa, Engl.

The planning, erection, and operation of a semitechnical pilot plant for hydrogasification of coal in a fluidized bed with an input of 100 kg C/h are described. Process data are presented using both lignite (brown coal) and hard coal. Operating results obtained during the development phase demonstrated that hydrogasification is suitable as a component of a large scale gasification unit. J.D.

N82-29472# Army Facilities Engineering Support Agency, Fort Belvoir, Va. Technology Support Div.

WASTE VEGETABLE OIL AS A FUEL EXTENDER Final Report

J. F. THOMPSON, JR. Oct. 1981 44 p

(AD-A113488; USAFESA-T-2101) Avail: NTIS HC A03/MF A01 CSCL 11H

This report presents the conditions under which waste hydrogenated vegetable oil can be mixed with waste and virgin petroleum oils and remain in a homogeneous state. GRA

N82-29473# Army Facilities Engineering Support Agency, Fort Belvoir, Va. Technology Support Div.

COAL-OIL MIXTURES PROBLEMS AND OPPORTUNITIES

J. F. THOMPSON, JR. 15 Jan. 1982 26 p refs

(AD-A113533; USAFESA-T-2100) Avail: NTIS HC A03/MF A01 CSCL 21D

This report presents the problem areas and identifies solutions for implementing Coal-Oil Mixture Technology. The report also contains an overview of industrial and Government experiences in

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fuel production, stabilization, and combustion. The report provides references and points of contact/addresses of those manufacturers currently involved in Coal-Oil Mixture Technology. Author (GRA)

N82-29476# UOP, Inc., Des Plaines, Ill.
UNITED STATES AIR FORCE SHALE OIL TO FUELS, PHASE 2 Interim Technical Report, 1 Apr. 1979 - 30 Sep. 1980
J. R. WILCOX, J. G. SIKONIA, T. G. BOARD, and F. J. RIEDL
Wright-Patterson AFB, Ohio AFWAL Nov. 1981 295 p refs
(Contract F33615-78-C-2079)
(AD-A114531; AFWAL-TR-81-2116) Avail: NTIS HC A13/MF A01 CSDL 21D

Phase II of this project was conducted to demonstrate innovative technology to reduce the cost of converting shale oil to high yields of aviation turbine fuels. To carry out this program, UOP selected a processing scheme involving hydrocracking as the primary conversion unit. The Phase II program included pilot plant processing, fouling studies and economic analysis. The pilot plant operations performed during Phase II involved four specific processing steps: feed preparation, low pressure hydrotreating, high pressure hydrotreating, and hydrocracking. Two shale oil feedstocks were utilized for each processing step: shale oil derived from Occidental Modified In-Situ retort and shale oil obtained from the Paraho direct-heated retort. Using data generated from the pilot plant operations and the study basis provided by the USAF, economic analyses were performed to find the cost of production of jet fuel, and total liquid product at a 15% discounted cash flow rate of return (DCFRR) on investment. GRA

N82-29477# Finnish Energy Economy Association, Helsinki.
CLASSIFICATION AND PROPERTIES OF PEAT FOR FUEL PURPOSES
B. BERGGREN, A. KALMARI, and P. LEINO 1980 30 p refs
(DE82-900924; EKONO-158) Avail: NTIS (US Sales Only) HC A03/MF A01; DOE Depository Libraries

The normal peat classification systems used to determine the types of peat and the degree of decomposition are provided. The properties of peat as a fuel are discussed starting from practical production parameters applied in Finnish conditions. Chemical composition, heating values, moisture content, and bulk densities form the basis for fuel use. Boiler and furnace design depends on several factors which are discussed. Basic differences between milled peat, sod peat, peat briquettes and peat pallets, which are the normal commercial forms in which peat can be obtained in Finland, are described. DOE

N82-29479# Atomic Energy of Canada Ltd., Chalk River (Ontario). Physical Chemistry Branch.
GASOLINE AND OTHER TRANSPORTATION FUELS FROM NATURAL GAS IN CANADA
E. A. SYMONS and A. I. MILLER Mar. 1981 33 p refs In ENGLISH; FRENCH summary
(DE81-700550; AECL-7258) Avail: NTIS (US Sales Only) HC A03/MF A01; DOE Depository Libraries

Ways in which natural gas might displace crude oil as a source of fuels for the Canadian transportation market are reviewed. Three approaches are possible; (1) direct use as compressed natural gas, (2) conversion of natural gas to methanol, and (3) further conversion of methanol to synthetic gasoline. DOE

N82-29486# Aerospace Research Corp., Roanoke, Va.
DEVELOPMENT OF WOOD AS AN ALTERNATIVE FUEL FOR LARGE POWER-GENERATING SYSTEMS. PART 1: RESEARCH ON WOOD-BURNING GAS TURBINES Final Report
J. T. HAMRICK and T. M. HAMRICK Sep. 1981 87 p refs
(Contract DE-AC05-78ET-20058)
(DE82-002034; DOE/ET-20058/T2-PT-1) Avail: NTIS HC A05/MF A01

Research is reported on the burning of pulverized green wood in suspension as a power plant fuel. Burner systems suitable for research into retrofitting of central station boilers as well as gas turbines were designed, built, and tested. It was determined that with combustion air preheated to 10000 F, green wood chips

pulverized to pass a 1/2 in. screen could be burned completely in suspension in a distance of 20 ft. For gas turbines where the combustion products must be mixed with air for cooling to 1500 to 18000 F before passing through the turbine, it was necessary to use smaller and partially dried wood particles to achieve complete combustion in the 20 ft distance. A gas cleaning method recently developed for effluent from coal-fired pressurized fluidized beds was adapted for use with the wood suspension burner and applied to a 500 hp gas turbine. The theoretical analyses, and results of computations made in the design of the gas turbine combustion system are provided together with preliminary experimental results. Conclusions from the program are that retrofitting of large boiler systems is less practical from an economic and wood supply standpoint than installation of 15 to 20 MW combined cycle gas turbine systems at 10 to 20 mile intervals in the forested areas of the country. The financial mechanism for spawning such a dispersed power generation program was provided by the Public Utility Regulatory Policy Act of 1978. Power in 15 to 20 MW amounts can be fed into most distribution lines in the US. Wheeling power in this manner from small, efficient power producing systems can save on fuel transportation and power distribution costs while providing local jobs. A 18 MW system with commercially available modular components was designed. The projected capital cost is less than \$600 per installed KW (1981) and the estimated operating efficiency is 32 to 33%. GRA

N82-29487# Aerospace Research Corp., Roanoke, Va.
DEVELOPMENT OF WOOD AS AN ALTERNATIVE FUEL FOR LARGE POWER-GENERATING SYSTEMS. PART 2: SELECTION OF AN OIL- OR GAS-FIRED BOILER SYSTEM FOR RETROFIT Final Report
J. T. HAMRICK Sep. 1981 30 p refs
(Contract DE-AC05-78ET-20058)
(DE82-002033; DOE/ET-20058/T2-PT-2) Avail: NTIS HC A03/MF A01

Four boiler systems which use oil as a fuel were studied to determine the feasibility of retrofitting them to burn wood as an alternative fuel for power plants. It was concluded that direct burning of wood in one of the systems provides an economical alternative and that conversion of the three remaining boilers to operation in a waste heat mode in a combined cycle with wood burning-gas turbines offered the greatest economy of operation. Boiler system no. 1 of the Eugene, Oregon Water and Electric Board was chosen as the most viable candidate for retrofitting. An evaluation of that system was made and a preliminary retrofit design was developed. The retrofit system employs six wood-burning gas turbines. The exhaust gases from the turbines are passed through the boiler providing enough heat to operate at 75% of boiler capacity. The overall results are as follows: the net system output as retrofitted is 22,755 kW compared to current maximum output of 7500 kW; the overall efficiency of the combined system based on electrical output of the generators and higher heating value of the wood feed is 32.5%; the estimated cost of the system is \$7,966,235 or \$352 per installed kW not including land; and based upon use of Douglas fir and hemlock bark and wood mixture with heating value of 9840 Btu/lb and 40% moisture, 504 tons of wood waste per day will be required. DOE

N82-29488# Aerospace Research Corp., Roanoke, Va.
DEVELOPMENT OF WOOD AS AN ALTERNATIVE FUEL FOR LARGE POWER-GENERATING SYSTEMS. PART 3: COMPUTER SIMULATION OF THE DYNAMIC RESPONSE OF AN INDUSTRIAL GAS TURBINE WITH LARGE-VOLUME COMBUSTION AND FILTERING SYSTEM Final Report
N. A. HAMRICK Sep. 1981 46 p refs
(Contract DE-AC05-78ET-20058)
(DE82-001997; DOE/ET-20058/T2-PT-3) Avail: NTIS HC A03/MF A01

Computer simulations are presented for predicting the dynamic response of an industrial gas turbine generator set which includes a large burner and clean-up system for direct combustion of solid fuel. The transient response is determined for both design speed and start up. Results of the simulations can be used to determine

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necessary control system parameters. Initial simulations are discussed for the cases of a sudden major load increase or decrease and a moderately varying load at design speed, and for turbine start up including modified test bed running. The method should minimize control design time and safety risks during the development of the new turbine system. DOE

N82-29490# Kansas Energy Office, Topeka. Energy Research and Resource Development Div.

PRODUCTION OF ALCOHOL FUELS VIA ACID HYDROLYSIS EXTRUSION TECHNOLOGY

R. NOON and T. HOCHSTETLER 1981 47 p refs
(DE82-901333; NP-2901333) Avail: NTIS HC A03/MF A01

Pilot plant data obtained using a modified single screw grain extruder to facilitate the conversion of raw cellulosic materials into fermentable monosaccharides via acid hydrolysis are analyzed. Cellulose availability and cost, cellulose conversion theory, cellulose conversion performance of extrusion technology, system analysis, and economics are discussed. DOE

N82-29610# Bendix Corp., Englewood, Colo. Office of Energy, Environment, and Technology.

DEVELOPMENT OF A LOW COAL, AUTOMATED REMOTE CONTROLLED RESIN CARTRIDGE INSERTER, ROOF BOLT SPIN/THRUST/HOLD ASSEMBLY Final Technical Report

A. F. EMS Oct. 1981 180 p refs
(Contract DE-AC22-76ET-13348; ET-76-C-01-8933; BM-H0-262028)
(DE82-003733; DOE/ET-13348/T1) Avail: NTIS HC A09/MF A01

A bolter module that performs all functions required to install resin grouted roof bolts in low coal was developed and tested. Design concepts were established and the system effects of module installation on a variety of existing roof bolters, continuous miners, and emerging miner/bolters were studied. The design was accomplished. The fabrication, assembly, checkout, and initial laboratory test of the module was completed. Tests provided initial reliability data and improvement information. Extended testing was performed to provide reliability and maintenance performance data and information for further module improvements. Phase VI consisted of the organization and analyses of the test data was organized and analyzed. Operational and reliability improvements based upon the test data and the design work required for module mounting to the GFE multipurpose test chassis for underground test was implemented. DOE

N82-29673# California Univ., Berkeley. Lawrence Berkeley Lab. Earth Sciences Div.

EARTH SCIENCES DIVISION PROGRAMS Annual Report, 1980

Jul. 1981 262 p refs
(Contract W-7405-ENG-48)
(DE82-000804; LBL-12100) Avail: NTIS HC A12/MF A01

The highlights of programs in Earth sciences are presented under four headings; geosciences, geothermal energy development, nuclear and marine sciences. Basic and applied research in a wide spectrum of topics are utilized. The programs provide results that will be of value in helping to secure the nation's energy future. Separate abstracts have been prepared for each project for inclusion in the Energy Data Base. DOE

N82-29679# Bituminous Coal Research, Inc., Monroeville, Pa. **LONGWALL DATA BANK Semiannual Project Report, 28 May - 28 Nov. 1981**

Dec. 1981 90 p
(Contract DE-AC01-81FE-00080)
(DE82-005090; DOE/FE-00080/2; BCR-L-1260) Avail: NTIS HC A05/MF A01

Progress is reported in compiling and transferring to the coal industry comprehensive longwall operational data representing 95% of the US longwall installations as well as presenting abstracts of domestic and foreign literature published since 1975 related to longwall production, productivity, and dust control. The literature search was completed, except for an ongoing review of weekly

abstract publications. Working cards were completed for the comprehensive index file for all longwall publications of interest; and abstracts were prepared for selected longwall publications. Revised questionnaire forms, with information from the original questionnaires, were forwarded for updating to nearly all companies presently in the questionnaire file. Selected operational data were tabulated and compared. DOE

N82-29680# High Life Helicopters, Inc., Puyallup, Wash. **AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY, JORDON QUADRANGLE, MONTANA Final Report**

1981 154 p refs Prepared in cooperation with QEB, Inc., Lakewood, Colo. 2 Vol.
(Contract DE-AC13-76GJ-01664)
(DE81-025700; GJBX-180-81-VOL-2C) Avail: NTIS HC A08/MF A01

Thirty-one uranium anomalies meet the minimum statistical requirements as defined in Volume I. These anomalies are tabulated and are shown on the Uranium Anomaly Interpretation Map. Anomalies No. 1 to No. 3, and No. 10 to No. 12 are over areas underlain by the Tertiary Fort Union formation (Tfu, Tft, Tfl). The lignites in this formation are commonly uranium-bearing. Anomaly No. 4 is over an area underlain by late Cretaceous Bearpaw Shale (Kb) and Hell Creek formation (Khc). Anomalies No. 5 and No. 6 are over areas underlain by late Cretaceous Bearpaw Shale (Kb). Anomaly No. 7 is over an area underlain by late Cretaceous Bearpaw Shale (Kb) and Fox Hills Sandstone (Kfh). Anomalies No. 8, No. 14 to No. 16, and No. 23 to No. 30 are over areas underlain by late Cretaceous Bearpaw Shale (Kb). Anomaly No. 9 is over an area underlain by late Cretaceous Fox Hills Sandstone (Kfh). Anomalies No. 13 and No. 20 are over areas underlain by the late Cretaceous Hell Creek formation (Khc) and the Tertiary Fort Union formation (Tfu). The lignite seams in both these formations are commonly uranium-bearing. Anomalies No. 17 to No. 18, and No. 21 are over areas underlain by the late Cretaceous Hell Creek formation (Khc). Lignite seams in this formation are commonly uranium-bearing. Anomaly No. 19 is over an area underlain by the Tertiary Fort Union formation (Tfu). The lignite seams in this formation are commonly uranium-bearing. Anomaly No. 22 is over an area underlain by late Cretaceous Bearpaw Shale (Kb), Fox Hills Sandstone (Kfh), and the Hell Creek formation (Khc). Anomaly No. 31 is over an area underlain by Recent alluvium (Qal). DOE

N82-29681# Western Geophysical Co. of America, Houston, Tex. Aero Service Div.

AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY MEDFORD QUADRANGLE, OREGON Final Report

Apr. 1981 120 p refs 2 Vol.
(Contract DE-AC13-76GJ-01664)
(DE82-005545; GJBX-384-81-VOL-1) Avail: NTIS HC A06/MF A01

Traverse lines were flown in an east-west direction at a line spacing of three miles. Tie lines were flown north-south approximately twelve miles apart. A total of 16,880.5 line miles of geophysical data were acquired, compiled, and interpreted during the survey, of which 2925 line miles are in this quadrangle. These data were acquired to be compiled with and other information in order to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States. DOE

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N82-29683# National Coal Board, London (England). Mining Research and Development Establishment.

FIELD TRIALS WITH A ROADHEADER EQUIPPED WITH A 10,000 PSI WATER JET ASSIST SYSTEM

M. G. TOMLIN Jul. 1981 40 p

(Contract DE-AC01-78ET-13339; ET-78-C-01-3126)

(DE82-010837; DOE/ET-13339/1; TU(81)-10) Avail: NTIS HC A03/MF A01

Field trials at Middleton Mine with a Dosco Mk2A roadheader fitted with a prototype 10,000 psi water jet assist system are described, together with an appraisal of the performance of the equipment used. When cutting an artificially constructed Grindleford sandstone heading, no effect on specific energy requirements or cutting rates were recorded when using jets. Benefits in the reduction, or elimination, of frictional sparking and dust make were, however, observed visually. More encouraging results were obtained when cutting Middleton limestone, especially the weather outer layer of exposed rock. Improved cutting rates were obtained with a high pressure water assistance, coupled with other benefits including increased pick life and reduced machine vibration. It is concluded that, while a 10,000 psi water jet assist system would not be wholly effective in a tough rock such as Middleton limestone, it could be used to good effect in the moderately hard stratas which a Dosco Mk2A cannot, at present, cut efficiently. It is further suggested that the application of jets at higher pressures could give even greater benefits. DOE

N82-29704# South Carolina Energy Research Inst., Columbia. Center for Organic Sediments Research.

PEAT RESOURCE ESTIMATION IN SOUTH CAROLINA Final Report, Year 2

M. HOLMES, M. ANDREJKO, D. CORVINUS, M. TISDALE, and T. J. VIGERSTAD Jan. 1982 101 p refs Prepared in cooperation with South Carolina Univ., Columbia

(Contract DE-FG01-79ET-14694)

(DE82-006852; DOE/ET-14694/T6) Avail: NTIS HC A06/MF A01

The results of the two years of a planned four-year study of the quantity and energy potential of peat in South Carolina is discussed. In this year's survey two activities were undertaken. The first was to visit highly probable peat deposits to confirm the presence of fuel-grade peat. The second was to survey and characterize in more detail the areas judged to be of highest potential as major resources. The factors carrying the greatest weight in the determination of priority areas were: a description of peat deposits in the scientific literature or from discussions with state and federal soil scientists; mention of organic soils on soil maps or in the literature; and information from farmers and other local citizens. DOE

N82-29729# Styrelsen foer Teknisk Utveckling, Stockholm (Sweden).

PRE-PROJECT: ENERGY OUT OF LIQUID MANURE. EXTRACTION OF HEAT OUT OF AN AEROBIC, WET PROCESS OF COMPOSTING IN ORDER TO HEAT TWO MANSIONS

K. A. PETTERSSON Mar. 1981 48 p refs In SWEDISH (DE82-900991; STU-80-4784) Avail: NTIS (US Sales Only) HC A03/MF A01; DOE Depository Libraries

The conditions for the construction of an economical plant of wet composting are considered. Eleven cu. m. oil were saved when 90,000 SEK were invested. By means of a heat pump the temperature was increased to 600 C. The properties of the manure are improved which simplifies the subsequent handling. DOE

N82-29736# Gruy Federal, Inc., Arlington, Va.

POTENTIAL FOR SUBSTITUTION OF GEOTHERMAL ENERGY AT DOMESTIC DEFENSE INSTALLATIONS AND WHITE SANDS MISSILE RANGE

C. A. BAKEWELL and J. L. RENNER Jan. 1982 146 p refs (Contract DE-AC08-80NV-10072)

(DE82-007081; DOE/NV-10072/4) Avail: NTIS HC A07/MF A01

Geothermal resources that can provide substitute energy at defense installations are identified and evaluated. The geologic characteristics and related economics of potential geothermal resources located at or near the installations were estimated. The geologic assessment identified installations with possible geothermal resources and Atlantic coastal plain resource configurations that represented the alternatives available to east coast bases. These locations and resource configurations, were examined to determine the relative economics of substituting potential geothermal energy for part or all of the existing oil, gas, and electrical energy usage. DOE

N82-29765# Fluor Engineers and Constructors, Inc., Irvine, Calif.

ECONOMIC EVALUATION OF THE COPRODUCTION OF METHANOL AND ELECTRICITY WITH TEXACO GASIFICATION-COMBINED-CYCLE SYSTEMS Final Report

R. E. BROWN, R. C. DELANEY, W. W. HSU, R. H. RAVIKUMAR, S. C. SMELSER, and R. STOCK Jan. 1982 229 p refs (Contract EPRI PROJ. 239-2)

(DE82-901983; EPRI-AP-2212) Avail: NTIS HC A11/MF A01

Process and cost reduction options for the production of methanol fuel for peaking and intermediate load generating units are evaluated. Methanol is coproduced with electricity from medium Btu gas generated in an oxygen blown gasification combined cycle (GCC) plant firing Illinois No. 6 coal. The liquid phase methanol process is used in a once through configuration where the unconverted reactor effluent is used for gas turbine fuel. The cost of methanol was determined by first calculating the revenue requirements of GCC plant without methanol coproduction. The methanol coproduction case was then credited with those electricity revenues and the remaining revenues required (in excess of the electricity credit) then represented the revenue requirement for methanol coproduction. DOE

N82-29768# Danmarks Tekniske Bibliotek, Lyngby (Denmark). Fysisk Lab.

BIOGAS OF MANURE AND SLUDGE

F. KRAEMER, J. GUNDERMANN, E. KOFOED, and J. NIELSEN Jan. 1981 128 p refs In DANISH

(DE82-900839; NP-2900839) Avail: NTIS (US Sales Only) HC A07/MF A01; DOE Depository Libraries

Biogas production from farmyard manures and sewage sludges is based on anaerobic processes (methane-bacteria) and aerobic processes (fermentative bacteria). Biogas product has high calorific value and a number of small, pilot-scale and full-scale municipal systems of biogas production is described inclusive technological solutions and cost-benefit analysis. Experience of electric power generators fueled by biogas is evaluated from the view point of competitiveness with other fuels. DOE

N82-29807# Columbia Univ., Palisades, N.Y. Geological Observatory.

COMPREHENSIVE STUDY OF THE SEISMOTECTONICS OF THE EASTERN ALEUTIAN ARC AND ASSOCIATED VOLCANIC SYSTEMS Annual Progress Report, 1 Mar. 1981 - 28 Feb. 1982

K. H. JACOB, E. HAUKSSON, L. R. SYKES, J. DAVIES, L. HOUSE, J. MORL, S. MCNUTT, D. JOHNSON, J. PETERSON, J. HAUPTMAN et al. 1981 82 p refs

(Contract DE-AS02-76ER-03134)

(DE82-005473; DOE/ER-03134/T1) Avail: NTIS HC A05/MF A01

Assessment of the seismic potential for occurrence of great earthquakes in three seismic gaps (Shumagin Islands, Unalaska

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Island, and Yakataga-Kayak regions) was completed. In the best instrumented seismic gap in the Shumagin Islands region, the likelihood for a great earthquake within the next two decades is high. Analysis of earthquake data collected from a telemetered network operated in the Shumagin seismic gap shows near quiescence in the shallow portion of the main thrust zone. High time resolution data (0.01 sec), and wider frequency bandpass data (0.5 to 30 Hz) are being collected. Seismic data for two eruptive sequences of Pavlof volcano were obtained. DOE

N82-29814# Los Alamos Scientific Lab., N. Mex.
SYNTHESIS OF HYDROCARBONS IN THE EARTH'S CRUST
N. E. VANDERBORGH Nov. 1981 6 p refs
(Contract W-7405-ENG-36)
(DE82-007356; LA-8983) Avail: NTIS HC A02/MF A01

An alternative theory for the generation and migration of petroleum is suggested. Considerable evidence supports the conclusion that life processes persist deep within terrestrial and marine environments. Such in vivo processes may survive in photon-free ecologies using mechanisms that both reduce carbon dioxide and oxidize sulfides. These in vivo conversions create petroleum. Author

N82-30120# Los Alamos Scientific Lab., N. Mex.
ANALYSIS OF THERMODYNAMIC DATA FOR METHANE HYDRATES
G. R. B. ELLIOTT Jan. 1982 17 p refs
(Contract W-7405-ENG-36)
(DE82-010843; LA-9035-MS) Avail: NTIS HC A02/MF A01

Data taken over nearly a century, which established pressure-temperature relationships for methane gas over solid methane hydrates, are not adequate to establish the thermodynamic relationships needed for engineering evaluations regarding the potential recovery of methane (natural gas) from natural deposits of solid hydrates. The problems lie in several areas: (1) equilibrium is hard to establish, and hysteresis is observed; (2) composition-pressure-temperature data are unavailable but are needed because the methane hydrates are (at least assumed to be) nonstoichiometric; (3) the data are not as precise as would be desirable; (4) accurate pressure-to-fugacity corrections are not possible for the higher pressure data where the corrections become larger; and (5) the heat-capacity data are needed for evaluation of heats of reaction from pressures for the reaction solid-yields-liquid-plus-gas, but these data are not available except by estimation. It is recommended that better thermodynamic data for pressure-temperature-composition relationships (for example, by isopiestic balance) be evaluated. DOE

N82-30137# Science Applications, Inc., Englewood, Colo.
BETC INFORMATION MANAGEMENT SYSTEM WITH FOCUS ON ROS ESTIMATION Final Report
J. K. WILLOUGHBY, J. A. GARDNER, S. B. HEATH, and M. A. KEHLER Dec. 1981 39 p refs
(Contract DE-AC19-79BC-10032)
(DE82-004695; DOE/BC-10032/43) Avail: NTIS HC A03/MF A01

A special purpose information data base system was designed to support the technical staff in the areas of enhanced oil recovery (EOR) and residual oil saturation estimation (ROS). It is revealed that four basic data types most often required by potential system users are: (1) numeric files; (2) bibliographic citations and abstracts; (3) project information such as schedules and budgets; and (4) reference to persons that are authorities in various relevant topical areas. The need for a unique subject taxonomy and for four different data types resulted in the design of a system that permits the retrieval of information by searching the subject taxonomy, selecting a subject term, or terms, and determining the appropriate data types in one step searching. To accommodate a diverse user group, the system incorporates a range of man/machine interface features including both menu selection and command language capabilities. A numeric and bibliographic production system was implemented and data are loaded, a citation template is developed,

and guidelines for a data base administration function within the Center are developed. DOE

N82-30358# Ontario Research Foundation, Toronto.
SOLVENT RECOVERY FOR THE OIL-AGGLOMERATION COAL-CLEANING PROCESS Final Report
C. H. CHEH Sep. 1981 80 p refs Sponsored by EPRI
(Contract EPRI PROJ. 1840-1)
(DE82-900855; EPRI-CS-2057) Avail: NTIS HC A05/MF A01

Solvent removal and recovery from coal pellets produced by the spherical agglomeration process were studied. Different types of pellets were prepared using an eastern and a western coal and three grades of solvents. Three dryers, namely Turbo, Roto-louvre, and Holo-flite, were selected for laboratory testing to remove the solvent from the pellets. Results showed that all three dryers can evaporate the solvent from the coal pellets to very low levels; however, a large amount of coal fines was generated in the Holo-flite dryer. Superheated steam and simulated flue gas were tested as the driving media to study the drying and recovery of the solvent from the coal pellets. Solvent recovery was found to be very high when superheated steam was used but very poor when simulated flue gas was used. It is recommended that the Turbo dryer, which has been using superheated steam in some of its commercial units, be studied further on a pilot scale. A flow scheme of the pilot plant is proposed. DOE

N82-30359# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT REFINED COAL (SRC) PROCESS: FLUID DYNAMIC BEHAVIOR OF LARGE BUBBLE COLUMNS Interim Report
K. PARIMI Jan. 1982 28 p refs
(Contract DE-AC05-76ET-10104)
(DE82-007660; DOE/ET-10104/39; REPT-560RM162; REPT-53; IR-56) Avail: NTIS HC A03/MF A01

The fluid dynamics of large scale bubble columns were studied. An experimental program to test specific design concepts were devised and design improvements for the SRC-II demonstration plant dissolver were recommended. Existing knowledge in the areas of flow regime, gas holdup and mass transfer, backmixing and solids accumulation is reviewed. DOE

N82-30360# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT REFINED COAL (SRC) PROCESS: COKING OF SRC-2 PROCESS STREAMS. PART 1: COKING CHARACTERIZATION AND COKING METHOD DEVELOPMENT FOR SRC-2 PROCESS STREAMS. PART 2: MICROPROCESS COKING STUDIES AND DATA VERIFICATION AND CORRELATIONS Topical Report, Jan. 1980 - Sep. 1981
C. S. WEN Sep. 1981 141 p refs
(Contract DE-AC05-79ET-10104)
(DE82-005308; DOE/ET-10104/21; REPT-627RM083; REPT-53; IR-44) Avail: NTIS HC A07/MF A01

Characterization of SRC-II process streams and solids with respect to coke formation was studied using methods developed specifically for this purpose, such as solvent fractionation, thermogravimetry, Fourier transform infrared spectroscopy, and scanning electron/optical microscopy. Different process streams were investigated including coal feedstock, feed slurry, dissolver effluent, atmospheric flash bottoms, vacuum tower bottoms, process solvent, recycle slurry, and coke-like materials from dissolver and hot separator as well as a Ft. Lewis dissolver preheater outlet sample. In the solvent fractionation study, solids from the dissolver contained very small amounts of toluene and pyridine solubles. Heavy solid products such as atmospheric flash bottoms and vacuum tower bottoms usually have about 45% wt pyridine insolubles. The amount of fixed carbon plus heavy volatile matter in certain streams appears to give a good correlation with coke formation in continuous pilot plant operations. DOE

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N82-30361# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT REFINED COAL (SRC) PROCESS: SRC 2 PROCESSING OF PITTSBURGH SEAM (IRELAND AND POWHATAN NO. 6 MINES) COAL IN PDU P-99. RUNS P99-77 TO P99-83 Interim Report, Nov. 1980 - Apr. 1981

H. G. MCILVRIED, W. GALL, and S. T. MATHIAS Aug. 1981
240 p refs
(Contract DE-AC05-79ET-10104)
(DE82-004481; DOE/ET-10104/20; REPT-53; IR-43) Avail:
NTIS HC A11/MF A01

The results of seven solvent refined coal-II runs (Runs P99-77 through P99-83) made on Process Development Unit P-99 feeding two Pittsburg Seam coals are presented. The first five runs were made on Ireland Mine coal, while the latter two runs used Powhatan No. 6 Mine coal. Four of these runs (Runs P99-77, -78, -80, and -81) form a 2(2) factorial experiment to investigate the effect of dissolver lift-drag ratio (L/D) ratio and the concentration of 5500F-distillate in the feed slurry on yields. The results of this factorial experiment generally confirm conclusions reported previously: dissolver L/D ratio has little effect on yields over the range of L/D ratio studied; and increasing the amount of light distillate in the feed slurry significantly increases the yield of heavy distillate.

DOE

N82-30363# Pittsburgh and Midway Coal Mining Co., Englewood, Colo. Chemical and Minerals Div.

SOLVENT-REFINED-COAL (SRC) PROCESS. HYDRODYNAMICS AND AXIAL MIXING IN A THREE PHASE BUBBLE COLUMN Interim Report

S. KARA (Pittsburgh Univ.), B. G. KELKAR (Pittsburgh Univ.), Y. T. SHAH (Pittsburgh Univ.), and N. L. CARR (Gulf Research and Development Co., Pittsburgh) Jan. 1982 54 p refs
(Contract DE-AC05-79ET-10104)
(DE82-007255; DOE/ET-10104/28; REPT-53; IR-51) Avail:
NTIS HC A04/MF A01

The hydrodynamics and the mixing properties in a 15.2 cm diameter by 335.3 cm high stainless steel column with three phases (air, water and coal) in cocurrent upflow were studied. The effect of solids particles size, solids concentration, slurry velocity and gas velocity on gas holdup and heat dispersion coefficients were determined. All the experimental data were correlated empirically and the results were compared with other published literature. Theoretical explanations of some results were provided.

DOE

N82-30369# Bergbau-Forschung G.m.b.H., Essen (West Germany). Abteilung Verfahrenstechnik.

CAKING AND COKING POWER OF BITUMINOUS COALS UNDER HIGH PRESSURE Final Report, Apr. 1981

H. D. BEYER Bonn Bundesministerium fuer Forschung und Technologie Apr. 1982 62 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-82-055; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 13

The caking and coking power of bituminous coals, characterized by the swelling index (DIN 51 741, ISO 501) and the dilatometer test (DIN 51 739), respectively, were studied at high pressures. In the context of the further development of coal gasification processes, pressures up to 100 bar were considered. Pressure devices were developed in which swelling index and dilatation can be measured at pressures up to 100 bar under the geometric and thermal conditions required for standard methods. Pressure, heating rate, coal grain size and gas atmosphere (Ar and H₂) were varied apart from the coal type in the course of the measurements. The measurements show swelling index and dilatation may decrease, may sometimes increase or increase first followed by a decrease at higher pressures. Therefore, it is in general not possible to establish relationships according to which the data characterizing caking and coking power can be calculated on the basis of the data obtained under standard conditions. For this reason, the prediction of caking and coking power of feed coals in coal refining processes, working under pressure, requires

measurements conducted under the envisaged operating pressure. The developed pressure devices are suited for this purpose and can be used on a routine basis.

Author (ESA)

N82-30413# Committee on Science and Technology (U. S. House).

SYNTHETIC FUELS ENVIRONMENTAL RESEARCH AND DEVELOPMENT

Washington GPO 1982 238 p refs Hearing before the Subcomm. on Energy Develop. and Appl. and the Subcomm. on Nat. Resources, Agr. Res. and Environ. of the Comm. on Sci. and Technol., 97th Congr., 1st Sess., no. 65, 1 Oct. 1981
(GPO-89-263) Avail: Subcommittee on Energy Development and Applications

The environmental effects of process streams from synthetic fuels plants and process improvements being investigated to minimize the presence of hazardous materials in the process streams are reviewed. The environmental protection research being performed by industry, measures for the protection and monitoring of worker health, and what industry sees as the major developmental unknowns in synthetic fuels process development were discussed. The benefits and limitations of federal research and development programs in the Department of Energy and the Environmental Protection Agency were considered. Recommendations for the improvement of these programs for the benefit of both the public health and the synthetic fuels industry were presented.

J.D.

N82-30415# Studsvik Energiteknik A.B., Nykoping (Sweden). **BIOPULVER - BIOMASS POWDER. A TECHNICAL AND ECONOMIC COMPARISON WITH OTHER FUELS**

P. JANSON and K. SEGERUD Oct. 1980 104 p In SWEDISH
(DE82-901027; STUDEVIK-EP-80-23) Avail: NTIS (US Sales Only) HC A06/MF A01; DOE Depository Libraries

The techniques and cost of the manufacture, distribution, and use of biomass powder are discussed parallel to competitive fuels. A comparison is made, projected to around the year 1990. Biomass powder seems to become competitive in large boilers of 0.5 - 5 Mw which have short operating cycles and must be controlled. The ability to compete with other fuels is judged to be best in the regions with a good supply of straw.

DOE

N82-30418# Department of Energy, Bartlesville, Okla. Energy Technology Center.

LIQUID FOSSIL FUEL TECHNOLOGY Quarterly Technical Progress Report, Jan. - Mar. 1981

B. LINVILLE, ed. Aug. 1981 70 p refs
(DE82-003270; DOE/BETC/QPR-81/1) Avail: NTIS HC A04/MF A01

Liquid fossil fuel cycle is discussed. Extraction techniques which are subdivided into resource assessment and production, liquid processing which includes characterization of liquids from petroleum, coal, shale and other alternate sources, thermodynamics and process technology; utilization; and project intergration and technology transfer are summarized.

DOE

N82-30420# Exxon Research and Engineering Co., Linden, N.J. Systems Advancement and Transfer Div.

FUNDAMENTAL CHARACTERIZATION OF ALTERNATE-FUEL EFFECTS IN CONTINUOUS-COMBUSTION SYSTEMS Quarterly Progress Report, 1 Jul. - 30 Sep. 1981

R. M. KOWALIK and L. A. RUTH Oct. 1981 11 p
(Contract DE-AC22-77ET-11313)
(DE82-002946; DOE/ET-11313/8) Avail: NTIS HC A02/MF A01

The overall objective of this research program is to assist in the development of fuel-flexible combustion systems which can accommodate future alternate fuels derived from non-petroleum resources, with particular emphasis on liquid hydrocarbon fuels and gas turbine combustors. The program is divided into coordinated experimental and analytical efforts. The objectives of the experimental program are to obtain an improved understanding of the relationships among soot production, fuel nitrogen

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conversion, fuel properties, and combustor operating conditions in highly backmixed systems and to provide a data base for the development of corresponding analytical models/correlations. The approach has been to study soot production and fuel nitrogen conversion processes in several jet-stirred combustors. The objective of the analytical program is to provide modeling/correlation capabilities which can be used as design aids for the development of fuel-tolerant combustion systems.

DOE

N82-30591# Oak Ridge National Lab., Tenn. **DEVELOPMENT OF PROCESSES FOR RECOVERY OF MINERALS FROM EASTERN SHALE**

I. SPIEWAK, T. M. GILLIAM, and M. D. SILVERMAN 1981 19 p refs Presented at the IGT Symp. on Syn. Fuels from Oil Shale II, Nashville, 26 Oct. 1981

(Contract W-7405-ENG-26)

(DE82-002872; CONF-811054-2) Avail: NTIS HC A02/MF A01

Eastern oil shales contain low concentrations of many potentially important metals, including aluminum, chromium, cobalt, iron, molybdenum, nickel, uranium and zinc. It is indicated that the minerals present in retort residues can be leached using sulfuric or hydrochloric acid. The retorting process and posttreatment by roasting affects the dissolution rate of various elements. The recovery of commercially useful materials such as alumina, cobalt, molybdenum and uranium from these solutions is complex and needs further investigation. It is found that minerals recovery from retort residues may be economically justified and may provide environmental benefits.

GRA

N82-30592# Oak Ridge National Lab., Tenn. Energy Div. **LAND-AND RESOURCE-USE ISSUES AT THE VALLES CALDERA**

P. R. INTEMANN 1981 10 p refs Presented at the Geothermal Resources Council Ann. Meeting, Houston, Texas, 25-29 Oct. 1981 Submitted for publication

(Contract W-7405-ENG-26)

(DE82-002726; CONF-811015-17) Avail: NTIS HC A02/MF A01

The Valles Caldera which processes a wealth of resources are described. Among the most significant of these are the geothermal energy resource and the natural resource. Wildlife, scenic, and recreational resources are considered components of the natural resource. The use of land in the caldera to achieve the full benefits of one resource may adversely affect the value of other resources. Measures can be taken to minimize adverse affects and to maximize the benefits of all the varied resources within the caldera as equitably as possible.

GRA

N82-30593# California Univ., Livermore. Lawrence Livermore Lab.

LAWRENCE LIVERMORE NATIONAL LABORATORY OIL PROJECT Quarterly Report, Jul. - Sep. 1980

J. F. CARLEY, ed. 2 Nov. 1981 16 p refs

(Contract W-7405-ENG-48)

(DE82-003643; UCID-16986-81-3) Avail: NTIS HC A02/MF A01

A preliminary process flowsheet for a countercurrent, above ground gas combustion retort system was developed and used to calculate the mass and energy balances for a 50,000-bbl/d shale oil plant. The ability of Campbell's kinetic model to predict gas evolution during pyrolysis of Colorado oil shales was tested. Losses of S during combustion of retorted shale and the reaction of char burned were determined. Leaching of oxidized shale in water removed Ca and Mg sulfates.

E.A.K.

N82-30594# Department of Energy, Pittsburgh, Pa.

DEMONSTRATION OF LONGWALL MINING IN THIN SEAMS

E. A. CURTH and J. A. GILL (Leeco, Inc.) 1981 39 p refs Presented at the 110th AIME Ann. Meeting, Chicago, 22 Feb. 1981

(DE82-000130; CONF-810203-15) Avail: NTIS HC A03/MF A01

The Government and Leeco concluded a cost-sharing agreement in 1976 to demonstrate longwall mining of a thin coalbed, 1 m or less, in a mine near Hyden, Ky. A premining

investigation laid the groundwork for mine design and equipment specifications. Four-legged shields, a face conveyor, a stage loader and an in-web shearer were selected to operate on a 183 m face. Longwall mining began in 1979 and initially was slowed by low mining height and equipment problems. A rock mechanics program provides early warning capability and criteria for future mine design. Monitoring of surface effects is included.

DOE

N82-30596# Gruy Federal, Inc., Houston, Tex. **EASTERN GAS SHALES PROJECT: OFFSET WELL TESTING PROGRAM. INTERFERENCE TESTING OF COLUMBIA GAS TRANSMISSION CORP., WELLS 1066A AND 10056B, MEIGS COUNTY, OHIO Final Report**

A. RDISSI and J. H. GOODRICH Oct. 1981 18 p

(Contract DE-AC21-81MC-16120)

(DE82-002036; DOE/MC-16120/T1) Avail: NTIS HC A02/MF A01

The objective is to quantitatively determine variations in reservoir pressure performance between a control well and two offset wells prior to and after microstimulation of the borehole. Field operations generally proceeded smoothly despite relatively complicated downhole equipment in the offset wells in which bottomhole pressures were monitored from three separate zones in the shals separated by three Lynes inflatable packers. This was the first time that this type of temporary completion was attempted in the eastern United States. Two failures of the electrical cable that transmitted pressure signals in well A and three packer failures in well A were the only mechanical problems encountered. These failures were quickly remedied and the tests were successfully concluded.

DOE

N82-30597# Sandia Labs., Albuquerque, N. Mex. SPR Geotechnical Div.

STRATEGIC PETROLEUM RESERVE (SPR) GEOLOGICAL SITE CHARACTERIZATION REPORT, BIG HILL SALT DOME

R. J. HART, T. S. ORTIZ, and T. R. MAGORIAN Sep. 1981 174 p refs

(Contract DE-AC04-76DP-00789)

(DE82-001834; SAND-81-1045) Avail: NTIS HC A08/MF A01

The Big Hill Salt Dome were analyzed to determine its suitability for use in the strategic petroleum reserve (SPR). Objectives are to: (1) acquire, evaluate, and interpret existing data pertinent to geological characterization of the Big Hill Dome; (2) characterize the surface and near surface geology and hydrology; (3) characterize the geology and hydrology of the overlying cap rock; (4) define the geometry and geology of the dome; (5) determine the feasibility of locating and constructing 14 10 MMB storage caverns in the south portion of the dome; and (6) assess the effects of natural hazards on the SPR site.

GRA

N82-30600# Texas A&M Univ., College Station.

FLUID TREATMENT FOR STIMULATION OF RESERVOIR SANDSTONES AND ENHANCED RECOVERY OF OIL AND GAS Final Report

W. H. HUANG Jun. 1981 12 p

(Contract DE-FG03-78ET-13405; ET-78-G-01-3307)

(DE82-001821; DOE/ET-13405/T1) Avail: NTIS HC A02/MF A01

Fluid treatment techniques which by means of well stimulation, is most effective in old producing sand wells with low permeability and which are severely damaged was studied. The productivity of these wells may be enhanced and restored to their original levels through stimulation with alkaline solution under specific unique conditions. It is shown that the original permeability of the reservoirs is restored or increased after damaged by brine solution.

GRA

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N82-30601# Bureau of Mines, Washington, D. C. Div. of Production/Consumption Data Collection and Interpretation.

MINERAL INDUSTRIES OF LATIN AMERICA Mineral Perspective Report

O. MARTINO, D. HYDE, and P. VELASCO Dec. 1981 128 p (PB82-161001; LC-79-607095) Avail: NTIS HC A07/MF A01 CSCL 081

The mineral industries of about 34 countries and areas in the Latin American region of the Western Hemisphere are summarized. Mineral reserves, production, international mineral trade, and the role of minerals within each country and in terms of world supply are reviewed in text and tables. The principal mining companies are listed, and basic information is presented on labor, energy, and transportation, relative to the mineral industries. Base maps for each country or area show the location of major mines, oilfields and gasfields, and plant facilities--including iron and steel works, nonferrous smelters and refineries, and cement plants. Maps also show major roads pipelines, railways, and ports that are important to mineral transportation and trade. GRA

N82-30704*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

LEWIS PRESSURIZED, FLUIDIZED-BED COMBUSTION PROGRAM. DATA AND CALCULATED RESULTS

R. J. ROLLBUHLER Mar. 1982 63 p refs (NASA-TM-81767; E-830; NAS 1.15:81767) Avail: NTIS HC A04/MF A01 CSCL 10B

A 200 kilowatt (thermal), pressurized, fluidized bed (PFB) reactor and research test facility were designed, constructed, and operated. The facility was established to assess and evaluate the effect of PFB hot gas effluent on aircraft turbine engine materials that may have applications in stationary powerplant turbogenerators. The facility was intended for research and development work and was designed to operate over a wide range of conditions. These conditions included the type and rate of consumption of fuel (e.g., coal) and sulfur reacting sorbent material; the ratio of feed fuel to sorbent material; the ratio of feed fuel to combustion airflow; the depth of the fluidized reaction bed; the temperature and pressure in the reaction bed; and the type of test unit that was exposed to the combustion exhaust gases. S.L.

N82-30717*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CATALYTIC COMBUSTION OF ACTUAL LOW AND MEDIUM HEATING VALUE GASES

D. L. BULZAN 1982 19 p refs Presented at the Joint Power Generation Conf., Denver, 17-21 Oct. 1982 (Contract DE-A101-77ET-10350)

(NASA-TM-82930; E-1326; DOE/NASA/10350-34; NAS 1.15:82930) Avail: NTIS HC A02/MF A01 CSCL 10A

Catalytic combustion of both low and medium heating value gases using actual coal derived gases obtained from operating gasifiers was demonstrated. A fixed bed gasifier with a complete product gas cleanup system was operated in an air blown mode to produce low heating value gas. A fluidized bed gasifier with a water quench product gas cleanup system was operated in both an air enriched and an oxygen blown mode to produce low and medium, heating value gas. Noble metal catalytic reactors were evaluated in 12 cm flow diameter test rigs on both low and medium heating value gases. Combustion efficiencies greater than 99.5% were obtained with all coal derived gaseous fuels. The NOx emissions ranged from 0.2 to 4 g NO2 kg fuel. E.A.K.

N82-30739# California Univ., Berkeley. Lawrence Berkeley Lab. Earth Sciences Div.

SIMPLE MODEL FOR FAULT-CHARGED HYDROTHERMAL SYSTEMS

G. S. BODVARSSON, C. W. MILLER, and S. M. BENSON Jun. 1981 7 p refs Presented at the Ann. Meeting of the Geothermal Resources Council, Houston, Texas, 5-8 Oct., 1981 (Contract W-7405-ENG-48)

(DE82-001008; LBL-12869) Avail: NTIS HC A02/MF A01

A two dimensional transient model of fault-charged hydrothermal systems was developed. The model is used to analyze temperature data from fault charged hydrothermal systems, estimate the recharge rate from the fault, and determine how long the system is under natural development. The model can also be used for theoretical studies of the development of fault controlled hydrothermal systems. The model was tentatively applied to a low temperature hydrothermal system. A reasonable match was obtained with the observed temperature data, and a hot water recharge rate of .0000009 cu m/s.m was calculated. Author

N82-30743# Ames Lab., Iowa.

FOSSIL-ENERGY Quarterly Report, 1 Apr. - 30 Jun. 1981

Aug. 1981 54 p (Contract W-7405-ENG-82)

(DE82-003213; IS-4775) Avail: NTIS HC A04/MF A01

Progress in the following areas of fossil energy is reported: physiochemical cleaning and recovery of fine coal; a systematic investigation of the organosulfur components in coal; microstructures of coal; rapid analysis of mineral content in coal; coal blending experiments; performance characteristics of heavy media cyclones using fly ash derived heavy media; briquetting solvent treated coal; and coal preparation and testing. GRA

N82-30751# Sandia Labs., Albuquerque, N. Mex.

ADVANCED TECHNOLOGY FOR IN SITU TECHNOLOGY AND FOSSIL ENERGY

R. K. TRAEGER 1981 14 p Presented at the Showcase for Technol. Conf., Albuquerque, N. Mex., 28 Oct. 1981 (Contract DE-AC04-76DP-00789)

(DE82-001315; SAND-81-2222C; CONF-811018-2) Avail: NTIS HC A02/MF A01

The technological capabilities and programs carried out at universities and national laboratories in new Mexico in the areas of exploration, drilling and mining, recovery processes, conversion processes, diagnostics, and environmental effects of fossil energy resource development are discussed. DOE

N82-30754# Sandia Labs., Albuquerque, N. Mex. Geothermal Technology Development Div.

GEOTHERMAL TECHNOLOGY DEVELOPMENT PROGRAM Quarterly Progress Report, Apr. - Jun. 1981

J. R. KELSEY, ed. Oct. 1981 69 p refs

(Contract DE-AC04-76DP-00789) (DE82-003110; SAND-81-2093) Avail: NTIS HC A04/MF A01

The Geothermal technology development program is described. Special attention is given to the ongoing research in rock penetration mechanics, fluid technology, borehole mechanics, and diagnostics technology. L.F.M.

N82-30755# BDM Corp., Albuquerque, N. Mex.

GEOTHERMAL WELLS: A FORECAST OF DRILLING ACTIVITY

G. L. BROWN, A. J. MANSURE, and J. N. MIEWALD Jul. 1981 65 p refs

(Contract DE-AC04-76DP-00789) (DE82-003109; SAND-81-7127; BDM/TAC-80-557-TR-R2) Avail: NTIS HC A04/MF A01

Numbers and problems for geothermal wells expected to be drilled in the United States between 1981 and 2000 AD are forecasted. The 3800 wells forecasted for major electric power projects (totaling 6 GWe of capacity) are categorized by type (production, etc.), and by location (The Geysers, etc.). 6000 wells are forecasted for direct heat projects (totaling 0.02 Quads per

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year). Equations are developed for forecasting the number of wells, and data is presented. Drilling and completion problems in The Geysers, The Imperial Valley, Roosevelt Hot Springs, the Valles Caldera, northern Nevada, Klamath Falls, Reno, Alaska, and Pagosa Springs are discussed. Likely areas for near term direct heat projects are identified. DOE

N82-30757# Westinghouse Electric Corp., East Pittsburgh, Pa. Research and Development Center.

AIR/GAS SYSTEM DYNAMICS OF FOSSIL-FUEL POWER PLANTS, VOLUME 5. SYSTEM EXCITATION SOURCES Interim Report, Oct. 1981

F. R. GOLDSCHMIED, D. N. WORMLY, and D. ROWELL Oct. 1981 209 p refs Prepared in cooperation with MIT 5 Vol. (Contract EPRI PROJ. 1651) (DE82-900878; EPRI-CS-1444-VOL-5) Avail: NTIS HC A10/MF A01

Combustion air/flue gas system dynamic problems in fossil fuel power plants involving significant pressure and flow dynamic variations are addressed. A computer based mathematical model was used to study system stability, surging and transient response to changes in damper settings and disturbances generated by fans and other equipment. Low frequency periodic oscillations resulting from air preheater rotation and higher frequency disturbances resulting from forced draft induced draft and recirculation fans were identified. Significant disturbances were found at frequencies corresponding to fan rotation speed and its harmonics, including blade passage frequency. The fan was operated at flows corresponding to and less than the peak efficiency point, and a disturbance associated with rotating stall at a frequency of approximately two thirds of rotation frequency was produced. GRA

N82-30761# Kinetics Technology International G.m.b.H., Hamburg (West Germany).

COAL FIRING OF PROCESS HEATERS Final Report, Oct. 1980

W. BALTHASAR, J. SCHOEDEL, R. RUGGIERI, and J. VANRIJNSOEVER Bonn Bundesministerium fuer Forschung und Technologie Apr. 1982 67 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-056; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 13,50

Coal firing as a standard practice was reviewed. With the recent resurgence of coal utilization, coal firing of modern process furnaces was studied in light of significant developments in boiler design. A process heater for coal firing was designed and results were compared with oil fired units. Typical furnaces with oil firing of recent manufacture were used. Results show that furnaces can be built with coal firing under various design philosophies, but all of them are more expensive than for oil firing. All these analyses do not even include coal storage, grinding and feed as well as dust collection and flue gas treatment. Hence, coal firing of process furnaces is far too expensive. Author (ESA)

N82-30767# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

AQUACULTURE FACILITY POTENTIAL AT BOULDER HOT SPRINGS, BOULDER, MONTANA

J. G. KELLER Nov. 1981 20 p refs (Contract DE-AC07-76ID-01570) (DE82-005244; EGG-GTH-5512; GTA-REPT-1) Avail: NTIS HC A02/MF A01

The potential of using geothermal water to develop a commercial aquaculture facility to raise channel catfish at Boulder Hot Springs, Montana is examined. Maximum catfish growth occurs in water with a temperature from 800 F to 850 F. This temperature can be maintained when the 1750 F geothermal water is mixed with the available 550 F water. The only economically viable culture considered was the raceway culture. The 4000 gpm supply of

550 F water could supply 7 to 8 raceways with a total production of 269,000 to 307,000 pounds of catfish per year. DOE

N82-31101# National Center for Resource Recovery, Washington, D. C.

PROPOSED DRAFT DOCUMENT FOR GSA OFFICE WASTE REMOVAL AND PROCUREMENT OF DENSIFIED REFUSE DERIVED FUEL FOR USE AS A SUPPLEMENTAL FUEL IN GAS OPERATED BOILERS

J. A. CAMPBELL Sep. 1981 90 p refs Sponsored in part by Army (Contract DE-AC01-76CS-20167) (DE82-002000; DOE/CS-20167/8) Avail: NTIS HC A05/MF A01

A contract specifying waste collection and disposal from buildings managed by Government Services Administration (GSA) in the Washington, D. C. area and the production and delivery of pelletized fuel for burning with coal in one or two GSA steam generating plants is given. DOE

N82-31104# General Atomic Co., San Diego, Calif.

HIGH-TEMPERATURE GAS-COOLED REACTOR FOR PROCESS-HEAT APPLICATIONS

R. N. QUADE and C. F. MCDONALD Jul. 1981 12 p refs Presented at the ASME Winter Ann. Meeting, Washington, D.C., 11-15 Nov. 1981

(Contract DE-AT03-76SF-70046) (DE81-029133; GA-A-16395; CONF-811101-8) Avail: NTIS HC A02/MF A01

The high temperature gas cooled reactor (HTGR) offers a unique heat source for process heat applications because its operating temperature is substantially higher than operating temperatures of other nuclear reactor types. The HTGR is being evaluated for reactor core outlet temperatures of 750, 850, and 950 C. The 750 C nuclear heat source design represents one that can be used in a near term deployment strategy and can be coupled to a variety of process heat applications. The 850 C design allows an even larger penetration into the process heat market and can be applied to a number of processes for the production of synthetic fuels. The longer term HTGR design with outlet coolant temperatures of 950 C and above permits the attainment of the full potential of the HTGR as a heat source. A transitional deployment strategy for the various HTGR designs is described. DOE

N82-31156# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ACQUISITION OF WIND RIGHTS FOR WIND ENERGY DEVELOPMENT

R. J. NOUN Nov. 1981 12 p refs Presented at the 5th Bien. Wind Energy Workshop, Washington, D.C., 5-7 Oct. 1981 (Contract DE-AC02-77CH-00178; EG-77-C-01-4042)

(DE82-001545; SERI/TP-211-1421; CONF-811043-5) Avail: NTIS HC A02/MF A01

Identifying suitable sites for large wind machine clusters, or wind farms, requires more than finding a location with an adequate wind resource. Consideration must also be given to the question of how land use policies and regulations will affect the siting of wind system installations. In particular, the issue of acquiring wind rights, or guaranteed access to the wind resource for electric power generation, will be vital to the development of wind energy. This paper examines several methods for acquiring and preserving access to the wind resource and for dealing with related land use issues. DOE

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N82-31465# Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.

ROLE OF TEMPERATURE, SOLVENT, AND AGITATION IN COAL DISSOLUTION AND LIQUEFACTION Quarterly Report, Sep. - Nov. 1981

D. E. BRIGGS and S. EBNESAJJAD Dec. 1981 45 p refs
(Contract DE-FG22-81PC-40811)
(DE82-000015; DOE/PC-40811/1) Avail: NTIS HC A03/MF A01

The role of temperature, solvent character and agitation in the dissolution and liquefaction of bituminous coal was studied. If any of the coal is peptized or dissolved at 3400 C, it becomes pyridine insoluble upon cooling. Few or no chemical bonds are broken. Up to 90% of the DMMF coal becomes pyridine soluble when heated to 4000 C in the given solvent mixture. A minimum rotation rate is required to keep the coal particles suspended with the propeller/impeller. Below the rotation rate, some coal particles settle to the bottom of the reactor and pyrolyze causing unusually high gas formation and the appearance of exothermic peaks in the temperature profile. Dissolution yield remains unchanged when rotation rate is increased beyond the value required for complete suspension of coal particles and adequate heat transfer at the reactor surfaces. The onset temperature of dissolution of Kentucky No. 9 coal lies in the range of 355 to 3750 C. It is marked by the onset of gas formation. While dissolution is rapid at 4000 C, it does not occur to any appreciable extent at temperatures below 3700 C. DOE

N82-31466# Auburn Univ., Ala. Coal Conversion Lab.
STUDIES IN COAL LIQUEFACTION WITH APPLICATION TO THE SRC AND RELATED PROCESSES Quarterly Report, Nov. 1980 - Jan. 1981

J. A. GUIN and C. W. CURTIS 1981 83 p refs
(Contract DE-AC22-79ET-13397)
(DE82-010868; DOE/ET-13397/9; FE-3397-9) Avail: NTIS HC A05/MF A01

The nature and importance of gas-liquid mass transfer in coal liquefaction is assessed. Different processes in coal liquefaction were studied. A method for ascertaining and eliminating locally unenhanced regions in a stirred vessel using gas absorption with chemical reaction is discussed. Gas-Liquid mass transfer was found to be important to the quality of liquids made from coal. The reduction of the iron sulfates, szmolnokite and coquimbite, to pyrrhotite during coal liquefaction is examined. The effect of temperature, gas, and solvent type on the evolution of a known coal particle size distribution during liquefaction is discussed. The particle size distribution changes in various ways depending on the process conditions, as the particles dissolve. The nature of rhodium dispersed on an Al₂O₃ support as determined by IR is reported. This system (Rh-Co-Al₂O₃) was used to calibrate a vacuum adsorption/IR apparatus which is utilized to study coal liquefaction sorbate molecules on coal mineral catalysts, in conjunction with their reactivity. DOE

N82-31467# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT-REFINED-COAL (SRC) PROCESS. REPORT ON THE SRC-2 PROCESS COST MODEL. A. SRC-2 PROCESS COST MODEL. B. COMPARISON OF THE 11% TO 16% ASH COALS USING THE SRC-2 PROCESS COST MODEL Interim Report

T. HAND Feb. 1982 109 p refs
(Contract DE-AC05-76ET-10104)
(DE82-010423; DOE/ET-10104/30; RDR-53; IR-53) Avail: NTIS HC A06/MF A01

The SRC-II Process Cost Model was used to quantify the advantage of higher yields of fuel products into economic terms for a commercial-sized SRC-II plant. The study consists of two parts: part 1, SRC-II process cost model, and part 2, Comparison of 11% to 16% Ash Coals Using the SRC-II process cost model. Part 1 describes the cost model itself, which evaluates the comparative economics of process alternatives planning for future R, and D efforts under the SRC-II program. The model is a computerized economic model of the SRC-II commercial process.

It is a modular, flow oriented model that estimates the capital investment, operating costs, and product slate for the SRC-II process as a function of the process design. Part 2 describes a comparative economic study using the SRC-II process cost model to quantify the benefits of cleaning Ireland coal to an 11% ash content versus a 16% ash content. The 11% ash coal gives higher yields of fuel products than the 16% ash coal when fed to the SRC-II process development unit P-99. DOE

N82-31469# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT-REFINED-COAL (SRC) PROCESS: PREPILOT SRC-2 DEVELOPMENT PROJECT FEED COAL EFFECTS ON KINETICS TASK. VOL. 5: RESEARCH AND DEVELOPMENT TECHNICAL SUPPORT PROGRAMS, PART 2, PREPILOT STUDIES

N. L. CARR, M. E. PRUDICH, and W. G. MOON Feb. 1982 113 p refs
(Contract DE-AC05-76ET-10104; DE-AC05-79ET-10104)
(DE82-007759; DOE/ET-10104/23; RDR-53; IR-46) Avail: NTIS HC A06/MF A01

The processing of two different coals and a binary mixture thereof are discussed, as well as the kinetics of coal liquefaction. The two coals included an Ireland mine (high reactivity) coal and a Blacksville mine (low reactivity) coal. Feed coal type was found to have a definite effect on the process kinetics with the Ireland coal being extremely sensitive to changes in the operating variables and Blacksville coal behaving in an almost invariant manner. It was determined that the effect of blending feed coals at constant processing conditions can be characterized by a simple, unweighted, linear averaging rule. Model were developed to correlate the yield responses with the variables which were examined. DOE

N82-31477# Spectron Development Labs., Inc., Costa Mesa, Calif.

EXPERIMENTAL INVESTIGATION OF SYN FUEL SPRAY CHARACTERISTICS AND COMBUSTION DYNAMICS Quarterly Technical Progress Report, 1 Jul. - 30 Sep. 1981

Oct. 1981 37 p refs
(Contract DE-AC22-80PC-30299)
(DE82-010788; SDL-82-2176-24Q) Avail: NTIS HC A03/MF A01

Spray formation with petroleum based fuels was studied. The fuel heating system was modified to provide well controlled temperatures up to 1320 C with No. 6 fuel oil. A simplex and a two fluid atomizing injector with No. 6 fuel oil were tested. Assembly of a traverse system for the Droplet Sizing Interferometer (DSI), installation and alignment of the DSI, and initiation of spray characterization measurements were studied. The monodisperse droplet combustion facility was assembled and operated without a droplet stream. A pulsed droplet ejection (ink jet) device for the generation of a monodisperse droplet stream is developed. A design of a droplet generator is completed and the procurement of parts is initiated. DOE

N82-31478# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT-REFINED-COAL (SRC) PROCESS: MOLECULAR SIEVE DRIER TESTS ON PDU P-99, VOLUME 6, PROCESS DEVELOPMENT UNIT WORK, PART 3, ENGINEERING STUDIES Interim Report, Apr. - Aug. 1981

J. A. GRAY, J. G. IANTORNO, and W. GALL Feb. 1982 49 p refs
(Contract DE-AC05-76ET-10104)
(DE82-011202; DOE/ET-10104/37; RDR-53; IR-62) Avail: NTIS HC A03/MF A01

A molecular sieve (Type 3A) drier system was installed on PDU P-99 for testing. During 70 h of continuous operation, three drying and two regeneration cycles were completed. The drier processed bleed off gas at unit pressure and ambient temperature in tandem with the butane scrubber. High pressure hydrogen regenerated the molecular sieve adsorbent at 5000 F. The results

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were in good agreement with the predicted performance, and the apparatus operated with minimum difficulty. DOE

N82-31479# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT-REFINED-COAL (SRC) PROCESS. PREPILOT SRC-2 DEVELOPMENT PROJECT: HYDROGEN MASS-TRANSFER STUDY Interim Report, Feb. - Sep. 1981

N. L. CARR, W. E. KING, JR., and W. G. MOON Feb. 1982 44 p refs
(Contract DE-AC05-76ET-10104)
(DE82-010772; DOE/ET-10104/22; RDR-53; IR-45) Avail: NTIS HC A03/MF A01

The experiments performed on the A-1 Unit to investigate hydrogen mass transfer effects in SRC-II coal liquefaction reactors are summarized. An Ireland coal was investigated for the effects of mixing energy level, method of hydrogen introduction, and hydrogen treat rate. Powhatan No. 6 coal was investigated for the effect of mixing energy level. It is indicated that below a mixing energy level corresponding to 400 rpm a significant cement like solid deposition within the reactor occurs. Below this mixing energy level the C5() liquid yield decreases, and the selectivity of the reaction changes, resulting in an increase in the C1-C4 yield. Increasing the preheater hydrogen flow from 4 to 6 q of H₂/100 g of slurry prevented the formation of solid deposits at a mechanical mixing energy level as low as that corresponding to 200 rpm. The highest C5() yield in the entire data set occurred when the preheater hydrogen flow was at the higher level. DOE

N82-31489# Montana State Univ., Bozeman. Dept. of Chemical Engineering.

CATALYTIC HYDROGENATION OF COAL-DERIVED LIQUIDS Interim Report, Sep. - Nov. 1981

L. BERG and F. P. MCCANDLESS Dec. 1981 49 p refs
(Contract DE-AC22-76ET-10495; EX-76-C-01-2034)
(DE82-007910; DOE/ET-10495/T4; FE-2034-25) Avail: NTIS HC A03/MF A01

An experimental study was completed to determine the optimum relationship between temperature and space velocity for a hydrotreating-hydrocracking catalyst developed for the denitrogenation of solvent refined coal (SRC-II). The temperature range was 350 to 5000 C, liquid hourly space velocity was 0.25 to 2.5 and the throughput was held constant at 4500 ml-60ml of catalyst. The surprising result is that 5000 C and 1.25 LHSV is the best conditions. Conditions were finally found under which a commercially available catalyst will give acceptability denitrogenation of SRC. It is Harshaw's HT400 E 1/32" and the unique factor is to add 1.5 volume percent of water to the SRC feed. When operated in this manner, the catalyst gave 0.3 wt percent nitrogen in the product for 140 hours, was regenerated and did even better. Without water addition, specification denitrogenation was obtained for only forty hours. The hydrotreating-hydrocracking catalyst that was developed demonstrated hundreds of hours of use and dozens of regenerations, both in batch and trickle bed reactors. This appears to be an economically attractive way to convert solvent refined coal into an acceptable feedstock for a conventional petroleum refinery and thus permit coal to reduce somewhat the burden on petroleum for transportation on grade fuels. DOE

N82-31498# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

PRESENT STATUS ON GASIFICATION/PYROLYSIS PROCESSES IN THE UNITED STATES

T. B. REED Mar. 1982 10 p refs Presented at the Ind. Wood Energy Forum '82, Washington, D.C., 8-10 Mar. 1982
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-009543; SERI/TP-234-1560) Avail: NTIS HC A02/MF A01

An eight term matrix of options is presented leading to over 20,000 types of gasifiers, depending on choice of fuel, end product, and other factors discussed in depth. A number of tests are

suggested that would help producers and customers evaluate specific gasifiers. DOE

N82-31546*# Lockheed-California Co., Burbank.

ADDITIONAL EXPERIMENTS ON FLOWABILITY IMPROVEMENTS OF AVIATION FUELS AT LOW TEMPERATURES, VOLUME 2 Final Report

F. J. STOCKEMER and R. L. DEANE Aug. 1982 56 p refs
(Contract NAS3-21977)
(NASA-CR-167912; NAS 1.26:167912) Avail: NTIS HC A04/MF A01 CSCL 21D

An investigation was performed to study flow improver additives and scale-model fuel heating systems for use with aviation hydrocarbon fuel at low temperatures. Test were performed in a facility that simulated the heat transfer and temperature profiles anticipated in wing fuel tanks during flight of long-range commercial aircraft. The results are presented of experiments conducted in a test tank simulating a section of an outer wing integral fuel tank approximately full-scale in height, chilled through heat exchange panels bonded to the upper and lower horizontal surfaces. A separate system heated lubricating oil externally by a controllable electric heater, to transfer heat to fuel pumped from the test tank through an oil-to-fuel heat exchanger, and to recirculate the heated fuel back to the test tank. B.W.

N82-31550# Gabrielson (James E.), Plymouth, Minn.

CATTAIL RHIZOME DERIVED ALCOHOL Final Report

Jan. 1982 36 p refs
(Contract DE-FG02-81AF-92016)
(DE82-007953; DOE/AF-92016/1) Avail: NTIS HC A03/MF A01

Alcohol production from cattail rhizomes is discussed. Over 60 fermentations were made and the conversion rates of the solid part of the rhizomes was very good. As much as 25 weight percent of rhizomes was converted. The alcohol concentration is only about 2% or less in the beer when the fermentation is complete. To obtain fuel grade alcohol from such material by conventional distillation requires much more energy than can be obtained by burning the alcohol. Either the fermentation must be carried out to produce a more concentrated product or the separation process must be improved. Based on the maximum land harvest rate and the best alcohol yield, production of 134 gallons of alcohol/acre of cattails is projected. DOE

N82-31551# Kansas Energy Office, Topeka. Energy Research and Resource Development Div.

POWER-GRADE BUTANOL RECOVERY AND UTILIZATION

R. NOON 12 Feb. 1982 21 p refs
(Contract DE-FG47-81AF-93013)
(DE82-011212; DOE/AF-93013/T1) Avail: NTIS HC A02/MF A01

A two-fold program to demonstrate and test a power grade butanol-acetone-ethanol fuel recovery system, and further to demonstrate the feasibility of using the fuel blend in a standard type engine is described. A development program was initiated to design and test an operational power grade butanol recovery plant that would operate at one liter per hour output and test and assess the performance of power grade butanol in a spark ignition automotive engine. This project demonstrated that recovery of a power grade butanol fuel blend is simple and can be accomplished at a considered energy advantage over ethanol. It was further demonstrated that such a power grade blend works well in a typical spark ignition engine. DOE

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N82-31558# Oak Ridge National Lab., Tenn. Instrumentation and Controls Div.

STATE-OF-THE-ART ASSESSMENT OF COAL PREPARATION PLANT AUTOMATION

K. R. CAR, G. O. ALLGOOD, R. L. ANDERSON, W. H. ANDREWS, N. C. BRADLEY, C. H. BROWN, G. S. CANRIGHT, G. CATON, W. R. HAMEL, and J. T. HUTTON Feb. 1982 199 p refs (Contract W-7405-ENG-26)

(DE82-011296; ORNL-5699) Avail: NTIS HC A09/MF-A01

As the basis for a continuing program to optimize the performance of coal preparation plants through the application of modern instrumentation and controls technology, the state of the art in the industry was assessed. Coal preparation literature was surveyed comprehensively, coal preparation facilities were visited, and discussions were held with workers in the industry. The objective was to determine the feasibility of and need for increased automation, to identify areas where instrument development is needed, and to analyze characteristics of the coal industry relevant to further automation. The salient conclusions of the study are that the coal preparation industry in the United States derives little of the benefit available from instrumentation and controls technology and rapid recovery of capital investment will result from automation. An appreciable savings of a valuable energy resource can be effected through the orderly development of an automation program. Benefits due to improvements in control of coal preparation plants include an increased yield of clean coal, a reduced coal content in plant refuse, lower operating costs, lower equipment maintenance costs, and an improved ability to meet contract specifications. DOE

N82-31559# Oak Ridge National Lab., Tenn. INTERNATIONAL SURVEY OF COAL PREPARATION TECHNOLOGY

J. C. MOYERS and K. O. JOHNSON Apr. 1982 73 p refs (Contract W-7405-ENG-26)

(DE82-009870; ORNL/TM-8207) Avail: NTIS HC A04/MF A01

A survey of the technology and coal preparation in foreign nations was conducted. The objectives were to determine the extent and practices of coal preparation, to identify new developments, and to identify problem areas that warrant additional research and development emphasis. The fraction of national hard coal production that is prepared ranges from less than 25% in China and India to more than 75% in Australia, Poland, and the United Kingdom. The same basic preparation processes and equipment are used worldwide, but there is a wide range in the complexity of preparation plants due to the differences in coal characteristics and market requirements. The most significant new development appears to be the introduction of modern control systems that utilize computers and on-line analytical instruments. The major problem facing the industry appears to be that of cleaning and dewatering fine coal. DOE

N82-31561# Camp, Dresser and McKee, Inc., Austin, Tex. PROCESS CATALOG FOR SYNFUEL TECHNOLOGIES IN TEXAS

Sep. 1981 158 p refs Sponsored by the Water Resources Council and Texas Dept. of Water Resources (PB82-159955; REPT-9331-110) Avail: NTIS HC A08/MF A01 CSCL 21D

Specific information are presented regarding the types of synfuel processes most likely to be developed in Texas. Included is descriptive information for processes to gasify and liquefy coal and lignite and to convert biomass to usable fuels. Process flow diagrams and narrative descriptions, material and energy balances, water requirements and wastewater quantities and qualities are presented. GRA

N82-31562# TRW, Inc., Redondo Beach, Calif. DEVELOPMENT OF TECHNOLOGY FOR COALBED METHANE RECOVERY. PROGRAM PLANNING Final Report, Sep. 1980 - Jul. 1981

A. GILLIES and A. SNYGG Jun. 1981 215 p refs

(Contract GRI-5080-321-0333)

(PB82-168436; GRI-81/0008-1) Avail: NTIS HC A10/MF A01 CSCL 21D

A program option for the development of technology for economic recovery of coalbed methane was developed. As a first step in the planning process, an assessment of technology currently used in the oil and gas industry was conducted to determine its suitability for use in recovery of methane from coalbeds. It was determined that the most limiting technology was stimulation of water and gas flow from the deeper, more gassy, coal formations. Twenty R&D projects addressing stimulation techniques and related topics were selected by the GRI and the GRI project advisors and plans for their conduct developed. These individual project plans were consolidated into a representative program plan option which describes how the individual stimulation tests can be integrated into three types of production scale tests each targeted at a particular class of coal formation. GRA

N82-31563# TRW, Inc., Redondo Beach, Calif. DEVELOPMENT OF TECHNOLOGY FOR COALBED METHANE RECOVERY PROGRAM PLANNING: APPENDIX A: TECHNOLOGY OPTIONS Final Report

Dec. 1981 60 p refs

(PB82-169699; GRI-81/0008-2-APP-A) Avail: NTIS HC A04/MF A01 CSCL 21D

Program planning for the technology development necessary for the efficient recovery of methane from coalbeds is discussed. The various options and techniques now available and used in the past are summarized. L.F.M.

N82-31687# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).

WELDING OF AL-MG ALLOY 5083-0 FOR THE CONSTRUCTION OF LNG STORAGE TANKS

Y. KURIYAMA, K. MINODA, T. IRISAWA, and H. NAGAOKA 15 Apr. 1981 29 p refs Presented at the IIV-JIW Colloq. Prod. Technol. and Quality Assurance, Nagoya, Japan, 15 Apr. 1981 Sponsored in part by the Welding Research Inst., Japan Prepared in cooperation with Shin-Nakahara-Cho, Yokohama, Japan Avail: NTIS HC A03/MF A01

Welding processes of 5083-0 thick plates, mechanical properties of the welded joints and measures for the prevention of weld defects, intended mainly LNG tank construction are studied. The followings are the main contents of this article. The welding processes currently applied for assembling large LNG tanks are conventional MIG, high current MIG and DCSP TIG, all of which are fully automated. The principal applications of automatic welding are as follows: (1) high current MIG process done on ground for assembling two to three panels into a block using large diameter (3.2 to approximately 4.8 mm) filler wire, and (2) mechanized all position MIG process for erection welding of the aforementioned blocks of tank shell and for the welding of filler joints of bottom and roof plates. S.L.

N82-31752# California Univ., Berkeley. Lawrence Berkeley Lab. National Geothermal Information Resource.

USER'S GUIDE TO THE GEOTHERMAL RESOURCE AREAS DATABASE

J. D. LAWRENCE, K. LEUNG, and W. YEN Oct. 1981 66 p refs

(Contract W-7405-ENG-48)

(DE82-011060; LBL-11492) Avail: NTIS HC A04/MF A01

A geothermal resource areas database called GRAD, designed to answer questions about the progress of geothermal energy development is discussed. This database will contain extensive information on geothermal energy resources for selected areas, covering development from initial exploratory surveys to plant construction and operation. The database is available for on-line

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interactive query by anyone with an account number on the computer, a computer terminal with an acoustic coupler, and a telephone. Some information is provided on obtaining access to the computer system being used, instructions on obtaining standard reports, and some aids to using the query language. DOE

N82-31753# ENSCO, Inc., Springfield, Va.
AUTOMATIC TRACKING OF COAL/SHALE BOUNDARIES WITH PULSE RADAR Final Report
31 Aug. 1981 68 p
(Contract DE-AC01-78ET-11067)
(DE82-007757; DOE/ET-11067/T1) Avail: NTIS HC A04/MF A01

Automatic tracking of coal/shale boundaries with pulse radar was studied. Existing radar equipment and a breadboard version of the processor in four mines in different areas of the country were tested. The ability of short pulse radar to locate the coal/shale boundary in the mine roof was verified. The design for a radar coal interface detector (CID) which could operate in roof coal thicknesses ranging from 2 inches to 24 inches was specified. The final system was unable to operate reliably in thin roof coal. This was due to the inability of the processor to separate the reflection from the surface return. A higher frequency transducer was tried, however, this unit was unable to penetrate the coal. It is concluded that the delivered system can be used in mines where the roof coal ranges from 9 inches to 24 inches thick. DOE

N82-31756# Occidental Research Corp., Irvine, Calif.
SHALE OIL: POTENTIAL FOR ELECTRIC POWER FUELS Final Report
M. GRAGG, R. E. LUMPKIN, H. D. GUTHRIE, and S. G. WOINSKY Dec. 1981 99 p refs
(DE82-901906; EPRI-AP-2186) Avail: NTIS HC A05/MF A01

The status of the oil shale industry and the impact it will have on the electric power industry in the years 1990 to 2000 is reviewed. The major problem most processes face today is scale-up to commercial size. An industry of nearly 400,000 BPD is anticipated for 1990. The industry could grow to 1,000,000 BPD by the year 2000 with the introduction of second generation processes in the 1990s. As the refineries improve their ability to handle shale oil, the availability of this fuel to the electric power industry for direct firing will decrease. The offgas from the oil shale industry could be of major importance to the electric power industry. One-quarter to one-third of the energy produced by the oil shale industry will be in the form of offgas (the gas produced in the retorting process). This will usually be a low Btu gas and therefore likely to be utilized on site to make electricity. The high yield of distillate fuels from shale oil could be important to the utility industry's demand for distillate fuels in peak shaving power generation. DOE

N82-31757# Battelle Pacific Northwest Labs., Richland, Wash.
WESTERN OIL-SHALE DEVELOPMENT. A TECHNOLOGY ASSESSMENT. VOLUME 4: SOLID WASTE FROM MINING AND SURFACE RETORTS Final Report
Jan. 1982 69 p refs
(Contract DE-AC06-76RL-01830)
(DE82-010107; PNL-3830-VOL-4) Avail: NTIS HC A04/MF A01

Information on the disposal, composition, and leachability of solid wastes produced by aboveground shale oil extraction processes was reviewed. The relationship of development to surface and groundwater quality in the Piceance Creek basin of northwestern Colorado are examined. Key areas of research necessary to quantitative assessment of impact are identified. The following information is presented: proposed surface retorting developments; surface retorting processes; environmental concerns; chemical/mineralogical composition of raw and retorted oil shale; disposal procedures; water quality; and research needs. DOE

N82-31769*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

MICRONIZED COAL BURNER FACILITY Patent Application
F. D. CALFO and M. W. LUPTON, inventors (to NASA) 30 Jun. 1982 13 p
(NASA-CASE-LEW-13426-1; US-PATENT-APPL-SN-393588)
Avail: NTIS HC A02/MF A01 CSDL 10B

A combustor or burner system in which the ash resulting from burning a coal in oil mixture is of submicron particle size is described. The burner system comprises a burner section, a flame exit nozzle, a fuel nozzle section, and an air tube by which preheated air is directed into the burner section. Regulated air pressure is delivered to a fuel nozzle. Means are provided for directing a mixture of coal particles and oil from a drum to a nozzle at a desired rate and pressure while means returns excess fuel to the fuel drum. Author

N82-31788# California Univ., Berkeley. Lawrence Berkeley Lab.

IMPROVED ENERGY RECOVERY FROM GEOTHERMAL RESERVOIRS

G. S. BOEDVARSSON, K. PRUESS, M. LIPPMANN, and S. BJÖERNSSON Jun. 1981 26 p refs Presented at the 56th Ann. Tech. Conf. and Exhibition of the Soc. of Petroleum Engrs. of AIME, San Antonio, Texas, 4-7 Oct. 1981
(Contract W-7405-ENG-48)
(DE82-001007; LBL-12341; CONF-811023-5) Avail: NTIS HC A03/MF A01

Numerical simulation methods are used to study how the exploitation of different horizons affects the behavior of a liquid-dominated geothermal reservoir. The reservoir model is a schematic representation of the Olkaria field in Kenya. The model consists of a two phase vapor dominated zone overlying the main liquid dominated reservoir. Four different cases were studied, with fluid produced from: (1) the vapor zone only, (2) the liquid zone only, (3) both zones and (4) both zones, but assuming lower values for vertical permeability and porosity. The results indicate that production from the shallow two phase zone, although resulting in higher enthalpy fluids, may not be advantageous in the long run. Shallow production gives rise to a rather localized depletion of the reservoir, whereas production from deeper horizons may yield a more uniform depletion process, if vertical permeability is sufficiently large. DOE

N82-31789# California Univ., Berkeley. Lawrence Berkeley Lab. Earth Sciences Div.

SIMPLE MODEL FOR FAULT-CHARGED HYDROTHERMAL SYSTEMS

G. S. BOEDVARSSON, C. W. MILLER, and S. M. BENSON Aug. 1981 25 p refs
(Contract W-7405-ENG-48)
(DE82-001510; LBL-12869-REV) Avail: NTIS HC A02/MF A01

A two-dimensional transient model of fault-charged hydrothermal systems has been developed. The model can be used to analyze temperature data from fault-charged hydrothermal systems, estimate the recharge rate from the fault, and determine how long the system has been under natural development. The model can also be used for theoretical studies of the development of fault-controlled hydrothermal systems. The model has been tentatively applied to the low-temperature hydrothermal system at Susanville, California. A reasonable match was obtained with the observed temperature data. DOE

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N82-31794# Geothermal Research, Information and Planning Services Commission, Santa Rosa, Calif.

G.R.I.P.S ACTIVITIES IN THE DEVELOPMENT OF DIRECT USE OF GEOTHERMAL RESOURCES AND SMALL SCALE GEOTHERMAL POWER DEVELOPMENT Final Report

Oct. 1981 137 p

(Contract DE-FC03-79ET-27194)

(DE82-002842; DOE/ET-27194/T7) Avail: NTIS HC A07/MF A01

The activities of the geothermal research information and planning services (G.R.I.P.S.) in the four Geysers-Calistoga KGRA counties (i.e., Lake, Mendocino, Napa, Sonoma) in California are reported. Activities in the G.R.I.P.S. information and outreach program, workshop presentations, pilot project development, permit processing improvements and Department of Energy reporting are described. GRA

N82-31799# Los Alamos Scientific Lab., N. Mex.

PROGRESS OF THE US HOT-DRY-ROCK PROGRAM

M. C. SMITH 1982 26 p refs Presented at the Intern. Conf. on Geothermal Energy, Florence, Italy, May 1982

(Contract W-7405-ENG-36)

(DE82-004364; LA-UR-81-3431; CONF-820506-1) Avail: NTIS HC A03/MF A01

The Hot Dry Rock (HDR) which concentrates on the use of hydraulic fracturing to create flow passages and heat transfer surface between two wells drilled into hot crystalline rock of low initial permeability was studied. A recirculating pressurized water loop was used to extract heat at rates up to 5MW(t) from a system of this type in granitic rock at a depth of 2600 m. Two wells for a larger, deeper, hotter system were drilled at the same location. They will be connected by a set of hydraulic fractures, and the resulting heat extraction loop is expected to yield the engineering experience and performance data which are required to demonstrate the commercial usefulness of such systems. The HDR resource base of the United States is evaluated and local areas that appear especially promising either for future heat extraction experiments or for eventual commercial development are investigated. DOE

N82-31828# New York State Energy Research and Development Authority, New York.

CUMULATIVE ENVIRONMENTAL IMPACTS OF COAL CONVERSION

Dec. 1981 392 p refs

(DE82-901166; NYSEDA-81-29) Avail: NTIS HC A17/MF A01

The conversion of eight oil-fired power plants to coal and the construction of six new coal-fired power plants by 1994, were proposed as part of the State Energy Master (SEMP). The potential cumulative environmental impacts associated with implementing this plan are presented. The general conclusions from this report and a summary of major findings by topics follow. The entire plan could be implemented without causing significant adverse cumulative environmental effects, providing that appropriate mitigation measures and coordinated planning take place as required. The greatest potential for adverse cumulative effects would be in the New York City Metropolitan Area. The issues of potential concern are air quality, combustion wastes disposal, and transportation. Minor impacts, primarily of a site-specific nature, would occur. A variety of mitigation measures are available to control these impacts adequately. DOE

N82-31830# California Univ., Livermore. Lawrence Livermore Lab.

TECHNOLOGY ASSESSMENT: ENVIRONMENTAL, HEALTH, AND SAFETY IMPACTS ASSOCIATED WITH OIL RECOVERY FROM US TAR-SAND DEPOSITS

J. I. DANIELS, L. R. ANSPAUGH, and Y. E. RICKER 13 Oct. 1981 146 p refs

(Contract W-7405-ENG-48)

(DE82-003756; UCRL-53210) Avail: NTIS HC A07/MF A01

Data were extrapolated to determine pollutant levels expected from conceptual commercial surface and in situ facilities producing

20,000 bbl/d of recovered oil. The likelihood-of-occurrence of these impacts was then assessed. Experience from other industries, including information concerning health and ecosystem damage from air pollutants, measurements of ground-water transport of organic pollutants, and the effectiveness of environmental-control technologies was used to make the assessment. DOE

N82-31834# Tennessee Valley Authority, Chattanooga. Office of Natural Resources.

PRODUCTION OF SULFATE AEROSOLS IN THE PLUME OF A COAL-FIRED POWER PLANT UNDER NORMAL AND REDUCED PRECIPITATOR OPERATION

J. F. MEAGHER, E. M. BAILEY, and L. STOCKBURGER, III Dec. 1981 34 p refs

(DE82-901919; TVA/ONR/ARP-82/6) Avail: NTIS HC A03/MF A01

The effect of primary aerosol on sulfate aerosol production was examined. Plumes were measured by using an instrumented helicopter and flue gas analyses which were performed on each of the two stacks. The plume particle loading was increased during four of the experiments through a reduction in the electrostatic precipitator (ESP) capacity. The relatively high nighttime rates were measured just after sunset and may result from delayed reactions of free radical precursors which were produced during the daylight hours. It is indicated that a region of rapid SO₂ oxidation must exist for the first minutes after the flue gas is emitted from the stacks and the difference between extrapolated intercepts from aircraft measurements and flue gas sampling. DOE

N82-31848# Coastal Environments, Inc., Baton Rouge, La.

AN INTRODUCTION TO THE ENVIRONMENTAL LITERATURE OF THE MISSISSIPPI DELTAIC PLAIN REGION

J. L. VANBEEK, D. J. DAVIS, R. E. EMMER, S. A. HSU, I. A. MENDELSSOHN, D. S. SABINS, C. L. WAX, K. M. WICKER, J. B. JOHNSTON, and M. W. YOUNG Oct. 1981 213 p refs

Sponsored in part by the Bureau of Land Management

(PB82-161621; FWS-OBS-79/30) Avail: NTIS HC A10/MF A01 CSCL 13B

Selected environmental literature of the Mississippi Deltaic Plain Region is reviewed. This review introduces some of the major ecosystem components and processes, describes oil and gas production activities, and guides the reader to available literature. GRA

N82-31861# Idaho National Engineering Lab., Idaho Falls.

RAFT RIVER GEOSCIENCE CASE STUDY, VOLUME 1

M. R. DOLENC, L. C. HULL, S. A. MIZELL, B. F. RUSSELL, P. A. SKIBA, J. A. STRAWN, J. A. TULLIS, and R. GARBER, ed. Nov. 1981 160 p refs

(Contract DE-AC07-76ID-01570)

(DE82-003355; EGG-2125-VOL-1) Avail: NTIS HC A08/MF A01

The Raft River Geothermal Site has been evaluated over the past eight years by the United States Geological Survey and the Idaho National Engineering Laboratory as a moderate-temperature geothermal resource. The geoscience data gathered in the drilling and testing of seven geothermal wells suggest that the Raft River thermal reservoir is: (1) produced from fractures found at the contact metamorphic zone apparently the base of detached normal faulting from the Bridge and Horse Well Fault zones of the Jim Sage Mountains; (2) anisotropic, with the major axis of hydraulic conductivity coincident to the Bridge Fault Zone; (3) hydraulically connected to the shallow thermal fluid of the Crook and BLM wells based upon both geochemistry and pressure response; (4) controlled by a mixture of diluted meteoric water recharging from the northwest and a saline sodium chloride water entering from the southwest. Although the hydrogeologic environment of the Raft River geothermal area is very complex and unique, it is typical of many Basin and Range systems. DOE

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N82-32151# Los Alamos Scientific Lab., N. Mex.
ADVANCED-FUEL REVERSED-FIELD PINCH REACTOR (RFPR)
R. L. HAGENSON and R. A. KRAKOWSKI Oct. 1981 5 p
refs Presented at the 9th Symp. on Eng. Probl. of Fusion Res.,
Chicago, 26-29 Oct. 1981
(Contract W-7405-ENG-36)
(DE82-002387; LA-UR-81-3145; CONF-811040-46) Avail: NTIS
HC A02/MF A01

The utilization of deuterium-based fuels offers the potential advantages of greater flexibility in blanket design, significantly reduced tritium inventory, potential reduction in radioactivity level, and utilization of an inexhaustible fuel supply. The conventional DT-fueled reversed-field pinch reactor (RFPR) designs reviewed, and the recent extension of these devices to advanced-fuel (catalyzed-DD) operation is presented. Attractive and economically competitive DD/RFPR systems are identified having power densities and plasma parameters comparable to the DT systems. Converting an RFP reactor from DT to DD primarily requires increasing the magnetic field levels a factor of two, still requiring only modest magnetic coil fields. When compared to the mainline tokamak, the unique advantages of the RFP (e.g., high beta, low fields at the coils, high ohmic-heating power densities, and unrestricted aspect ratio) are particularly apparent for the utilization of advanced fuels. DOE

N82-32203# Department of Energy, Washington, D. C.
STATE-OF-THE-ART ASSESSMENT OF METHANE-FUELED VEHICLES

Feb. 1982 12 p refs
(DE82-009287; DOE/CE-0026) Avail: NTIS HC A02/MF A01

The desirability of methane, either in the form of compressed natural gas or liquefied natural gas, as a fuel for spark-ignition and compression-ignition engines in vehicles was studied by considering the attributes and disadvantages of methane as a vehicle fuel, the availability of engines designed for methane operation, the cost of engine conversion systems, on-vehicle fuel storage systems, environmental effects, vehicle performance, safety, economics, fueling facilities and domestic supplies of methane. DOE

N82-32296# Joint Publications Research Service, Arlington, Va.
BELGIUM, FRG UNDERGROUND COAL GASIFICATION PROJECT

L. WILLEMS *In its* West Europe Rept.: Sci. and Technol., No. 99 (JPRS-80536) p 19-22 9 Apr. 1982 Transl. into ENGLISH from Knecht (Belgium), 24 Feb. 1982 p 58-59
Avail: NTIS HC A04

Plans for the underground coal gasification of one to five K deep coal reserves are described. The European energy market is surveyed. Retrocombustion with a mixture of pure oxygen and high pressure steam at a depth of 860 m is under investigation. J.D.

N82-32297# Joint Publications Research Service, Arlington, Va.
FRANCE TO TRY FUEL OIL COAL MIXTURE AS SUBSTITUTE FUEL

In its West Europe Rept.: Sci. and Technol., No. 99 (JPRS-80536) p 23-24 9 Apr. 1982 Transl. into ENGLISH from Le Nouvel Econ. (France), 15 Feb. 1982 p 55
Avail: NTIS HC A04

Plans for a pilot plant for the production of 8 TPD of an equal part mixture of fuel oil containing suspended coal particles of 40 to 50 microns diameter are announced. The fuel is intended for use by small and medium size enterprises. Development of a stable mixture having flow and combustion properties similar to those of fuel oil is sought. J.D.

N82-32351# Simmonds Precision Products, Inc., Vergennes, Vermont. Instrument Systems Div.

COMMERCIAL AIRCRAFT AIRFRAME FUEL SYSTEMS SURVEY AND ANALYSIS Final Report, Oct. 1980 - Jun. 1982

P. G. WEITZ Atlantic City, N.J. FAA Jul. 1982 98 p refs
(Contract DTFA03-80-C-0080)
(DOT/FAA/CT-82/80; REPT-181-320-100) Avail: NTIS HC
A05/MF A01

A selection of commercial aircraft airframe fuel systems was studied to determine areas where incompatibility with antimisting kerosene fuel (AMK) may exist. Incompatibility can be due to reduced fuel system component performance with AMK or shear degradation of the AMK by the fuel system components. Survey results, to date, indicate that potential component performance problems with AMK are more significant than loss of AMK flammability protection due to shear degradation. Components of interest include ejector pumps, fuel filters, and auxiliary power units. Author

N82-32458# Environmental Protection Agency, Ann Arbor, Mich. Standards Development and Support Branch.

REFINING OF COAL-DERIVED SYNTHETIC CRUDES

J. MCGUCKIN Feb. 1982 49 p refs
(PB82-169095; EPA-AA-SDSB-82-4) Avail: NTIS HC A03/MF
A01 CSCL 07A

The refining of coal derived (H Coal, EDS and SRC-II) synthetic crudes both alone in grass roots refineries and in combination with petroleum crudes in existing refineries is examined. The H Coal syncrude is the cheapest to refine and the SRC-II syncrude is the most expensive. While the costs per mBtu of refining syncrudes in grass roots or existing refineries is fairly close, the use of existing refineries will greatly reduce new capitol investment and appears to be the most likely scenario. GRA

N82-32483# Southwest Research Inst., San Antonio, Tex.
MICROSTRUCTURAL STUDY OF FAILURE MECHANISMS DURING MECHANICAL TESTING IN COAL GASIFICATION ENVIRONMENTS Annual Report, Mar. 1980 - Feb. 1981

R. A. PAGE Nov. 1981 50 p refs
(Contract GRI-5014-362-0291)
(PB82-180647; GRI-82/0006) Avail: NTIS HC A03/MF A01
CSCL 11F

The program objectives and approach for a microstructural study of the behavior of iron-chromium-nickel alloys under the combined effects of stress and corrosive species encountered in coal gasification is discussed. The work involves systematic study of the effects of variations in alloy and environment compositions. Included are oxidizing and sulfidizing gas compositions. Model alloys were procured and heat treated. In addition, microstructural changes which occur in 310 stainless steel, Incoloy 800H, RA 333 and IN 657 during stress rupture testing in a simulated coal gasification environment at 1500 F were examined. Optical metallography and energy dispersive X-ray analysis were used to characterize the microstructure. This characterization is continuing and a mechanism was proposed. GRA

N82-32504*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CHARACTERIZATION OF AN EXPERIMENTAL REFEREE BROADENED SPECIFICATION (ERBS) AVIATION TURBINE FUEL AND ERBS FUEL BLENDS

G. T. SENG Aug. 1982 25 p refs
(NASA-TM-82883; E-1260; NAS 1.15:82883) Avail: NTIS HC
A02/MF A01 CSCL 21D

Characterization data and comparisons of these data are presented for three individual lots of a research test fuel designated as an Experimental Referee Broadened Specification (ERBS) aviation turbine fuel. This research fuel, which is a blend of kerosene and hydrotreated catalytic gas oil, is a representation of a kerojet fuel with broadened properties. To lower the hydrogen content of the ERBS fuel, a blending stock, composed of xylene bottoms and hydrotreated catalytic gas oil, was developed and employed to produce two different ERBS fuel blends. The ERBS

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fuel blends and the blending stock were also characterized and the results for the blends are compared to those of the original ERBS fuel. The characterization results indicate that with the exception of the freezing point for ERBS lot 2, which was slightly high, the three lots, produced over a 2 year period, met all general fuel requirements. However, although the properties of the fuels were found to be fairly consistent, there were differences in composition. Similarly, all major requirements for the ERBS fuel blends were met or closely approached, and the properties of the blended fuels were found to generally reflect those expected for the proportions of ERBS fuel and blending stock used in their production. Author

N82-32513# Coordinating Research Council, Inc., Atlanta, Ga. Analysis Panel.

THE 1981 CRC ALTITUDE OCTANE REQUIREMENT PROGRAM

Dec. 1981 64 p refs
(Contract DAAK70-81-C-0128; CRC PROJ. CM-124-81)
(AD-A116988; CRC-523) Avail: NTIS HC A04/MF A01 CSCL 21D

The effect of altitude on octane requirements of 1981 model automobiles equipped with electronic systems for controlling air-fuel mixture and spark timing is reported. J.D.

N82-32514# Helstad (Scott), La Crosse, Wisc.
ALCOHOL PRODUCTION FROM CHEESE, WHEY AND CORN FOR A FARM-SIZE OPERATION Final Report, Jul. - Dec. 1981
S. HELSTAD 24 Dec. 1981 35 p
(Contract DE-FG02-81AF-92018)
(DE82-010534; DOE/AF-92018/2) Avail: NTIS HC A03/MF A01

The goal of this project was to construct a farm size alcohol distillery, capable of producing 200,000 gallons per year of equivalent 200 proof alcohol that is both labor and energy efficient. The distillery was completed in October and was operated on a weekly basis. It has taken until mid-November to work many of the bugs out. This operation is now capable of demonstrating the energy consumption and economics of producing alcohol on a small scale. The data and conclusions that can be made from results achieved so far are: (1) a batch process can be energy efficient if it operates at an optimum level; (2) the cost of producing alcohol in small batch operations is likely to be prohibitive; and (3) it is doubtful a farmer could construct a small, efficient distillery alone. GRA

N82-32515# Santa Clara Univ., Calif.
CHARACTERIZATION AND RESEARCH INVESTIGATION OF ALCOHOL FUELS IN AUTOMOBILE ENGINES

L. H. BROWNING, ed. and J. F. NEBOLON, comp. Feb. 1982 193 p refs
(Contract DE-AC03-78CS-51737)
(DE82-009350; DOE/CS-51737/1) Avail: NTIS HC A09/MF A01

The use of pure methanol and ethanol in spark ignition engines is evaluated. Engine and fuel/air induction system modifications, acoustic induction system, dynamometer testing, cold start experiments, fleet tests using neat alcohol fuels and fuel blends, thermokinetic combustion process modeling, smog formation studies, and an evaluation of environmental and health hazards are discussed. The combustion modeling studies revealed that higher compression ratios can be exploited to enhance power and efficiency without paying an NO sub x penalty. Methanol thermally ignites more easily than gasoline. The study indicates that as much as 30% water can be added to the methanol substantially reducing NO sub x emissions without diminishing power or thermal efficiency. However, this achievement is accompanied with increased hydrocarbon and aldehyde emissions. Electric heaters can overcome cold starting problems in mild climates. These heaters plus fuel additives are most effective for very cold climates. Engine optimization for alcohols is still in an early stage of development. DOE

N82-32517# Department of Energy, Bartlesville, Okla. Energy Technology Center.

USER'S GUIDE FOR THE ALTERNATIVE-FUEL DATA BANK

Feb. 1982 56 p
(DE82-008254; DOE/BETC/SP-81/7) Avail: NTIS HC A04/MF A01

An information system that is designed to provide rapid access to information concerning alternative fuels for transportation uses is described. This information system operates on the PDP-11/70 computer. The Alternative Fuels Data Bank (AFDB) consists of three files that contain bibliographical information on publications and summaries of current research activities. The data stored in these files deal with the use of fuels from nonpetroleum sources and nonconventional fuels from petroleum sources in transportation applications. The computer programs serve as a data base management system that manipulates data in the files (that is, stores, changes, and deletes the data) and retrieves it as required to produce printed reports. The only equipment needed, besides the manual, are a telephone and remote access terminal. The AFDB is open to the research community at no cost. A brief history and description of the AFDB are provided. DOE

N82-32518# Purdue Univ., Lafayette, Ind.
PERFORMANCE OF SRC II FUELS IN GAS-TURBINE COMBUSTORS. ALTERNATIVE-FUELS-UTILIZATION PROGRAM

E. H. TONG and A. M. MELLOR Dec. 1981 115 p refs
(Contract DE-AC02-80CS-50098)
(DE82-010471; DOE/CS-50098/1) Avail: NTIS HC A06/MF A01

Jet A, SRCII-Middle Distillate (SRCII-MD), and a 50/50 Jet A/SRCII-MD blend were burned in three different laboratory combustion rigs to study fuel property effects on combustion performance. Soot concentration, flame radiation, combustion efficiency and flame stabilization measurements were conducted in test rigs simulating conventional and prechamber geometry gas turbine combustors. A special ignition rig was used to study ignition performance. SRCII fuel's soot concentrations and flame radiation intensities were higher than those for Jet A. Generally the 50/50 blend behaved more like the SRCII-MD than the Jet A in these areas. Exhaust plane soot concentrations and average flame radiation intensities were found to correlate with hydrogen content, although the latter showed an equivalence ratio dependence. For experimentally determined weak extinction limits and minimum ignition energies, comparisons were made with predictions based on characteristic time models that had been developed and verified for petroleum fuels. From this work, compositional fuel properties appeared to have secondary effects on both stabilization and ignition performance. Combustion efficiency results indicated higher efficiencies for the SRCII-MD than for the blend. However, this was thought to be due to sampling difficulties caused by the ingestion of liquid fuel into the sampling line. GRA

N82-32520# Brown and Caldwell, Walnut Creek, Calif.
UNITED PACKING: ALCOHOL FEASIBILITY STUDY Final Report

Oct. 1981 83 p Sponsored in part by California State Solid Waste Management Board
(PB82-178476) Avail: NTIS HC A05/MF A01 CSCL 21D

Cull fruit contains significant amounts of sugar which can be converted into ethanol using current technology. The ethanol has several uses one of which is a fuel to provide on-site energy for plant processing needs. Ethanol production is only one part in an overall energy management plan for the plant that is discussed. Cogeneration and other power production options utilizing ethanol, to provide both total and partial energy independence from utilities are also examined. Information from the alcohol production evaluation, energy survey, biomass profile, and power production analysis is integrated, and an overall energy management plan is defined. GRA

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N82-32521# Bureau of Mines, Amarillo, Tex. Div. of Helium Operations.

ANALYSES OF NATURAL GASES, 1980 Information Circular, 1981

B. J. MOORE Jan. 1982 242 p refs
(PB82-178849; BM-IC-8856) Avail: NTIS HC A11/MF A01
CSCL 21D

Analyses and related source data for 675 natural gas samples from wells and pipelines in 24 States and 5 foreign countries are presented. All of these samples were collected as a part of investigations of the occurrences of helium in natural gases of countries with free market economies. The analyses were made by mass spectrometer and a special helium analysis apparatus.

GRA

N82-32522# Environmental Protection Agency, Ann Arbor, Mich. Standards Development and Support Branch.

INDIRECT LIQUEFACTION PROCESSES

J. MCGUCKIN Feb. 1982 79 p refs
(PB82-179755; EPA-AA-SDSB-82-5) Avail: NTIS HC A05/MF A01 CSCL 21D

The technology feasibility of the various coal gasification and indirect liquefaction technologies are discussed. Also included is the best-estimate costs for methanol and gasoline using the various technologies with three different coal feedstocks by critically analyzing publicly available design studies and placing them on a common technical basis. The conclusion is that ethanol from coal is cheaper than gasoline via either the Mobile MTG process or the Fisher-Tropsch process.

GRA

N82-32523# Pennsylvania State Univ., University Park.
IMPORTANCE OF ACTIVE SITES FOR CHAR GASIFICATION IN OXYGEN (AIR) AND CARBON DIOXIDE Annual Report, Oct. 1980 - Sep. 1981

P. L. WALKER, JR., R. G. JENKINS, and L. R. RADOVIC Oct. 1981 53 p refs
(Contract GRI-5014-363-0235)
(PB82-180621; GRI-81/0018) Avail: NTIS HC A06/MF A01
CSCL 21D

The reactivities of chars, obtained by rapid and slow pyrolysis of raw and suitably pretreated North Dakota lignite under widely varying conditions of temperature, heating rate and residence time, were measured using thermogravimetric analysis. The pretreatment involved coal demineralization, ion exchange with ammonium acetate, and subsequently ion exchange with calcium acetate. In order to preserve the structure of the chars obtained by rapid pyrolysis, air was used as the reactant at low temperatures in the range 250 to 450C. Small amounts of sample (1-2 mg) were used in order to eliminate the effects of nonisothermal behavior and interparticle diffusional limitations on the observed kinetics. Major reactivity differences were observed as a function of pyrolysis residence time and the type of coal pretreatment used.

GRA

N82-32651# Texas Univ., Austin. Center for Energy Studies.
RESERVOIR PERFORMANCE IN VISCOELASTIC POROUS MEDIA

F. M. RAGO, H. OHKUMA, K. SEPEHRNOORI, and T. W. THOMPSON Jan. 1982 37 p refs
(Contract DE-AC08-79ET-27112)
(DE82-011899; DOE/ET-27112/1) Avail: NTIS HC A03/MF A01

The mass balance equations for a two-phase two-component fluid system are written for viscoelastic porous media. The resulting equations are approximated by finite differences and the resulting numerical simulator is used to conduct sensitivity study on the effects of uniaxial viscoelastic deformation in geopressured aquifers. Results of this study indicate that viscoelastic deformation may have considerable influence on the pressure maintenance of these aquifers. A numerical model of the geopressured aquifer in Brazoria County, Texas, is constructed and the numerical simulator is used to predict the ultimate recovery of solution gas from this viscoelastic geopressured aquifer.

DOE

N82-32804*# Geological Survey, Denver, Colo.

APPLICATION OF HCMM DATA TO REGIONAL GEOLOGIC ANALYSIS FOR MINERAL AND ENERGY RESOURCE EVALUATION Progress Report, Dec. 1981 - Jun. 1982

K. WATSON, Principal Investigator and S. H. MILLER Jun. 1982 4 p Sponsored by NASA HCMM
(E82-10382; NASA-CR-169173; NAS 1.26:169173) Avail: NTIS HC A02/MF A01 CSCL 08G

Using a thermal-inertia mapping algorithm which provides greater discrimination capability than those in current use, a geologic features was detected in the Cabeza Prieta, Arizona, area. Initially seen on an image formed as a difference of two thermal-inertia images, it was found to be the extension of a bilaterally symmetrical aeromagnetic feature which trends northeast for a distance of at least 1200 km.

M.G.

N82-32829# Du Pont de Nemours (E. I.) and Co., Aiken, S.C. Analytical Chemistry Div.

GEOLOGY AND MINERAL RESOURCES OF THE JOHNSON CITY, PHENIX CITY, AND ROME 10 X 20 NTMS QUADRANGLES

B. S. KARFUNKEL, comp. Nov. 1981 96 p refs
(Contract DE-AC09-76SR-00001)

(DE82-011253; DPST-81-141-10) Avail: NTIS HC A05/MF A01

Geologic and mineral resources data for the Savannah River Laboratory are presented. The national uranium resource evaluation (NURE) hydrogeochemical and stream-sediment reports for the Johnson City, Phenix City, and Rome 10 x 20 National Topographic Map Series quadrangles in the southeastern United States are included. Background geologic and mineral resources information which aid in the interpretation of the NURE geochemical reconnaissance data are provided.

DOE

N82-32830# California Dept. of Conservation, Sacramento. Div. of Oil and Gas.

RESERVOIR ASSESSMENT OF THE GEYSERS GEOTHERMAL FIELD

R. P. THOMAS, R. H. CHAPMAN, and H. DYKSTRA 1981 138 p

(Contract DE-FG03-79ET-27108)

(DE82-011700; DOE/ET-27108/T1; TR27) Avail: NTIS HC A07/MF A01

Big Sulphur Creek fault zone, in the geysers geothermal field, may be part of a deep seated, wrench style fault system. Hydrothermal fluid in the field reservoir may rise through conduits beneath the five main anomalies associated with the Big Sulphur Creek wrench trend. Some geophysical anomalies (electrical resistivity and audio magnetotelluric) evidently are caused by the hot water geothermal field or zones of altered rocks; others represent the underlying heat source, a possible magma chamber; and others (microearthquake activity) may be related to the steam reservoir. A large negative gravity anomaly and a few low resistivity anomalies suggest areas generally favorable for the presence of steam zones, but these anomalies apparently do not directly indicate the known steam reservoir. At the current generating capacity of 930 MWe, the estimated life of the geysers geothermal field reservoir is 129 years. The estimated reservoir life is 60 years for the anticipated maximum generating capacity of 2000 MWe as of 1990. Wells at the geysers are drilled with conventional drilling fluid (mud) until the top of the steam reservoir is reached; then, they are drilled with air. Usually, mud, temperature, caliper, dual induction, and cement bond logs are run on the wells.

DOE

N82-32856*# Westinghouse Electric Corp., Madison, Pa. Synthetic Fuels Div.

LOW AND MEDIUM HEATING VALUE COAL GAS CATALYTIC COMBUSTOR CHARACTERIZATION

J. A. SCHWAB Nov. 1982 137 p refs

(Contract DEN3-277; DE-AI01-77ET-10350)

(NASA-CR-165560; DOE/NASA/0277-1; NAS 1.26:165560)

Avail: NTIS HC A07/MF A01 CSCL 10B

Catalytic combustion with both low and medium heating value coal gases obtained from an operating gasifier was demonstrated.

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A practical operating range for efficient operation was determined, and also to identify potential problem areas were identified for consideration during stationary gas turbine engine design. The test rig consists of fuel injectors, a fuel-air premixing section, a catalytic reactor with thermocouple instrumentation and a single point, water cooled sample probe. The test rig included inlet and outlet transition pieces and was designed for installation into an existing test loop.
S.L.

N82-32873# American Boiler Mfrs. Association, Arlington, Va. EMISSIONS AND EFFICIENCY PERFORMANCE OF INDUSTRIAL COAL STOKER FIRED BOILERS: DATA SUPPLEMENT

Aug. 1981 493 p
(Contract DE-AC01-77ET-10386; EF-77-C-01-2609)
(DE81-030266; DOE/ET-10386/T1-VOL-3) Avail: NTIS HC A21/MF A01

Tables and plots of field test data on emissions and efficiency performance of coal stoker fired boilers are given. The tables contain the gaseous, particulate, coal and efficiency data. The plots correlate the major parameters with percent boiler design capacity and excess air. A few additional relationships are also included in the plots. The data supplement is based on the findings of an extensive coal stoker test program. GRA

N82-32880# Engineering and Economics Research, Inc., Vienna, Va.

HYDROTHERMAL INDUSTRIALIZATION ELECTRIC-POWER SYSTEMS DEVELOPMENT Final Report

J. MARKIEWICZ and M. ALBERT Mar. 1982 206 p
(Contract DE-AC07-80ID-12186)
(DE82-009295; DOE/ID-12186/T1) Avail: NTIS HC A10/MF A01

The nature of hydrothermal resources, their associated temperatures, geographic locations, and developable capacity are described. The parties involved in development, required activities and phases of development, regulatory and permitting requirements, environmental considerations, and time required to complete development activities are examined and development costs are described. A profile of the geothermal industry and participants and their operating characteristics is presented. The current development status of geothermal energy in the US is outlined. The work on market penetration is summarized and development information for 56 high temperature sites is presented. DOE

N82-32883# Institute of Gas Technology, Chicago, Ill.

METHANE FROM COAL SEAMS

M. C. DOHERTY 1981 14 p refs Presented at the Intern. Conf. on Small Energy Sources, Los Angeles, 9-18 Sep. 1981
(Contract DE-AC21-79ET-14851)
(DE82-902126; CONF-8109111-2) Avail: NTIS HC A02/MF A01

Coalbed methane resources are discussed. The technology to recover the gas, the ongoing research and development, and coal seam gas as a source of energy are examined. DOE

N82-33479# Department of Energy, Pittsburgh, Pa. Energy Technology Center.

HYDROPROCESSING OF SOLVENT-REFINED COAL: CATALYST-SCREENING RESULTS

G. J. STIEGEL, R. E. TISCHER, and L. M. POLINSKI Mar. 1982 103 p refs
(DE82-008568; DOE/PETC/TR-82/7) Avail: NTIS HC A06/MF A01

Four catalysts for hydroprocessing a 50 wt% mixture of SRC-I in a prehydrogenated creosote oil using a continuous flow unit. All catalysts employed were nickel-molybdates with varying properties. Reaction conditions were 2000 psi, 8 SCFH of hydrogen, volume hourly space velocity of 0.6 to 1.0 cc of SRC-I/hr/cc of catalyst, and 48 hours at 7500 F followed by 72 hours at 7800 F. The results indicate that the Shell 324 catalyst is best for hydrogenation of the feedstock but only marginally better than CB 81-44 for denitrogenation. The CB 81-44 catalyst may be slightly better than Shell 324 for the conversion of the +8500 F fraction

of the feedstock. Desulfurization was uniformly high for all catalysts. Catalysts with a bimodal pore size distribution (i.e., SMR7-6137(1)) appear to be better for denitrogenation than unimodal catalysts (i.e., SMR7-6137(4)) containing the same metals loading. Unimodal catalysts (i.e., Shell 324) with higher metals loadings are comparable to bimodal catalysts (i.e., CB 81-44) containing less metals. DOE

N82-33480# General Electric Co., Schenectady, N. Y. Research and Development Center.

SIGNIFICANT PARAMETERS IN THE CATALYZED CO2 GASIFICATION OF COAL CHAR

C. L. SPIRO, D. W. MCKEE, P. G. KOSKY, E. J. LAMBY, and D. H. MAYLOTTE 1982 30 p refs
(Contract DE-AC21-80MC-14591)
(DE82-008508; DOE/MC-14591/T1) Avail: NTIS HC A03/MF A01

Alkali and alkaline earth carbonates have been used to catalyze the CO2 gasification of coal chars prepared by pyrolysis of Illinois No. 6 coal. We have found that alkaline earth carbonates are fair gasification catalysts, through throughputs are insensitive to loadings in the range of 5 to 20% by weight. The order of efficacy is Ba Sr Ca. Alkali carbonates are excellent catalysts, with throughputs showing a dependence on loadings and atomic number. In particular, at high loadings (20% wt) the order is Cs K Na Li. As kinetic parameters for the alkali carbonate Boudouard reaction with coal chars differ significantly from that of graphites, an alternative redox cycle mechanism has been proposed involving an alkali hydride intermediate. GRA

N82-33481# Pittsburgh and Midway Coal Mining Co., Englewood, Colo.

SOLVENT REFINED COAL (SRC) PROCESS. EFFECT OF MIXING ENERGY ON HYDROGEN REACTION RATES IN SRC-11 REACTORS

C. P. P. SINGH, Y. T. SHAH, and N. L. CARR Jan. 1982 40 p refs
(Contract DE-AC05-76ET-10104)
(DE82-008447; DOE/ET-10104/50) Avail: NTIS HC A03/MF A01

An attempt was made to analyze theoretically the conditions which may lead to hydrogen starvation in SRC-II reactors. Literature correlations for mass transfer coefficients in bubble columns were combined with experimental data from a stirred vessel (CSTR) on the basis of specific power consumption. Specific power consumption, i.e., consumption of mixing energy per unit volume per unit time, is proportional to $N(3)$, where N is the stirred speed, and approximately proportional to superficial gas velocity (U_g) in a bubble column. For operating conditions selected to give maximum practicable reaction rate, i.e., under conditions of highest possibility of hydrogen starvation, results indicate that the fractional decrease in the rate of reaction would be insignificant (4%) for superficial gas velocity, U_g , above 1 cm/s. Based on the present study, it is believed that the higher the gas velocity (the longer the reactor) in the large scale reactor situation, hydrogen reaction rates will not be significantly influenced by mass transfer in normal operation of the reactor. DOE

N82-33483# Solvent Refined Coal International, Inc., Englewood, Colo.

STATUS REPORT FOR THE SOLVENT-REFINED-COAL (SRC-2) DEMONSTRATION PROJECT Final Summary Report

Feb. 1982 424 p
(Contract DE-AC05-78OR-03055)
(DE82-009653; DOE/OR-03055/T2) Avail: NTIS HC A19/MF A01

The status of the process design and related activities of the solvent refined coal (SRC-2) demonstration project are discussed. The following subjects are addressed: descriptions, including block flow diagrams, of the overall plant and of the individual units within the plant; rationale for the selection of the specific process used in each of the plant units; significant design and process changes which have been made since the Phase Zero conceptual design.

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Areas of technical risk and recommended mitigative actions; general operating philosophy; status of the various design project activities, such as environmental, permitting, and research and development support are also discussed. The purpose of the SRC-2 Demonstration Project was to demonstrate the technical and economic viability of the SRC-2 process with large scale equipment so that the risk of subsequent commercialization activity would be reduced. DOE

N82-33485# Advanced Fuel Research, Inc., East Hartford, Conn.

COAL GASIFICATION REACTIONS WITH ON-LINE IN-SITU FTIR ANALYSIS

P. R. SOLOMON and D. G. HAMBLEM 18 Dec. 1981 61 p refs

(Contract DE-AC01-81FE-05122)
(DE82-005658; DOE/FE-05122/T1) Avail: NTIS HC A04/MF A01

The entrained flow reactor was tested with four coals at temperatures up to 1200 C. The reactor works well and in situ gas analysis by Fourier transform infrared spectroscopy can be routinely performed. The initial data were reduced and compared to a previously developed pyrolysis model. The agreement between theory and experiment is good. The reactor, and plans for modification to improve the accuracy and completeness of the data are described. The pyrolysis model is reviewed and the most recent modifications employing distributed rate kinetics are discussed. The pyrolysis results are discussed and compared with the prediction of the model. DOE

N82-33487# Argonne National Lab., Ill. Fossil Energy Program. TECHNICAL EVALUATION: PRESSURIZED FLUIDIZED-BED COMBUSTION TECHNOLOGY

S. A. MILLER, G. J. VOGEL, S. M. GEHL, J. E. HANWAY, JR., R. F. HENRY, K. M. PARKER, E. B. SMYK, W. M. SWIFT, and W. F. PODOLSKI Apr. 1982 246 p refs
(Contract W-31-109-ENG-38)
(DE82-014903; ANL/FE-81-65) Avail: NTIS HC A11/MF A01

The technology of pressurized fluidized bed combustion, particularly in its application to a coal burning combined cycle plant, is evaluated by examining the technical status of advanced concept plant components - boiler system (combustor, air handling and air injection equipment, and heat exchangers); solids handling, injection, and ejection system; hot gas cleanup equipment; instrumentation control system; and the gas turbine - along with materials of plant construction. Environmental performance as well as energy efficiency are examined, and economic considerations are reviewed briefly. The evaluation concludes with a broad survey of the principal related research and development programs in the United States and other countries, a foreview of the most likely technological developments, and a summary of unresolved technical issues and problems. DOE

N82-33486# Little (Arthur D.), Inc., Cambridge, Mass. STAND-ALONE IGNITION DEVICES Final Report, 1 Dec. 1980 - 1 Nov. 1981

R. F. TOPPING Nov. 1981 55 p refs
(Contract GRI-5080-345-0375)
(PB82-180662; GRI-81/0019) Avail: NTIS HC A04/MF A01
CSCL 13A

Promising concepts for residential, non-pilot gas ignition systems for residential heating not requiring conventional electric connection were identified. Recommendations for future work to accelerate commercialization are presented. Concepts identified by a comprehensive literature survey and research task were evaluated. Overall feasibility, stage of development, applicability, reliability, cost/benefit, environmental impact, and safety were considered. Objective criteria were used to technically rank near and far term concepts and, assuming introduction during the mid to late 1980's, the commercial viability of each technically feasible concept was estimated. GRA

N82-33489# Environmental Protection Agency, Ann Arbor, Mich. Standards Development and Support Branch.

CONVERSION OF AMMONIA PLANTS TO METHANOL PRODUCTION

D. P. HEISER Feb. 1982 18 p refs
(PB82-177494; EPA-AA-SDSB-82-3) Avail: NTIS HC A02/MF A01 CSCL 07A

The technical feasibility and capital cost of converting an ammonia plant to a methanol plant, both using natural gas as a feedstock is examined. It was determined that the ammonia industry, which currently produces about 20 million tons of ammonia per year in the United States, could convert their facilities to produce 16.4 million tons per year of methanol, or a fuel oil equivalent of 150,000 barrels per day. Such a conversion would cost about \$2.1 billion, compared to a cost of \$3.1 billion for building new natural gas based methanol plants of the same capacity. While converting ammonia plants to methanol production has favorable capital costs over that of building new plants, the savings of one third is not large, particularly considering the effects of eliminating (or reducing) ammonia production. Thus, it would appear at this time that large savings cannot be obtained from the conversion of ammonia plants to methanol production. GRA

N82-33490# Environmental Protection Agency, Ann Arbor, Mich. Standards Development and Support Branch.

EXXON DONOR SOLVENT COAL LIQUEFACTION PROCESS

J. MCGUCKIN Feb. 1982 23 p refs
(PB82-177460; EPA-AA-SDSB-82-8) Avail: NTIS HC A02/MF A01 CSCL 07A

The history, technological feasibility, product quality, and cost of the Exxon donor process is examined. Available design studies addressing the process are critiqued and the best description and cost estimates are selected. The conclusion reached is as follows: a recent study by Exxon Research and Engineering was found to contain the most recent information on the EDS process. Increased costs and lowered process efficiencies render all older studies out-of-date. GRA

N82-33491# Environmental Protection Agency, Ann Arbor, Mich. Standards Development and Support Branch.

THE H-COAL AND SRC-2 PROCESSES

D. P. HEISER Feb. 1982 53 p refs
(PB82-173998; EPA-AA-SDSB-82-7) Avail: NTIS HC A04/MF A01 CSCL 07A

The product quality and cost of the H coal and solvent refined coal II (SRC-II) processes are examined. Available design studies addressing these processes are critiqued and the most accurate description and cost estimates are selected. The critique of the available studies shows that costs in constant dollars have risen dramatically over the last five years and that most of the available studies are now out of date. GRA

N82-33507# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

EFFECT OF SIMULATED MEDIUM-BTU COAL-GASIFIER ATMOSPHERES ON THE BIAxIAL STRESS-RUPTURE BEHAVIOR OF FOUR CANDIDATE COAL-GASIFIER ALLOYS

R. M. HORTON Oct. 1981 43 p refs
(Contract DE-AC07-76ID-01570)
(DE82-010614; EGG-FM-5657) Avail: NTIS HC A03/MF A01

Tests of four candidate alloys for internal use in coal gasifiers (Type 310 stainless steel, Incoloy 800H, Haynes 188, and IN-657) were conducted in four simulated coal gasifier atmospheres (CGA) up to approximately 500 h, to determine whether their biaxial stress rupture strength and life were adversely affected. Exposure to these atmospheres at temperatures below 11720 K did not decrease these rupture properties below those measured in air. Only at 12550 K were the rupture properties in the various CGA atmospheres consistently below those measured in air at atmospheric pressure. DOE

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N82-33550# Southwest Research Inst., San Antonio, Tex. Fuels and Lubricants Research Lab.

RESEARCH ON FIRE-RESISTANT DIESEL FUEL Interim Report, 1 Oct. 1979 - 31 Dec. 1981

W. D. WEATHERFORD, JR., G. E. FODOR, M. D. KANAKIA, D. W. NAEGELI, B. R. WRIGHT, and F. W. SCHAEKEL Dec. 1982 154 p refs

(Contract DAAK70-80-C-0001; DAAK70-82-C-0001; DA PROJ.

1L7-62733-AH-20; DA PROJ. 1T1-61102-AH-51; DA PROJ.

1L2-63104-D-150)

(AD-A117408; AFLRL-145; SWRI-6800-110) Avail: NTIS HC

A08/MF A01 CSCL 21D

When development of aqueous fire-resistant diesel fuel (FRF) was previously reported, it was shown that clear-to-hazy water-in-fuel, diesel fuel micro-emulsions could be prepared and that they exhibit reduced mist flammability and self-extinguishing pool fires at temperatures above the base fuel flash point. It was also demonstrated that unmodified diesel engines start, idle, and run without difficulty on such fuels. Research has been continued to establish compositional requirements for base fuels, surfactants, and water used in FRF formulations. DF-2, DF-1, DF-A, and NATO diesel fuel samples were obtained from refineries, bulk storage, and service stations. Aromatic concentrate (AC) products from various sources were evaluated for use in adjusting the total aromatic ring carbon (TARC) content of FRF formulations. Neat base fuel and AC-containing base fuel TARC effects on microemulsification efficacy were established for water containing various amounts of total dissolved solids and for the amide/amine/soap emulsifier with various levels of total acid number. GRA

N82-33551# Suntech, Inc., Marcus Hook, Pa.

AN EXPLORATORY RESEARCH AND DEVELOPMENT PROGRAM LEADING TO SPECIFICATIONS FOR AVIATION TURBINE FUEL FROM WHOLE CRUDE SHALE OIL, PART 5 Final Report, 2 Jan. 1979 - 1 Feb. 1982

H. E. REIF, J. P. SCHWEDOCK, and A. SCHNEIDER Wright-Patterson AFB, Ohio AFWAL Mar. 1982 142 p refs

(Contract F33615-78-C-2024; AF PROJ. 2480)

(AD-A117438; AFWAL-TR-82-2087-PT-5) Avail: NTIS HC

A07/MF A01 CSCL 21D

A computer model of Sun Tech's upgrading concept for converting 100,000 BPSD of raw Occidental shale oil into aviation turbine fuels has been developed. Using economic guidelines provided by the U.S. Air Force, the total liquid product cost when maximizing JP-4 jet fuel was \$1.22/gallon; \$1.24/gallon when maximizing JP-8 jet fuel; and \$1.19/gallon when producing JP-4 plus other fuels. Sensitivity analysis showed that the price of raw shale oil had the greatest impact on total liquid product costs.

Author (GRA)

N82-33557# Williams Bros. Engineering Co., Tulsa, Okla. Process Div.

ASSESSMENT OF UNDERGROUND COAL GASIFICATION IN BITUMINOUS COALS. VOLUME 1: EXECUTIVE SUMMARY Final Report

1981 117 p

(Contract DE-AC21-80MC-14584)

(DE82-014584; DOE/MC-14584/1193-VOL-1) Avail: NTIS HC

A06/MF A01

This report describes the bituminous coal resources of the United States, identifies those resources which are potentially amenable to Underground Coal Gasification (UCG), identifies products and markets in the vicinity of selected target areas, identifies UCG concepts, describes the state of the art of UCG in bituminous coal, and presents three R and D programs for development of the technology to the point of commercial viability. Of the 670 billion tons of bituminous coal remaining in place as identified by the National Coal Data System, 32.2 billion tons or 4.8% of the total are potentially amenable to UCG technology. The identified amenable resource was located in ten states: Alabama, Colorado, Illinois, Kentucky, New Mexico, Ohio, Oklahoma, Utah, Virginia, and West Virginia. The principal criteria

which eliminated 87.3% of the resource was the minimum thickness (42 inches). Three R and D programs were developed using three different concepts at two different sites. Open Borehole, Hydraulic Fracture, and Electrolinking concepts were developed. The total program costs for each concept were not significantly different. The study concludes that much of the historical information based on UCG in bituminous coals is not usable due to the poor siting of the early field tests and a lack of adequate diagnostic equipment. DOE

N82-33558# Oklahoma State Univ., Stillwater. Dept. of Chemistry.

CHARACTERIZATION OF COAL-DERIVED LIQUIDS AND OTHER FOSSIL-FUEL-RELATED MATERIALS EMPLOYING MASS SPECTROMETRY Final Report, 30 Sep. 1976 - 29 Sep. 1980

S. E. SCHEPPELE May 1982 40 p refs

(Contract DE-AS01-76ET-10589; EX-76-S-01-2537)

(DE82-015005; DOE/ET-10589/T1) Avail: NTIS HC A03/MF

A01

A document was prepared which assessed the state of the art in the mass spectrometric characterization of fossil fuel materials and the relevance of these data to the fossil fuel industry. A Kratos DS50 SM data system was successfully interfaced to a CEC 21-110B mass spectrometer. Communications between the NOVA 3/12 computer in the data system and the OSU central computer were established. A Grant Comparator/Microdensitometer was acquired and made operational. Plans were developed and hardware acquired for interfacing the densitometer to the NOVA 3/12 computer. A quartz direct introduction probe was acquired for the CEC 21-110B. A temperature controller for the probe was acquired and interfaced to the slow speed ADC on the auxiliary board in the data system/mass spectrometer interface. The combined FI/EI source was modified to operate in the FD mode and an apparatus was fabricated for conditioning FD emitters. A CSI supergrater 3 was interfaced to the PE 3920 gas chromatograph. The upgraded facility was used to develop mass spectrometric methods for the characterization of fossil fuel materials and to apply methods to the characterization of these materials. DOE

N82-33582# West Virginia Univ., Morgantown. Dept. of Mining Engineering.

STRESS DISTRIBUTION AND PILLAR DESIGN IN OIL SHALE RETORTS

S. S. PENG and R. E. THILL (Bureau of Mines, Twin Cities, Minn.) Jan. 1982 39 p refs

(PB82-176256; BM-RI-8597; LC-81-607827) Avail: NTIS HC

A03/MF A01 CSCL 08I

The design of retort interchamber pillars is important in determining surface stability over in situ retort mines and to the health and safety of miners, particularly with respect to possible escape of heat and toxic gases from retort chambers. Stress distribution in retort interchamber pillars, roof, and floor was examined with the aid of linear, finite-element analysis using data from experimentally determined mechanical properties. Properties determined included elastic moduli, strength, and creep constants in laboratory tests on core covering a 100-foot depth interval in the oil shale from the Piceance Basin in Colorado. The most critical stress concentration was found in the rib side of the interchamber pillar at a height above the floor line of 1.25 times the width. Guidelines for pillar design that consider pillar strength, creep, and retorting temperature effects are proposed. Author

04 FUELS AND OTHER SOURCES OF ENERGY

N82-33670# Argonne National Lab., Ill.
INFLUENCE OF SULFATION-ENHANCED SALT ADDITIVES ON THE CORROSION BEHAVIOR OF MATERIALS IN ATMOSPHERIC FLUIDIZED-BED COMBUSTORS

O. K. CHOPRA, G. W. SMITH, J. F. LENC, K. M. MYLES, and I. JOHNSON Dec. 1981 69 p refs
(Contract W-31-109-ENG-38)
(DE82-010204; ANL/CEN/FE-80-18) Avail: NTIS HC A04/MF A01

Increased utilization of CaO can reduce the amount of limestone required for SO₂ retention in atmospheric fluidized-bed combustion (AFBC) systems. A recently developed method of improving the utilization involves treating the limestone with various salts, such as NaCl, CaCl₂, or Na₂CO₃. The influence of these sulfation-enhancement salt additives on corrosion of candidate structural materials for AFBC systems was investigated. Four 100-h and two 1000-h corrosion test runs were conducted in a 152-mm-ID fluidized bed coal combustor. In each run, three air cooled corrosion probes and four uncooled corrosion coupon holders, each with seven specimens were installed at various locations in the fluidized bed and freeboard sections of the combustor. The temperature of the corrosion specimens ranged from 400 to 8500 C. As controls, some of the runs were made without any salt additions. The results indicate that the presence of salt has no effect on the corrosion behavior of the various iron and nickel base alloys that were placed in the freeboard section of the combustor. Although the uncooled alloys within the fluidized bed do undergo oxidation/sulfidation corrosion, the addition of CaCl₂ does not further affect the corrosion rate; the addition of NaCl or Na₂CO₃ increases the corrosion rates for the high nickel alloys, but not for the stainless steels. The observed corrosion rates for all of the alloys from within the fluidized bed containing approximately 2 mol% CaCl₂ or Na₂CO₃ are in good agreement with the rates reported in other similar studies without salt additions. The corrosion data and a metallographic evaluation of the corrosion specimens are presented. DOE

N82-33692# Department of Energy, Pittsburgh, Pa. Energy Technology Center.

APPARATUS DEVELOPMENT FOR MEASURING HEAT FLUX IN A DIRECT COAL-LIQUEFACTION PREHEATER

R. M. KORNOISKY, M. PERLMUTTER, W. FUCHS, and J. A. RUETHER Apr. 1982 68 p refs
(DE82-012013; DOE/PETC/TR-82/8) Avail: NTIS HC A04/MF A01

A device is evaluated for determining heat flux in a direct coal liquefaction preheater. The heat fluxmeter determines heat flux from measurements of temperature difference across the preheater tube wall at a given plane perpendicular to the tube axis. Six fluxmeters were installed in a 5.08 m length of nominal 1 1/2 inch diameter, schedule XX pipe enclosed in stacked electric furnaces. Heat flux to a heat transfer fluid flowing through the pipe was measured and compared to values predicted by the fluxmeters. Fair agreement was observed, and the method can be used as an empirical calibration procedure for fluxmeters. A number of apparatus improvements were identified that will be incorporated in the planned experimental program. DOE

N82-33805# Western Geophysical Co. of America, Houston, Tex. Aero Service Div.

AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY: ALTURAS QUADRANGLE, CALIFORNIA Final Report

May 1981 110 p refs Prepared for Bendix Field Engineering Corp., Grand Junction, Colo.
(Contract DE-AC13-76GJ-01664)
(DE82-005539; GJBX-406-81-VOL-1) Avail: NTIS HC A06/MF A01

An airborne high sensitivity gamma-ray spectrometer and magnetometer survey was conducted over ten (10) areas over northern California and south western Oregon. These include the 20 x 10 NTMS quadrangles of Roseburg, Medford, Weed, Alturas, Redding, Susanville, Ukiah, and Chico along with the 10 x 20

areas of the Coos Bay quadrangle and the Crescent City/Eureka areas combined. This report discusses the results obtained over the Alturas, California, map area. Traverse lines were flown in an east-west direction at a line spacing of six (6) miles. Tie lines were flown north-south approximately eighteen (18) miles apart. A total of 16,880.5 line miles of geophysical data were acquired, compiled, and interpreted during the survey, of which 1631.6 line miles are in this quadrangle. The purpose of this study is to acquire and compile geologic and other information with which to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States. DOE

N82-33806# Bendix Field Engineering Corp., Grand Junction, Colo.

GRAND JUNCTION AREA OFFICE, UNITED STATES DEPARTMENT OF ENERGY 1980/1981 ACTIVITIES REPORT

Mar. 1982 70 p
(Contract DE-AC13-76GJ-01664)
(DE82-009638; GJBX-11-82) Avail: NTIS HC A04/MF A01

Geologic, geochemical, geophysical, and other data were acquired which contributed to assessment of the distribution and magnitude of uranium resources of the United States as well as to determination of areas favorable for the occurrence of uranium and to establishment of potential resource estimates. The data collection phase of the NURE program was organized around six major activity elements: quadrangle evaluation, data acquisition, resource assessment, geologic studies, technology applications, and mineral economics. This fifth activities report presents summary results on work performed during the period 1980/1981 in each of these element areas, together with appendices that cite individual project data and resulting reports. By the end of 1981, evaluation of an additional 28 quadrangles had been completed, bringing to 163 the total number covered by the NURE program. DOE

N82-33807# Science Applications, Inc., Golden, Colo.

FLOW CHARACTERISTICS IN GEOPRESSURED ZONES AND SALT WATER AGULFERS Annual Report, Sep. 1980 - Aug. 1981

B. AMIRIJAFARI, F. RIGBY, and W. E. SIMMONS Sep. 1981 93 p refs Sponsored by Gas Research Inst.
(PB82-181280; GRI-81/0041) Avail: NTIS HC A05/MF A01 CSDL 081

A simple numerical model was developed to investigate the effects of gas evolution in geopressured flow and was used to study the combined effects of production strategy, completion design, and aquifer characteristics on production and reinjection. Well cost estimates were made and tradeoffs between well cost and increased productivity for some well design options were calculated. Model requirements for predicting aquifer pore clogging were discussed. GRA

N82-33812# Bituminous Coal Research, Inc., Monroeville, Pa.
FIELD SURVEY OF FLOAT DUST IN COAL MINING OPERATIONS Research Report, Mar. 1980 - Mar. 1981

J. A. KOST, J. F. COLINET, and G. A. SHIREY Oct. 1981 163 p
(Contract DI-BM-J0-308030)
(PB82-172719; BM-OFR-17-82) Avail: NTIS HC A08/MF A01 CSDL 081

The amount, size, and deposition of float coal dust generated during the mining and transporting of coal in underground mining operations were determined. Rock dust distributed by trickle dusters was also sampled. In addition to four belt transfer points, two continuous and two conventional mining sections were sampled at five mines. Float dust samples were collected on deposition pans; total airborne dust was collected with personal samplers equipped with filter cassettes; cascade impactors provided relative size distributions of the samples. production, air flow, and water flow were monitored to examine their effect on dust levels. GRA

04 FUELS AND OTHER SOURCES OF ENERGY

N82-33827*# Solar Turbines International, San Diego, Calif.
LOW NOX HEAVY FUEL COMBUSTOR CONCEPT PROGRAM
Final Report

D. J. WHITE, R. T. LECREN, and A. P. BATAKIS Nov. 1981
93 p refs

(Contract DEN3-145; DE-AI01-77ET-13111)
(NASA-CR-165481; DOE/NASA/0145-1; NAS 1.26:165481;
SR81-R-4761-21) Avail: NTIS HC A05/MF A01 CSCL 10B

A total of twelve low NOx combustor configurations, embodying three different combustion concepts, were designed and fabricated as modular units. These configurations were evaluated experimentally for exhaust emission levels and for mechanical integrity. Emissions data were obtained in depth on two of the configurations. R.J.F.

N82-33835# Ultrasystems, Inc., Fairfax, Va.
ADVANCED BIO-ENERGY SYSTEMS FOR AIR FORCE
INSTALLATIONS Final Report, Feb. 1980 - Jan. 1981

W. J. HUFF and D. H. BOND Oct. 1981 100 p refs
(Contract DACA31-80-D-0020; AF PROJ. 2054)

(AD-A117084; FESA-T-2110; AFESC/ESL-TR-81-11) Avail:
NTIS HC A05/MF A01 CSCL 01A

This investigation was sponsored by the US Air Force to determine the potential of using innovative biomass energy conversion technology interface with in place energy generating hardware to sustain total annual facility energy requirements on a forested airbase. The investigation found that Eglin AFB, FL, has high potential for such a system, but that certain components and subsystems require test, evaluation and demonstration in an Air Force base environment before full implementation is possible. The investigation found that a biomass energy island system could be achieved through a centralized biomass gasification/combined cycle system to produce 135,000 lb/hr 150 psig steam (saturated) and 27 Mwh/hr electrical power from 1480 green tons of wood chips daily. A phased implementation system is recommended, consisting of separate integrable test and evaluation modules for combined cycle wood gasification and for cogeneration, which would dovetail into an expanded basewide energy self sufficient system. The investigation did not consider harvestation of base woodlands, which is the subject of a separate effort to define the wood resource aspects of a total biomass self-sufficient system.

Author (GRA)

N82-33843# Woods Hole Oceanographic Institution, Mass.
BIOMASS PRODUCTION, ANAEROBIC DIGESTION, AND
NUTRIENT RECYCLING OF SMALL BENTHIC OR FLOATING
SEAWEEDS

J. H. RYTHER Feb. 1982 45 p
(Contract DE-AC02-77CH-00178; EY-76-S-02-2948)
(DE82-009172; SERI/TR-98133-1B) Avail: NTIS HC A03/MF
A01

The development of a seaweed based ocean energy farm was studied. Forty two species of seaweed indigenous to the coastal waters of Central Florida were screened for high biomass yields in intensive culture. Yield varies inversely with seawater exchange rate, apparently because of carbon dioxide limitation at low exchange rates. The suitability of digester residue as a nutrient source for growing Gracilaria was studied. Nitrogen recycling efficiency from harvested plant through liquid digestion residue to harvested plant approaches 75%. It is shown that nutrient uptake and storage by Gracilaria, Ascophyllum, and Sargassum on nutrient starved plants are capable of rapidly assimilating and storing inorganic nutrients which may be used later for growth when no nutrients are present in the medium. A shallow water seaweed farm is proposed which can produce methane from harvested seaweed and use digester residues as a concentrated source of nutrients for periodic fertilizations. DOE

N82-33855# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

DESIGN OF THE GLENWOOD SPRINGS DOWNHOLE HEAT EXCHANGER

P. CHIU Apr. 1982 24 p refs
(Contract DE-AC07-76ID-01570)

(DE82-013809; EGG-GTH-5812) Avail: NTIS HC A02/MF A01

A heat exchanger has been designed to obtain 250,000 Btu/hr from a 20 in. diameter geothermal well at various brine temperatures. The system consists of a 10 in. diameter plastic pipe to promote convective flow in the well and a 4 in. diameter, Schedule 40 steel U-tube containing distilled water to extract the energy. Subject to the validity of the major assumptions, the required lengths of one leg of the U-tube at various brine temperatures are 34 ft (1500 F), 42 ft (1400 F), 54 ft (1300 F), and 75 ft (1200 F) for a mean working fluid temperature of 900 F. GRA

N82-33856# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

GEOHERMAL CONVERSION AT VETERANS HOSPITAL, BOISE, IDAHO

I. A. ENGEN and S. W. METZGER Feb. 1982 17 p
(Contract DE-AC07-76ID-01570)

(DE82-012198; EGG-GTH-5573) Avail: NTIS HC A02/MF A01

A geothermal resource near the Veterans Administration Hospital facilities in Boise, Idaho, has been used since the turn of the century for space heating of homes. A plan for using this resource in some of the Veterans Hospital facilities is discussed. Preliminary cost estimates are presented, economic evaluation criteria are given, and heating system alternatives for the facilities are compared. GRA

N82-33862# Stanford Univ., Calif. Petroleum Research Inst.
PRELIMINARY STUDY OF IN-SITU COMBUSTION IN
DIATOMITES

M. R. FASSIHI, S. ABU-KHAMSIN, W. E. BRIGHAM, L. A. WILLIAMS, and S. A. GRAHAM Mar. 1982 36 p refs
(Contract DE-AC03-76ET-12056)

(DE82-013272; DOE/ET-12056/32; SUPRI-TR-32) Avail: NTIS
HC A03/MF A01

The feasibility of applying in-situ combustion techniques to diatomaceous reservoirs, was examined for a section of core taken in the south plunge of the anticline in the Lost Hills field of the San Joaquin Valley in California was examined. A fast steam plateau, good oxygen utilization, and an unusual front were observed. Fingering caused formation of a second front downstream. This finger stabilized and later became very hot (16000 F). Velocity of front movement through the core almost doubled after the two fronts joined. The cores were compared before and after combustion by scanning microscopy, power X-ray diffraction, and extraction techniques. After burning, the sediments changed from dark brown to red in color. Small numbers of diatom frustules were transformed from amorphous opal to quartz, with accompanying occlusion of pore spaces. With the exception of the color change, however, the sediments remained largely unaltered. DOE

N82-33863# Los Alamos Scientific Lab., N. Mex.
HOT-DRY-ROCK GEOTHERMAL RESOURCE 1980

G. HEIKEN, ed., F. GOFF, ed., and G. CREMER, ed. Apr. 1980
116 p refs

(Contract W-7405-ENG-36)

(DE82-015082; LA-9295-HDE) Avail: NTIS HC A06/MF A01

The work performed on hot dry rock (HDR) geothermal resource evaluation, site characterization, and geophysical exploration techniques is summarized. The work was done by region (Far West, Pacific Northwest, Southwest, Rocky Mountain States, Midcontinent, and Eastern) and limited to the conterminous US.

DOE

04 FUELS AND OTHER SOURCES OF ENERGY

N82-33870# Kinetics Technology International Corp., Pasadena, Calif.

ASSESSMENT OF A COAL-GASIFICATION FUEL-CELL SYSTEM FOR UTILITY APPLICATION Final Report

P. G. CRONIN, A. J. MURPHY, R. J. NEWTON, and E. S. WAGNER May 1982 163 p refs Sponsored by EPRI (Contract EPRI PROJ. 1041-8) (DE82-903667; EPRI-EM-2387) Avail: NTIS HC A08/MF A01

The technical and economic feasibility of a coal gasification-advanced phosphoric acid fuel cell power plant for electric utility application were defined and assessed. The system design criteria selected resulted in a modular, relatively small sized power plant that could be configured with a basic building block of approximately 11 MW. A range of coals and lignite was evaluated as the basic feedstock for a low-Btu fixed-bed conventional air-blown coal gasifier. The system included gas processing, cleanup, compression and delivery of sulfur-free hydrogen-rich gas to an advanced phosphoric acid fuel cell. Equipment erection and operating costs, in 1981 dollars, were solicited from American industry for all process sections. The plant was designed and evaluated on the basis of low capital cost, lowest overall heat rate and, as far as possible, with off-the-shelf technology. A 44 MW lignite example plant utilizing the basic building block concept was defined and evaluated for Lincoln, Nebraska, as an example site. DOE

N82-33873# Procedyne Corp., New Brunswick, N. J.
CONVERSION OF WASTE PLASTICS TO FUEL OIL Final Report, 18 Sep. 1979 - 31 Oct. 1981

R. B. ROAPER and J. BHATIA Oct. 1981 188 p refs (Contract DE-AC01-79CS-40076) (DE82-002454; DOE/CS-40076/T1) Avail: NTIS HC A09/MF A01

Most of the plastics in use in the world today are produced from crude oil. This increased use of plastics results in an increased generation of discard and waste. In the case of thermoplastics, the types which constitute the bulk of the plastics in high volume use, it is theoretically possible to recycle discard and waste into virgin plastics. However, due to type incompatibility, and contamination with foreign materials, this approach has not proven economically feasible except for a small quantity of the discard and waste stream. A pyrolysis process was successfully demonstrated which converted atactic polypropylene, APP, to fuel oil and a small fraction of fuel gas. In the current program, a commercial plant, with capacity of 17,000,000 lb/year feedstock, was designed for the pyrolysis of APP waste to fuel oil. In addition, the feasibility of this approach was extended to waste or discarded isotactic polypropylene, PP, and low density polyethylene, LDPE, through pilot plant work, process design, and economic considerations. DOE

N82-33876# Westinghouse Research and Development Center, Pittsburgh, Pa. Chemical Engineering Dept.

MECHANISMS AFFECTING MASS TRANSFER IN FUEL CELLS

R. A. WENGLARZ 15 Mar. 1982 27 p refs (Contract DE-AM06-77RL-00600) (DE82-013431; DOE/RL-00600/T1) Avail: NTIS HC A03/MF A01

Particulate effects on molten carbonate fuel cells were analyzed. The analysis has been applied to a conceptual fuel cell with operating parameters appropriate to use with future power generation plants. Particle transport due to several mechanisms was considered and dominant mechanisms affecting particle delivery to anode channel surfaces and into anode pores were identified. Thermophoresis and gas flow out from anode pores are found to inhibit particle arrival on the anode and entry into pores so that neither anode channel blockage nor pore blockage are expected for particles with diameters smaller than about one micron. It is suggested that analytical approach could be applied to other fuel cell types in addition to the molten carbonate fuel cells. DOE

N82-33961# Southern Solar Energy Center Planning Project, Atlanta, Ga. Wind Program Div.

WIND ENERGY FEASIBILITY ASSESSMENT FOR THE US VIRGIN ISLANDS, SITING ASSESSMENT, ECONOMIC STUDY AND PROJECT PLAN

D. E. BALL, ed. Feb. 1981 110 p refs (DE82-009476; SSEC/TP-31262) Avail: NTIS HC A06/MF A01

A preliminary assessment of the wind energy potential in the US Virgin Islands is presented. Based upon the results of this assessment and a study of the topography of the islands, potential sites for wind energy conversion systems (WECS) are identified on St. Croix, St. Thomas, and St. John. Historical wind data from the islands is sparse and the analysis techniques used in this study are relatively unsophisticated. Therefore, the identification of potential WECS sites must be considered extremely preliminary. DOE

N82-33962# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

THE APPLICATION OF US UPPER-WIND DATA IN ONE DESIGN OF TETHERED WIND ENERGY SYSTEMS

R. J. ODOHERTY and B. W. ROBERTS Feb. 1982 133 p refs (Contract DE-AC02-77CH-00178; EG-77-C-01-4042) (DE82-012880; SERI/TR-211-1400) Avail: NTIS HC A07/MF A01

The upper atmospheric wind resource for the continental United States, Hawaii, and Alaska was assessed. The probability distributions of velocity are presented for 54 sites, and detailed calm wind analyses were undertaken for five of these locations. On the average, the wind lulls about 1 day per week for a period in excess of about 30 hours. It is shown that the average power density of this wind resource can be as high as 16 kW/m² at northeastern US sites. This power density is at a maximum around the 300 mb pressure level. DOE

05

ENERGY CONVERSION

Includes thermomechanical, thermoelectric, geothermal, ocean thermal, and wind energy conversion. Also includes nuclear reactors, magnetohydrodynamic generators, and fuel cells.

A82-38146

EFFICIENT OPTIMUM DESIGN OF STRUCTURES - PROGRAM DDDU

L.-X. QIAN, W. ZHONG, Y. SUI, and J. ZHANG (Dalian Institute of Technology, Dalian, People's Republic of China) Computer Methods in Applied Mechanics and Engineering, vol. 30, May 1982, p. 209-224. refs

An efficient optimization algorithm is developed for engineering structures subject to multiple constraints. This highly non-linear and implicit problem is reduced to a combination of a sequence of quasi-linear constraints and explicit problems of the statically determined structures. The method is based on the Kuhn-Tucker necessary conditions for optimality associated with a simple quadratic program designed simultaneously to determine the Lagrange multipliers and to delete non-active constraints. A number of examples including trusses and wing structures show that the method is efficient when compared with other competing techniques. (Author)

A82-38150

STUDY ON FREQUENCY CHARACTERISTICS OF A SMALL-SCALE WIND POWER SYSTEM WITH A D.C. GENERATOR

T. SUZUKI, H. OKITSU (Tokushima, University, Tokushima, Japan), and T. KAWAHITO (Takamatsu Technical College, Takamatsu, Japan) Wind Engineering, vol. 6, no. 2, 1982, p. 74-84. refs

The frequency characteristics of a small dc windpowered generator are modeled in terms of a transfer function for the shaft speed and output variation due to changes in the wind speed. The perturbation method is employed for the development of the transfer functions, which are approximated as a form of a first order lag element. It is found that the gain constant increases proportionally to the load resistance. The results are compared to tests with a two-blade horizontal axis dc wind turbine, and good agreement is found. Extension of the method to predicting optimal working points for large wind turbines, wind energy systems with battery storage, and wind turbines using alternators is indicated.

M.S.K.

A82-38174

LIQUID-METAL MHD-GENERATOR SYSTEM WITH AN INDUCTIVE ENERGY STORAGE UNIT [СИСТЕМА ЗИДКОМЕТАЛЛИЧЕСКОГО МГД-ПРЕОБРАЗОВАНИЯ ЭНЕРГИИ С ИНДУКТИВНЫМ НАКОПИТЕЛЕМ]

G. A. BARANOV, V. V. BREEV, K. I. DMITRIEV, B. G. KARASEV, and I. V. LAVRENTEV Magnitnaia Hidrodinamika, Apr.-June 1982, p. 84-90. In Russian. refs

The paper examines a liquid-metal MHD generator system intended as an electrical energy source for a thermonuclear reactor. The optimal characteristics of the system are examined, and it is shown, by feeding the inductive energy storage unit from the MHD generator, it is possible to achieve a total efficiency of 40% for a stored energy of 10-1000 MJ in the inductive unit.

B.J.

A82-38198

DYNAMICS AND STABILITY OF WIND TURBINE GENERATORS

E. N. HINRICHSSEN and P. J. NOLAN (Power Technologies, Inc., Schenectady, NY) (Institute of Electrical and Electronics Engineers, Summer Meeting, Portland, OR, July 26-31, 1981.) IEEE Transactions on Power Apparatus and Systems, vol. PAS-101, Aug. 1982, p. 2640-2648. refs

This paper describes the dynamic and stability properties of wind turbine generators connected to power systems. Both synchronous and induction generators are considered. A comparison is made between wind turbines, steam, and hydro units. The unusual phenomena associated with wind turbines are emphasized. The general control requirements are discussed, as well as various schemes for torsional damping such as speed sensitive stabilizer and blade pitch control. Interaction between adjacent wind turbines in a 'wind farm' is also considered.

(Author)

A82-38435

ALTERNATE EXPRESSIONS FOR THE AVERAGE OUTPUT POWER OF A WIND MACHINE

W. R. POWELL (Johns Hopkins University, Laurel, MD) Solar Energy, vol. 28, no. 6, 1982, p. 551, 552. Research supported by the U.S. Coast Guard (Contract N00024-81-C-5301)

A82-38673

ENERGY ACCOUNTING OF RIVER SEVERN TIDAL POWER SCHEMES

F. ROBERTS Applied Energy, vol. 11, July 1982, p. 197-213. refs

Energy accounting comparisons are constructed in order to make an economic analysis of three different tidal generating schemes for the Severn River in Britain. The plans included ebb generation, flood generation, and turbine-sluice configurations, and the analysis comprised totaling the energy needed to complete the construction in relation to the projected output. Necessary

construction components numbered caissons, shipping locks, embankments, transmission facilities, and turbines, with inputs limited to 1.75%/yr once the installations are completed. The total outputs for the installations were modeled as 12, 18, and 18 TWh/yr, respectively, with a projected lifetime of 120 yr. The least output/input ratio was found to be 10:1, with a highest possible value of 16:1. The energy return is highest with the smallest installation, a factor which is offset by the increased return with larger capacity.

M.S.K.

A82-38755

COATING MOLYBDENUM WITH A DIRECTIONALLY SOLIDIFIED METAL CERAMIC EUTECTIC - MO-AL₂O₃, CR₂O₃

L. R. WOLFF (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands) In: Plansee Seminar, 10th, Reutte, Austria, June 1-5, 1981, Proceedings. Volume 1. Reutte, Austria, Metallwerk Plansee GmbH, 1981, p. 131-140. refs

A new technique for the directional solidification of eutectic coatings has been developed in the course of the Cermet Project, a program aimed at the development of a cermet emitter material for a thermionic converter. The coating technology is described, and its advantages over previous directional solidification techniques are examined. Directionally solidified Mo-Al₂O₃, Cr₂O₃ coatings on Mo substrates have been produced on the basis of this technique, which is not restricted to this bivalent quaternary system.

B.J.

A82-38825#

SUPERCONDUCTING HOMOPOLAR MACHINERY - LIQUID METAL CURRENT COLLECTION AND DESIGN PRINCIPLES

J.-T. ERIKSSON (Tampere Institute of Technology, Tampere, Finland) Acta Polytechnica Scandinavica, Electrical Engineering Series, no. 48, 1982. 186 p. Research supported by the Foundation of Technical Advance. refs

The current collection problem of superconducting homopolar machines is treated. Auxiliary rotors at each end of the armature winding provide full torque at zero speed; the velocity dividing effect of this arrangement decreases collector losses by about a factor of 2.5 compared to conventional designs. Porous electrode surfaces made from spun tungsten wire are used, and experiments showed that as a cover liquid, oxalic acid provides excellent reducing properties. Adding 0.2 M sodium perchlorate suppresses the emulsification tendency. The ejection instability is phenomenologically explained using Kelvin-Helmholtz concepts, and is experimentally supported. The design procedure for superconducting homopolar machines is presented, offering a practical working tool for rough estimation of losses, efficiency, adequate number of armature current loops and the required amount of superconducting wire. The algorithm provides a convenient way of investigating parameter interconnections.

C.D.

A82-39183

THERMO-ELECTRIC COOLER TECHNOLOGY

G. L. DAVIS (Mullard, Ltd., Mitcham, Surrey, England) In: Advanced infrared detectors and systems; Proceedings of the Symposium, London, England, October 29, 30, 1981. London, Institution of Electrical Engineers, 1981, p. 40-47. Research supported by the Ministry of Defence (Procurement Executive). refs

The historical background of thermo-electric cooling is examined. Basic thermo-electric laws include the Seebeck effect, the Peltier effect, and the Thompson effect. After the advent of the semiconductor, the late 1950's saw a resurgence of interest in thermo-electrics. Questions of device design and construction are discussed, taking into account the principles of the heat pump, and the design of coolers. Attention is given to materials requirements, materials properties, materials preparation, the processing of thermo-electric materials, the connector system, problems of assembly, device performance in the case of two-stage and four-stage coolers, applications, and future possibilities.

G.R.

05 ENERGY CONVERSION

A82-39235

SOLUTION TO INSTABILITY PROBLEMS OF GRID-CONNECTED PWM DC-AC INVERTERS

L. BONTE, D. BAERT, J. VANDAMME, J. DE BILDE, and W. DHOOGHE (Gent, Rijksuniversiteit, Ghent, Belgium) *Electronics Letters*, vol. 18, July 8, 1982, p. 600-602. Research supported by the Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture.

The stability properties of the forward and the flyback inverter are compared. The former combines high efficiency, reliability, and power capacity. In order to obtain low distortion and to avoid problems with the firing and the quenching of thyristors, the switching frequency must be externally determined. Instabilities are avoided by means of a described feedback loop; increasing the low-frequency open circuit gain with the wrong circuit parameter decreases the output power. A free-running inverter is found not to be suitable for grid-connected applications. The forward inverter has 250 W capacity, its input voltage is 48 V and the efficiency is 75 percent at 100 W, a good result for a very low input voltage. The switching frequency is 50 kHz. C.D.

A82-39281

CHEMICAL SOURCES OF CURRENT [KHIMICHESKIE ISTOCHNIKI TOKA]

V. S. BAGOTSKII and A. M. SKUNDIN Moscow, *Energoizdat*, 1981. 360 p. In Russian. refs

The design and operation of primary cells, storage cells, and electrochemical generators are discussed, with attention given to the principles underlying cell processes. Chemical current sources of various types are described. The primary intent of the study is to explain why a particular chemical current source has the properties that it does. C.R.

A82-39775

INFLUENCE OF A FAIRING ON THE EFFICIENCY OF A SAVONIUS ROTOR [INFLUENCE D'UN CARENAGE SUR LE RENDEMENT D'UNE EOLIEUSE SAVONIUS]

M. BOTRINI and A. CHAUVIN (Aix-Marseille I, Universite, Marseille, France) *Entropie*, vol. 18, no. 104, 1982, p. 89-92. In French. refs

An attempt to improve the power coefficient and moment of the Savonius rotor by placing a fairing in front of the upwind-turning convex vane is described. A model was tested in a subsonic wind tunnel using a partially overlapping design, with trials run at 12.5 and 15 m/sec wind velocities using two different fairing configurations, one short and one long. The efficiency was calculated in terms of the free stream wind speed to the speed of the rotor, and it was found that the increase in power converted was sensitive to the length of the fairing. The longer fairing produced higher power coefficients. The ramp was concluded to augment the actual flow entering the rotor, in addition to reducing drag on the upwind-turning rotor. M.S.K.

A82-40421*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PRELIMINARY ANALYSIS OF A DOWNSIZED ADVANCED GAS-TURBINE ENGINE IN A SUBCOMPACT CAR

J. L. KLANN and R. L. JOHNSEN (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 23 p. refs

(Contract DE-AI01-77CS-51040)

(AIAA PAPER 82-1167)

(Previously announced in STAR as N82-26051)

A82-41136

ELECTROCHEMICAL PHOTOVOLTAIC CELLS BASED ON N-GAAS AND THE TRIIODIDE/IODIDE REDOX COUPLE IN ACETONITRILE

M. E. LANGMUIR, M. A. PARKER, and R. D. RAUH (EIC Laboratories, Inc., Newton, MA) *Electrochemical Society, Journal*, vol. 129, Aug. 1982, p. 1705-1710. Navy-supported research refs

(Contract XP-9-8002-7)

The electrochemical photovoltaic cell (EPC) based on n-GaAs and a CH₃CN, I₃(-)/I(-) redox electrolyte was evaluated. Greater than 1M I(-) was necessary to avoid concentration polarization at the photoanode above moderate illumination intensities. The charge separation at the illuminated n-GaAs/electrolyte interface was enhanced by adsorption of Se(2-) and Ru+3 or by complexing polymers such as polyvinyl pyrrolidone. In practical cells, a compromise is necessary between light absorption by I₃(-), and having sufficient I₃(-) to depolarize the counterelectrode. Best 'solar cell' efficiency in the quiescent electrolyte under 53 mW/sq cm irradiation was about 3.4% with an open-circuit voltage of 0.60, short-circuit current of 9 mA/sq cm, and fill factor 0.34 with no corrections for solution absorbance or cell reflectance. (Author)

A82-41138

THE SPECIFIC CONDUCTANCE OF MOLTEN CARBONATE FUEL CELL TILES

P. G. GLUGLA and V. J. DECARLO (General Electric Co., Schenectady, NY) *Electrochemical Society, Journal*, vol. 129, Aug. 1982, p. 1745-1747. Research supported by the Electric Power Research Institute. refs

The specific conductance of molten carbonate fuel cell electrolyte layers was examined. Two types of tiles, one prepared by electrophoretic deposition and one hot-pressed, both 45% LiAlO₂ by weight and 55% lithium potassium carbonate, with the former being 51% porous with pores averaging 0.25 microns, were tested. A four probe ac impedance technique was employed to measure the conductance by inputting an ac signal and assaying the impedance, which varied 2% over a 1-50 kHz range. The measurements were performed from room temperature to 800 C. Sample resistance below the melting point of the carbonate, 496 C, was 5000 ohms, and reduced to 0.1 ohm when the carbonate melted. Trials with an oxidant gas and a fuel gas revealed that the specific conductance is independent of the atmosphere. M.S.K.

A82-41246* Tennessee Univ. Space Inst., Tullahoma.

A DISCRETE GUST MODEL FOR USE IN THE DESIGN OF WIND ENERGY CONVERSION SYSTEMS

W. FROST (Tennessee, University, Tullahoma, TN) and R. E. TURNER (NASA, Marshall Space Flight Center, Huntsville, AL) *Journal of Applied Meteorology*, vol. 21, June 1982, p. 770-776. Research supported by the U.S. Department of Energy. refs

A discrete gust model has been designed which includes an expression for the number of times per unit time thy wind exceeds a specific value. This expression, based on Rice's (1944, 1945) number-of-crossings model, assumes that the yearly mean wind speed is averaged over a period of 10 minutes to 1 (one) hour. Vertical and lateral coherence functions are the basis for a mathematical filter which isolates atmospheric disturbances of a characteristic size (e. g., those which would completely engulf a rotor). Predictions are calculated using the given definition of cut-off frequency, then they are compared with actual data, showing that the model is reliable. The expression is provided in a format such that it may be used for engineering design calculations. R. K. R.

A82-42367* Ford Motor Co., Dearborn, Mich.
CERAMIC TECHNOLOGY FOR AUTOMOTIVE TURBINES
 A. F. MCLEAN (Ford Motor Co., Ceramic Materials Dept., Dearborn, MI) American Ceramic Society Bulletin, vol. 61, Aug. 1982, p. 861-865, 871. Research supported by the U.S. Department of Energy, U.S. Army, DARPA, and NASA. refs
 (ACS PAPER 1-CT-81P)

The paper presents an update on ceramic technology for automotive turbines. Progress in research and development of improved ceramics is reviewed, including approaches for assessing time-dependent strength characteristics. Processes for making shapes are discussed, and the design and testing of selected ceramic turbine components are reviewed. (Author)

A82-42548
WAVE POWER CONVERSION BY POINT ABSORBERS - A NORWEGIAN PROJECT

K. BUDAL and J. FALNES (Norges Tekniske Hogskole, Trondheim, Norway) International Journal of Ambient Energy, vol. 3, Apr. 1982, p. 59-67. Research supported by the Olje-og energidepartementet. refs

This paper describes a spherical buoy, which can perform heaving oscillation relative to a strut joined to an anchor on the sea bed. The buoy is supplied with latching means for optimum phase control and with an air turbine for power take-off. The electrical generator is rated at 0.4 MW. An estimate is given for the cost of a 200 MW power plant and for its annual energy production if placed off the west coast of Norway. The estimated electricity cost is approximately 4 p/kWh. At the present stage of the research, it is consequently not competitive with hydroelectric power plants in Norway. However, there are several options for cost reduction of a power-buoy plant. (Author)

A82-43067#
PERFORMANCE OF TORNADO WIND ENERGY CONVERSION SYSTEMS

T. VOLK Journal of Energy, vol. 6, Sept.-Oct. 1982, p. 348-350. Research supported by the New York State Energy Research and Development Authority and State of New York Power Authority. refs

Experimental results for operation of a Lexan laboratory scale model of a tornado wind energy conversion system (TWECS) are analyzed. Smoke was released through the bottom inlet region, while louvers on the tower created a confined vortex from air entering the tower. Flow velocity measurements were made and visualization was achieved by placing tufts on pitot tubes at various points of the flow. Power was assayed by means of a turbine dynamometer which produced simultaneous torque and angular velocity data. A velocity distribution inside the tower was mapped out, and it was found that the vortex in the tower exhibited characteristics of a solid-body rotation, rather than a Rankine vortex. Separate tests with the tower wrapped so only a chimney effect was presented revealed that only 30% power augmentation was gained with the presence of the louvers. Further studies to determine how a pressure gradient may form in the tower are indicated. M.S.K.

A82-43068#
COMMENT ON 'DYNAMIC ROTOR LOADS OF A WIND TURBINE VIA HAND-HELD CALCULATORS'

A. WORTMAN (AWD, Inc., Santa Monica, CA) Journal of Energy, vol. 6, Sept.-Oct. 1982, p. 351; Author's Reply, p. 352. refs

A82-43070
POWER AUGMENTATION OF CHEAP, SAIL-TYPE, HORIZONTAL-AXIS WIND-TURBINES

P. D. FLEMING and S. D. PROBERT (Cranfield Institute of Technology, Cranfield, Beds., England) Applied Energy, vol. 12, Sept. 1982, p. 53-70. Research supported by the Science and Engineering Research Council. refs

A history of the development of windpowered machinery is presented, and the installation of tipvanes and centerbodies to enhance the performance of low cost WECS for developing

countries are examined experimentally. Particular attention is given to sail wing rotors equipped with tip fins, peristaltic pumps repairable by semiskilled labor, and various configurations of tip fins and center bodies, which deflect the wind outward from the hub to the sails. Cheap, flat-plate tip fins were found to be effective in augmenting rotor performance by as much as 1.6 when facing only downwind. Best results were obtained with one tip vane per sail, with the fins downwind a distance at least equal to the pitch of a wind-filled sail. Further experimentation with stationary deflectors which redirect wind into the buckets of a Savonius rotor or the sails of a horizontal axis WECS are suggested. M.S.K.

A82-43129
ARRAY REPRESENTATION OF NONIDENTICAL ELECTRICAL CELLS

J. APPELBAUM, M. SHECHTER, G. YEKUTIELI (Weizmann Institute of Science, Rehovot, Israel), and J. BANY (Tel Aviv University, Tel Aviv, Israel) IEEE Transactions on Electron Devices, vol. ED-29, Aug. 1982, p. 1145-1151.

Electrical cells (electrochemical cells, fuel cells, solar cells) are of relatively low voltage and power levels. The cells are, therefore, connected in series and parallel combinations to form an array that produces the desired voltage and power. The cells are 'non-identical' in their parameter values and have a certain statistical distribution. The dispersion of the cell parameters affects the electrical behavior of the array in such a way that the power output of the array may differ from the power output of the individual cells operating separately at the same conditions. This difference depends on the cell type, cell parameter distribution, array configuration, and the load type. The paper introduces a general procedure for the determination of the array performance of nonidentical cells based on statistical considerations. An identical 'equivalent cell' was introduced, simplifying the array calculations. The procedure has been applied to voltage and current sources, series and parallel arrays, and four types of loads: matched load, constant resistant load, constant voltage, and constant current loads. (Author)

A82-43339#
SPACE HEATING THROUGH ISENTROPIC COMPRESSION UTILIZING WIND ENERGY

R. NOON (McGraw-Edison Co., Shawnee, KS) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, Aug. 1982, p. 204-207. refs

The following paper is a preliminary examination of using wind power to provide hot air for space heating using the shaft power of a wind turbine to isentropically compress air. Excluding mechanical losses, 71 percent of the shaft power supplied to a single stage compressor can be converted to internal energy gain, i.e., temperature rise. Approximate economic parameters indicate that such wind space heating systems are more economic than active solar systems when the average heating season available wind energy per collection area is 20 percent higher than that for solar. (Author)

A82-43687
ELECTROLYTE CREEPAGE IN GALVANIC CELLS. I - CONTRIBUTION TO THE PHENOMENA

H. W. NIENIETDT (Varta Batterie AG, Forschungs- und Entwicklungszentrum, Kelkheim, West Germany) Journal of Power Sources, vol. 8, Sept.-Oct. 1982, p. 257-265. refs

The subject of this investigation has been electrolyte creepage, a phenomenon which is held responsible for leaking of alkaline cells. Experiments show that the driving force is the electrochemical reduction of water or oxygen at the negative current collector. The electrolyte film contains a higher concentration of alkali than does the bulk electrolyte from which it is generated. The visible film is generated by condensation of water vapor. Investigations on the different behavior of ions show that potassium apparently moves faster than sodium; anions in the bulk electrolyte do not take part in film formation. Experiments show that two mechanisms might lead to leaking cells. One is an apparent leakage through pores, which can be suppressed by high pressure, smooth surfaces

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and pore plugging materials. The second effect is of an electrochemical nature. It cannot be prevented by usual means.

(Author)

A82-43688

ELECTROLYTE CREEPAGE IN GALVANIC CELLS. II - TRANSPORT MECHANISM AT HIGH PRESSURES

H. W. NIENTIEDT and H. LAIG-HOERSTEBROCK (Varta Batterie AG, Forschungs- und Entwicklungszentrum, Kelkheim, West Germany) *Journal of Power Sources*, vol. 8, Sept.-Oct. 1982, p. 267-272. refs

A mechanism for electrolyte creep is presented, explaining the high pressure that the electrolyte film can generate in the sealing zone of an alkaline cell. Also, the drop formation at the film front in creep experiments is explained. We assume that alkali atoms, underpotential deposited from the continuous electrolyte film, diffuse a short distance along the metal surface and again react with air and humidity to form a drop of electrolyte. The velocity of the whole film movement depends on the equivalent conductivity of the alkali ions in the continuous electrolyte film. (Author)

A82-44177

SOME RESTATEMENTS ON THE NATURE AND BEHAVIOR OF MnO₂ FOR LI BATTERIES

G. PISTOIA (CNR, Centro di Studio per la Elettrochimica e Chimica Fisica delle Interfasi, Rome, Italy) *Electrochemical Society, Journal*, vol. 129, Sept. 1982, p. 1861-1865. Research supported by the Consiglio Nazionale delle Ricerche. refs

A reconsideration of aspects of the behavior of MnO₂ as a cathode for nonaqueous Li cells shows that this compound's most active form is obtained by heating electrolytic MnO₂ in the 350-400 C range. It is determined that, in the disordered orthorhombic structure of electrochemical gamma-MnO₂, Li(+) is topochemically incorporated. This process causes structural alterations at relatively low Li(+) contents, and the flat discharge curves obtained suggest the formation of a pseudo-two-phase compound. Reversibility is incomplete because of these features, and is exhibited only in mild conditions. O.C.

A82-44178

BATTERY STATE OF CHARGE DETERMINATION IN PHOTOVOLTAIC SYSTEMS

R. WEISS and J. APPELBAUM (Tel Aviv University, Tel Aviv, Israel) *Electrochemical Society, Journal*, vol. 129, Sept. 1982, p. 1928-1933. refs

A novel on-line method of battery state of charge determination is introduced for the case of a working photovoltaic system. The method proposed is based on the extension of the known, open circuit voltage-charge relation to the opening battery voltage-charge relation, and combining it with the ampere-hour accounting method for finite periods of time, averaging out random measurement errors. Experimental comparison of the novel method with methods for a battery at rest shows good agreement at the control points, and further experimentation has validated it for conditions which prevail in autonomous photovoltaic systems. O.C.

A82-44182

MOTT-SCHOTTKY PLOTS AND FLATBAND POTENTIALS FOR SINGLE CRYSTAL RUTILE ELECTRODES

G. COOPER, J. A. TURNER, and A. J. NOZIK (Solar Energy Research Institute, Golden, CO) *Electrochemical Society, Journal*, vol. 129, Sept. 1982, p. 1973-1977. refs (Contract EG-77-C-01-4042)

Ideal Mott-Schottky plots were obtained for TiO₂ single crystal electrodes after a special surface preparation procedure. Precise flatband potentials were determined as a function of pH for three different types of TiO₂ boules; significant differences between boules were observed. These differences were reflected in corresponding differences in the electrode potential for the onset of anodic photocurrent. Surface treatments that produced linear Mott-Schottky plots but with frequency dispersion results in apparent flatband potentials that did not correlate with the potential for the onset of anodic photocurrent. Ideal Mott-Schottky behavior

could only be obtained for the specially prepared crystals if the electrolyte concentration was greater than 0.25M. (Author)

A82-44186

MASS-TRANSFER STUDY OF CARBON FELT, FLOW-THROUGH ELECTRODE

K. KINOSHITA and S. C. LEACH (SRI International, Menlo Park, CA) *Electrochemical Society, Journal*, vol. 129, Sept. 1982, p. 1993-1997. Research supported by the Electric Power Research Institute. refs

The mass-transfer characteristics of a carbon felt, flow-through electrode that has potential application for the positive electrode in zinc-bromine batteries were studied. The electrochemical technique of limiting current measurements for the cathodic reduction of 0.0055-0.062 M bromine in excess supporting electrolytes was used. In an electrochemical cell with perpendicular flow of electrolyte and current, limiting currents that were proportional to the electrolyte velocity, which was dependent on the electrode thickness but independent of the concentration of reactant species, were obtained at low Reynolds numbers. Analysis of the data using a model that relates the conversion efficiency of a porous electrode to a dimensionless group which contains experimental parameters such as porosity, pore diameter, flow rate, and diffusion coefficient, showed good agreement. (Author)

A82-44345#

COST ANALYSIS OF DAWT INNOVATIVE WIND ENERGY SYSTEMS

K. M. FOREMAN (Grumman Aerospace Corp., Bethpage, NY) In: *Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results*, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 532-540. refs (Contract XH-9-8073-1)

The results of studies of system engineering design alternatives and cost and energy output characteristics for diffuser augmented wind turbines (DAWT) are summarized. A DAWT configuration is effected by surrounding the wind turbine with an aerodynamic diffuser which lowers the atmospheric pressure downstream of the rotors to augment the flow past the blades. Research concentrated on defining short-length diffusers which can be built at low cost and still guarantee satisfactory performance. Design alternatives were found to be constrained by the unit system size and rating, structural design criteria, material selection, operational and environmental factors, manufacturing approach, production and scale economics, and siting characteristics, which are discussed. Cost analyses on DAWTs up to 150 kW indicate technical and financial feasibility with current technology. M.S.K.

A82-44572

POWER SUPPLIES, CONDITIONING AND DISTRIBUTION ON UOSAT

J. Z. SLOWIKOWSKI and M. J. BLEWETT (Surrey, University, Guildford, England) *Radio and Electronic Engineer*, vol. 52, Aug.-Sept. 1982, p. 425-430.

The solar arrays on four faces of the University of Surrey satellite (UOSAT) are designed to withstand temperatures from minus 120 C to plus 90 C, severe vibration, and shock. Solar cells with a conversion efficiency of 12 percent are employed to provide 29 W average power per panel at 25 C. The panels are routed in parallel to the battery charge regulators via blocking-diode pairs; two regulators are used for redundancy. The power system is designed to provide 18 W peak power and 8 W (orbit) average power to charge the 14 V NiCd battery, which has a nominal 6 Ah capacity. Power conditioning with a total output of 10 W is provided by a series switching regulator, which supplies plus 10 V, and a simple inverter power supply, which supplies plus 5 V and minus 10 V. The power distribution module and the current sensing and foldback operations are also described. A.B.

A82-44749#

METAL/GAS MHD CONVERSION [CONVERSION M.H.D. METAL/GAZ]

J. P. THIBAUT, F. JOUSSELLIN, A. ALEMANY (Grenoble, Institut de Mecanique, Grenoble, France), and A. DUPAS (Centre National d'Etudes Spatiales, Paris, France) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 9 p. In French. refs (IAF PAPER 82-407)

Operation features, theory, performance, and possible spatial applications of metal/gas MHD electrical generators are described. The working principle comprises an MHD channel, surrounded by a magnet, filled with a molten, highly conductive metal into which gas is pumped. The heat of the metal expands the gas, forcing a flow through the magnetic field crossing the channel, thus creating an electrical current conducted by the metal. The gas and metal are separated by a centrifugal device and both are redirected into the channel, forming thereby a double closed circuit when the heat of the molten metal is returned to the flow. Necessary characteristics for the gas such as a fairly low vaporization temperature and nonmiscibility with the metal, are outlined, and a space system using Li-Cs or Z-K as the heat carrier kept molten by a parabolic dish system is sketched. Equations governing the fluid mechanics, thermodynamics, and the electrical generation are defined. The construction of a prototype MHD generator using a tin-water flow operating at 250 C, a temperature suitable for coupling to solar heat sources, is outlined, noting expected efficiencies of 20-30 percent. M.S.K.

A82-44782*# Massachusetts Inst. of Tech., Cambridge.

FLOW AERODYNAMICS MODELING OF AN MHD SWIRL COMBUSTOR - CALCULATIONS AND EXPERIMENTAL VERIFICATION

A. K. GUPTA, J. M. BEER, J. F. LOUIS (MIT, Cambridge, MA), A. A. BUSNAINA, and D. G. LILLEY (Oklahoma State University, Stillwater, OK) ASME, Transactions, Journal of Fluids Engineering, vol. 104, Sept. 1982, p. 385-391; Discussion, p. 391, 392. refs (Contract DE-AC01-79ET-15518; NAG3-74)

This paper describes a computer code for calculating the flow dynamics of constant density flow in the second stage trumpet shaped nozzle section of a two stage MHD swirl combustor for application to a disk generator. The primitive pressure-velocity variable, finite difference computer code has been developed to allow the computation of inert nonreacting turbulent swirling flows in an axisymmetric MHD model swirl combustor. The method and program involve a staggered grid system for axial and radial velocities, and a line relaxation technique for efficient solution of the equations. Turbulence simulation is by way of a two-equation Kappa-epsilon model. The code produces as output the flowfield map of the nondimensional stream function, axial, and swirl velocity. Good agreement was obtained between the theoretical predictions and the qualitative experimental results. The best seed injector location for uniform seed distribution at combustor exit is with injector located centrally on the combustor axis at entrance to the second stage combustor. (Author)

A82-45217#

THE THEORY OF THE OPTIMUM MASS FLOW IN THE WIND TURBINE IN THE CASE OF HEAVY LOAD [EIN BEITRAG ZUR THEORIE DES OPTIMALEN MASSENDURCHSATZES DER WINDTURBINE BEI STARKER BELASTUNG]

W. WEBER Stuttgart Universitaet, Dr.-Ing. Dissertation, 1981. 102 p. In German. refs

The present investigation supplements studies conducted by Huetter (1942, 1974), who has explored an optimum design concept for windelectric converters in advanced wind-energy systems. It has been found that possibilities concerning the withdrawal of energy from air flows depend essentially on mass flow considerations. Questions arise regarding the energetic effects to which the air mass is exposed during its flow through the rotor. The application of concepts of the theory of heavily loaded propellers developed by Betz and Helmbold (1932) makes it possible to compute the performance coefficient for the operational

conditions of the wind turbine even for heavy loads. Efficiency calculations regarding a wind wheel with an infinite number of blades are discussed, and the calculation of the characteristics of wind turbine flow processes with the aid of the induction laws of Biot-Savart is considered. G.R.

A82-45317

FUEL CELLS: TECHNOLOGY STATUS AND APPLICATIONS; PROCEEDINGS OF THE SYMPOSIUM, CHICAGO, IL, NOVEMBER 16-18, 1981

Symposium sponsored by the Institute of Gas Technology, Chicago, IL, Institute of Gas Technology, 1982. 341 p \$40

Progress, experimentation, results from prototype construction and operations, and future directions for fuel cell construction, research, and applications are discussed. The basic theory, construction, and functioning principles of fuels cells are reviewed, and attention is given to solid polymer, phosphoric acid, molten carbonate, and solid oxide fuel cells. Fuel processing for fuel cells is examined, along with the economics and features of fuel cell uses by utilities, the military, municipalities, and for transportation. Specific mention is made of fuel cells in industrial cogeneration installations and technical and economic problems which must be solved to bring fuel cells to commercial readiness are described. M.S.K.

A82-45318

FUEL CELLS - FUNDAMENTALS AND TYPES: UNIQUE FEATURES

J. R. SELMAN (Illinois Institute of Technology, Chicago, IL) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 1-31. refs

An overview of the working principles, thermodynamic efficiencies, types, and engineering aspects of fuel cells is presented. It is noted that fuel cells are distinguished from other direct energy conversion devices by the existence of charge separation at the electrodes involving ions in an electrolyte. The electrical energy produced by a fuel cell is shown to be equal to the change in the free energy of the reactants, and thermodynamic balances of reactions in different fuel cells are provided. The production of electricity in the discharge mode involves a spontaneous reaction of overproduction of electrons at the anode and consumption of the electrons at the cathode, with the total ionic current being equal to the electronic current in the external circuit. Attention is given to the operations and problems of acid, alkaline, molten carbonate, and solid oxide fuel cells, in addition to applications of electro-organic fuel cells. M.S.K.

A82-45319

FUEL CELL SYSTEMS AND POTENTIAL APPLICATIONS

H. C. MARU (Energy Research Corp., Danbury, CT) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 33-44.

A general fuel cell system consists of several subsystems, including fuel cell, fuel processor, power conditioner and thermal management. The options and configurations possible for each of these subsystems are discussed in this paper. Selection of the appropriate subsystem is largely governed by the end application. A broad spectrum of fuel cell applications is visualized, from space systems to multimegawatt central generators. Important requirements of these applications are discussed in this paper. (Author)

A82-45320

MOLTEN CARBONATE FUEL CELLS - TECHNOLOGY STATUS

R. D. PIERCE (Argonne National Laboratory, Argonne, IL) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 67-81. refs

The functional principles, components, operating conditions, and problems in prototype molten carbonate fuel cell plants are

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described. Centralized carbonate fuel cells consist of four subsystems: a coal gasifier and gas cleanup system, fuel cell stacks, heat removal and recovery system, and a power conditioner to convert dc to ac current. The fuel in the cells comprises hydrogen and carbon monoxide, and produces current by means of completion of an electrical circuit through transfer of carbonate ions through the electrolyte and electrons from cell to cell and eventually into the external circuit. Electrodes are porous sheets which provide sites for the electrochemical reaction and conduction paths for the reactants and products. The construction of LiAlO_2 -carbonate electrolyte structures is noted, and the electrolyte distribution and structures, the anodes, cathodes, separator plate, and operational problems are considered. M.S.K.

A82-45321

SOLID ELECTROLYTE FUEL CELLS

H. S. ISAACS (Brookhaven National Laboratory, Upton, NY) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 83-107. refs (Contract DE-AC02-76CH-00016)

Progress in the development of functioning solid electrolyte fuel cells is summarized. The solid electrolyte cells perform at 1000 C, a temperature elevated enough to indicate high efficiencies are available, especially if the cell is combined with a steam generator/turbine system. The system is noted to be sulfur tolerant, so coal containing significant amounts of sulfur is expected to yield satisfactory performances with low parasitic losses for gasification and purification. Solid oxide systems are electrically reversible, and are usable in both fuel cell and electrolysis modes. Employing zirconium and yttrium in the electrolyte provides component stability with time, a feature not present with other fuel cells. The chemical reactions producing the cell current are reviewed, along with materials choices for the cathodes, anodes, and interconnections. M.S.K.

A82-45322

DEFENSE APPLICATIONS OF FUEL CELLS

R. R. BARTHELEMY (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 109-115.

Applications and developmental efforts by the service branches of the U.S. toward implementation of fuel cells for military purposes are reviewed. The fuel cells are being produced as a petroleum fuel substitute and are foreseen to offer quieter, more efficient power at less expense, with lower logistic problems, and to possess cogeneration potential. Applications are indicated for mobile, remote, facility, and emergency/auxiliary power systems. The systems range from one kilowatt to several MW, and can be interfaced with weapon systems. Research in phosphoric acid fuel cells is noted, as are applications in space, undersea, and in aircraft. M.S.K.

A82-45324

PROCESSING OF LIQUID HYDROCARBONS FOR FUEL CELL APPLICATIONS

J. E. YOUNG (Argonne National Laboratory, Argonne, IL) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 153-161. refs

In this paper the status of the technology related to the conversion of liquid fuels to fuel cell feeds is described. The constraints placed on any fuel conversion process by the fuel cell operating requirements are discussed in detail. Fuel conversion processes presently available for fuel cell application are described as well as processes currently in the technology development stage. Requirements for additional research and development in the area of liquid fuel utilization are discussed. (Author)

A82-45325* Gas Research Inst., Chicago, Ill.

40-KW PHOSPHORIC ACID FUEL CELL FIELD TEST - PROJECT PLAN

R. R. WOODS (Gas Research Institute, Chicago, IL) and R. A. DUSCHA (NASA, Lewis Research Center, Cleveland, OH) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 215-231.

A82-45326

APPLICATION OF FUEL CELLS TO HIGHWAY AND NONHIGHWAY TRANSPORTATION

J. R. HUFF, J. B. MCCORMICK, D. K. LYNN, R. E. BOBBETT, G. R. DOOLEY, C. R. DEROUIN, H. S. MURRAY, and S. SRINIVASAN (Los Alamos National Laboratory, Los Alamos, NM) In: Fuel cells: Technology status and applications; Proceedings of the Symposium, Chicago, IL, November 16-18, 1981. Chicago, IL, Institute of Gas Technology, 1982, p. 233-241. Research supported by the U.S. Department of Energy. refs

An assessment is made of the directions and progress in governmental and nongovernmental programs for testing the usefulness of fuel cells in transportation. The DoE is examining phosphoric acid, solid polymer, super acid, and alkaline electrolyte fuel cells for highway vehicles. Initial trials to develop a data base were performed on a golf cart, and computer simulations were devised for component operation and interaction. Fuel cells have been installed in a car and a city bus, with weights of 2.4 lb/sq ft and power densities of 7.4 lb/kW. Performance results in the car showed a 430-356 mile range using the equivalent of 20 gal of methanol for a 20 kW fuel cell. An advanced cell yielded a range of 612 miles, top speed of 68 mph, and a gasoline mileage equivalent of over 60 mpg. Further applications for aircraft, marine vehicles, rail carriers, and pipeline prime movers are discussed. M.S.K.

A82-46385* Toledo Univ., Ohio.

MODELING THE FULL-BRIDGE SERIES-RESONANT POWER CONVERTER

R. J. KING and T. A. STUART (Toledo, University, Toledo, OH) IEEE Transactions on Aerospace and Electronic Systems, vol. AES-18, July 1982, p. 449-459. refs (Contract NSG-3281)

A steady state model is derived for the full-bridge series-resonant power converter. Normalized parametric curves for various currents and voltages are then plotted versus the triggering angle of the switching devices. The calculations are compared with experimental measurements, made on a 50 kHz converter and a discussion of certain operating problems is presented. (Author)

A82-46507

SEMICONDUCTOR ELECTRODES. XLV - PHOTOELECTROCHEMISTRY OF N- AND P-TYPE MoTe_2 IN AQUEOUS SOLUTIONS

H. D. ABRUNA, A. J. BARD (Texas, University, Austin, TX), and G. A. HOPE Electrochemical Society, Journal, vol. 129, Oct. 1982, p. 2224-2228. Research supported by the Solar Energy Research Institute refs (Contract NSF CHE-80-00682)

The energetic location of the valence and conductor bands, and the voltammetric behavior of MoTe_2 (n and p-type) electrodes are investigated, and the potential utility of these electrodes in photoelectrochemical (PEC) cells is examined. The electrodes are found to exhibit qualitative behavior similar to the other layered semiconductors in terms of the sensitivity of their behavior to growth conditions and surface imperfections. PEC cells based on n- MoTe_2 with $\text{I}(-)/\text{I}_2$ as a redox couple are constructed and show monochromatic (red-light) energy conversion efficiencies of over 8%. Although these efficiencies are lower than those for other layered compounds, they could be of potential use if incorporated into polycrystalline layers. In addition, the location of the valence and conduction band edges is such that a wide choice of redox couples is possible. N.B.

A82-46510

CATALYSIS OF OXYGEN CATHODIC REDUCTION BY ADSORBED IRON/111/-TETRA/N,N,N-TRIMETHYLANILINIUM/PORPHYRIN ON GLASSY CARBON ELECTRODES

A. BETTELHEIM, R. PARASH, and D. OZER (Atomic Energy Commission, Negev Nuclear Research Centre, Beersheba, Israel) *Electrochemical Society, Journal*, vol. 129, Oct. 1982, p. 2247-2250. refs

The adsorption of iron(111)-tetra (N,N,N-trimethylanilinium) porphyrin on glassy carbon is investigated in aqueous solutions using cyclic voltammetry, differential pulse voltammetry, chronoamperometry, and the RRDE technique as part of a study of effective catalysts for the electrochemical reduction of dioxygen. Results show that the porphyrin catalyzes oxygen electroreduction, with the overpotential being reduced by about 400 mV and the hydrogen peroxide yield being about 5% compared to about 25% in the absence of the catalysts. In addition, the adsorbed porphyrin shows a high stability, especially in solutions at a pH of greater than 2. N.B.

A82-46663

WORK FUNCTION OF ZRCYOX-CS SYSTEMS

T. L. MATSKEVICH, N. N. SKVORTSOV, and T. V. KRACHINO (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR) (*Zhurnal Tekhnicheskoi Fiziki*, vol. 52, Jan. 1982, p. 111-113.) *Soviet Physics - Technical Physics*, vol. 27, Jan. 1982, p. 72-74. Translation. refs

Experimental results on the effects of oxidation of ZrC thermionic converters (TIC) on their work function in cesium vapor are reported. ZrC samples were degassed by heating at 2500 K for 6-10 hours, then exposed to 1/100,000 torr O₂ gas at 1200-1400 K. A work function decrease from 3.65-3.4 eV was followed by an increase to 4.2 eV. The entire system was subsequently heated to 400-450 K and leakage currents were recorded by an automatic platter and a microammeter. Examinations were made of the thermionic current in relation to cathode temperature ranging from 500-1400 K. Increases of the Cs vapor pressures from 0.0000175 to 0.027 torr induced an increase in the current. It was found that exposure of ZrC to O₂ decreased the work function of the cathode in Cs vapor in the temperature range 700-1400 K. Anode oxidation in a direct flow TIC with a ZrC-based cathode is concluded to increase the output voltage, while the formation of oxycarbide contaminants on the surface of refractory metals does not impair the thermionic properties of the metals in Cs vapor. M.S.K.

A82-46843#

NUMERICAL SIMULATION OF THE INHOMOGENEOUS DISCHARGE STRUCTURE IN NOBLE GAS MHD GENERATORS

T. HARA, A. VEEFKIND, and L. H. T. RIETJENS (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands) *AIAA Journal*, vol. 20, Nov. 1982, p. 1473-1480. Research supported by the Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek. refs

A numerical calculation has been developed to describe the two-dimensional, time-dependent behavior of an inhomogeneous plasma in nonequilibrium MHD generators. The development of 'streamers' as typical discharge structures is simulated. A cesium-seeded argon plasma is considered. The numerical conditions used in the calculations are set equal to the experimental conditions used in the Eindhoven shock-tube facility. The elliptic part of the equations is solved by the finite-element method and the hyperbolic part by integration along the characteristic lines. It is found that the current concentrations on each electrode edge grow within microseconds into discharge structures which are concentrated in nonstationary streamers transverse to the gas flow. After they are formed, these streamers are frozen in the gas and are convected downstream at the gas velocity. Inside the streamers the cesium is fully ionized and the electron temperature is in range of 4000-6000 K, and outside the streamers the electron density is about 10 to the 19th and the electron temperature is about 2500 K. These calculated results agree quite well with the

experimental ones observed in the Eindhoven shock-tube facility.

(Author)

A82-47419

MODE COMPETITION, SUPPRESSION, AND EFFICIENCY ENHANCEMENT IN OVERMODED GYROTRON OSCILLATORS

Y. CARMEL (Maryland, University, College Park, MD), K. R. CHU, M. E. READ, K. J. KIM, B. ARFIN, V. L. GRANATSTEIN (U.S. Navy, Naval Research Laboratory, Washington, DC), D. DIALETIS (Science Applications, Inc., McLean, VA), and A. FLIFLET (B. K. Dynamics, Inc., Rockville, MD) *International Journal of Infrared and Millimeter Waves*, vol. 3, Sept. 1982, p. 645-665. refs (Contract DE-AI01-80ER-52065)

The gyrotron is a source of millimeter wave radiation which is finding an increasing number of applications, principally in fusion research. Gyrotron oscillators are characterized by high efficiency at powers substantially above those possible with conventional mm wave sources. 1.1 MW at 100 GHz have been produced with a relatively short pulse length of 100 microsecond. However, for large fusion devices, CW powers at the megawatt level at frequencies over 100 GHz will be required. Operation with very high order modes as required for megawatt operation will require techniques to avoid mode competition. In connection with the present investigation, a large signal multimode analysis was conducted, which shows that the nature of competition between the TE(0,4,1) and TE(2,4,1) modes is such that the presence of one mode has the tendency to suppress the other. Hence stable operation of a single mode is possible. Attention is given to mode competition and mode locking, and to efficiency enhancement in a tapered magnetic field. G.R.

A82-47569

A MONOLITHIC GAINASP/INP PHOTOVOLTAIC POWER CONVERTER

W. W. NG, Y. Z. LIU, P. D. DAPKUS (Rockwell International Microelectronics Research and Development Center, Thousand Oaks, CA), and K. NAKANO (TRW, Inc., Redondo Beach, CA) *IEEE Transactions on Electron Devices*, vol. ED-29, Sept. 1982, p. 1449-1454. refs

A monolithic GaInAsP/InP photovoltaic power converter, optimized for power conversion at 1.06 micron, was successfully fabricated by mesa isolation on semi-insulating InP substrates. An estimation of the quantum efficiency achievable with double heterostructures grown by liquid-phase epitaxy is given. Open-circuit voltages of 7.6 V, power-conversion efficiencies of 30 percent, and fill factors as high as 75 percent, were obtained from a device consisting of twelve cell segments connected in series. (Author)

A82-47938

AERODYNAMIC DESIGN OF OPTIMUM WIND TURBINES

A. M. DE PAOR (University College, Dublin, Ireland) *Applied Energy*, vol. 12, Nov. 1982, p. 221-228. refs

A design procedure is presented and illustrated for one-, two- or three-bladed horizontal axis, constant chord wind turbines of optimum performance. Following specification of the number of blades, the lift coefficient, and the lift-to-drag ratio at the design point, algorithms are developed for finding: the tip-speed ratio at which the optimum power coefficient is developed, the ratio of blade chord to radius, and the manner in which each blade should be twisted along its axis. Programs are given for implementing the calculations iteratively on a programmable calculator. (Author)

A82-48001

ELECTRICAL ENGINEERING APPLICATIONS IN THE PACIFIC; PROCEEDINGS OF THE REGION 6 CONFERENCE, HONOLULU, HI, APRIL 1-3, 1981

Conference sponsored by the Institute of Electrical and Electronics Engineers. New York, Institute of Electrical and Electronics Engineers, 1981. 647 p.

MEMBERS, \$34.50; NONMEMBERS, \$46

Technological advances in the applications of electronics, computers, wind turbines, fiber optics, and software to industry,

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energy production, education, power and resource management, and communications are explored. The construction and connection of wind turbines to utility grids is examined. Attention is given to user perspectives and applications of computerized communication systems, control systems for astronomical equipment, and for advanced education for engineers. Progress in the development of OTEC systems is assessed, as are military implementation of satellite communication systems for large areas, semiconductor and LSI circuitry for integrated voice communications systems, and error control techniques for data transmission. M.S.K.

A82-48002

UTILITY SCALE APPLICATION OF WIND TURBINES

R. M. BELT (Hawaiian Electric Co., Inc., Honolulu, HI) In: Electrical engineering applications in the Pacific; Proceedings of the Region 6 Conference, Honolulu, HI, April 1-3, 1981. New York, Institute of Electrical and Electronics Engineers, 1981, p. 3-12.

The development of wind turbines for utility interconnection, problems inherent in utility scale application of wind-derived power, and specific features of interconnection with the Hawaiian electric system are discussed. Modern wind turbine generators are being developed to withstand sudden wind gusts, maintain generation stability, and tolerate external electrical faults. Utility integration of wind power is constrained by necessities of using optimized generator mixes. The total proportion of wind derived power that a grid may tolerate is as yet unknown, and is dependent on the generator control system response rates, noting that conventional ramping rates are in the range 1-5%. Control rates are bounded by maximum and minimum generation rates on spinning generators. Methods of determining on-site wind patterns using anemometry and electronically stored data are reviewed. Studies to determine the effects of frequent fluctuations on consumer equipment, and to adequately model the introduction of integrated wind farm-grid systems are indicated. M.S.K.

A82-48003

WIND GENERATOR NETWORK CONCEPTS

J. N. PETERSON (Idaho, University, Moscow, ID) In: Electrical engineering applications in the Pacific; Proceedings of the Region 6 Conference, Honolulu, HI, April 1-3, 1981. New York, Institute of Electrical and Electronics Engineers, 1981, p. 50-60.

A numerical model is developed for maximizing the number of wind turbine generators (WTG) at a number of isolated sites and minimizing the magnitude of fluctuations imposed on the grid. Two approaches were examined, maximized energy production constrained by a fixed allowable fluctuation level, and a fixed energy production with site weightings chosen to minimize the power fluctuations. Formulations are presented for the average power production at a site and the variance of the fluctuations. The value is extended to a WTG network. An example is provided for the optimal weightings calculated for a grid containing three WTG generator sites. A covariance matrix is defined, and comparison is made with the case that all WTGs are at one site. Optimal allocation is found to be best applied where the sites display different variances, rather than different means. Significant improvement is possible even where zero correlation is displayed. M.S.K.

A82-48004

OPERATING EXPERIENCE WITH A 200 KW MOD-OA WIND TURBINE GENERATOR AT KAHUKU

A. FUJINAKA, G. MIYASHITA, and D. M. RODRIGUES (Hawaiian Electric Co., Inc., Honolulu, HI) In: Electrical engineering applications in the Pacific; Proceedings of the Region 6 Conference, Honolulu, HI, April 1-3, 1981. New York, Institute of Electrical and Electronics Engineers, 1981, p. 61-77.

A82-48008

OTEC-1 - ELECTRICAL ASPECTS

R. E. BARNARD and N. SONENSHEIN (Global Marine Development, Inc., Newport Beach, CA) In: Electrical engineering applications in the Pacific; Proceedings of the Region 6 Conference, Honolulu, HI, April 1-3, 1981. New York, Institute of Electrical and Electronics Engineers, 1981, p. 211-221.

Electrical features of a U.S. DoE test ship for production of 1 MWh from an ocean thermal energy conversion system (OTEC) are described. The ship, in operation off Keahole Point, Hawaii, is anchored in 1372 m deep water, and is fitted with a 655 m polyethylene intake. Power for the operation of the ship is derived from an on-board 5.4 MW generator directly connected to a 7000 HP synchronous motor. Three 200 HP induction motors can also be powered by the generator for the cargo pumps. Adaptations necessary for the ship's wiring and load-handling equipment are outlined, including the maintenance of access to two 400 kW auxiliary generators. M.S.K.

A82-48009

OTEC RESEARCH AND THE SEACOAST TEST FACILITY

L. W. HALLANGER (Hawaii, Natural Energy Laboratory, Seacoast Test Facility, Honolulu, HI) In: Electrical engineering applications in the Pacific; Proceedings of the Region 6 Conference, Honolulu, HI, April 1-3, 1981. New York, Institute of Electrical and Electronics Engineers, 1981, p. 222-226.

OTEC mariculture, and other developing research programs at the Natural Energy Laboratory at Keahole Point, Hawaii are reviewed. The installation is designed to feature both onshore and offshore facilities, including cold water intakes and discharge pipelines, warm water intake and discharge pipelines, a pumping station, constant head tanks, laboratories, and support facilities. The Seacoast Test Facility for OTEC development is being constructed to have a ten year lifetime, a 50-ft depth warm water intake, 2100-ft cold water intake, uninterrupted flow from the intakes, cold water temperature rise limited to 1 C, degassing capability for the cold water, and biologically inert pipeline materials. An additional 250 gpm cold water pipeline is being fabricated for mariculture experimentation. Heat transfer monitors, biofouling and corrosion test sections are also being constructed. M.S.K.

N82-28782# RAND Corp., Santa Monica, Calif.

PROJECTED ENGINEERING COST ESTIMATES FOR AN OCEAN THERMAL ENERGY CONVERSION (OTEC)

E. C. GRITTON, R. W. HESS, and R. Y. PEI Jan. 1982 19 p refs Presented at 8th Ann. Ocean Energy Conf., Washington, D.C., 9 Jun. 1981

(RAND/N-1788-RC) Avail: NTIS HC A02/MF A01

The potential cost reductions that might be achieved if certain engineering, construction and financial improvements were realized in the ocean thermal energy conversion concept were investigated. Six options were analyzed: water-side heat transfer enhancement (for tube-and-shell heat exchangers), plate type heat exchangers, fiberglass reinforced plastic cold water pipes, elimination of the requirement that the transmission cable be buried at ocean depths of less than 300 feet, a shorter construction period, and a reduced fixed charge rate. It was found that the changes having the most effect on capital cost are the two heat exchanger options and the shorter construction period. However, to achieve major reductions in capital cost, say on the order of 30 percent, a combination of one of the heat exchanger options in conjunction with the coldwater pipe, transmission cable and construction period options will be required. R.J.F.

N82-28783*# National Aeronautics and Space Administration, Washington, D. C.

CAPTURING ENERGY FROM THE WIND

J. L. SCHEFTER 1982 88 p refs Original contains color illustrations

(NASA-SP-455; NAS 1.21:455; LC-81-600180) Avail: NTIS MF A01; SOD HC \$6.00 as 033-000-008-50-3 CSCL 10A

The history of windpower is reviewed. Wind turbine technology is discussed. Examples of small and large turbines are provided.

Electric power generation is considered. Numerous illustrations are included. N.W.

N82-28794# Altus Corp., San Jose, Calif.
HIGH ENERGY DENSITY BATTERY LITHIUM THIONYL CHLORIDE IMPROVED REVERSE VOLTAGE DESIGN Final Report, Jun. - Dec. 1981
 A. E. ZOLLA San Diego, Calif. Naval Ocean Systems Center
 Dec. 1981 56 p
 (Contract N66001-81-C-0310; XF11111801)
 (AD-A113498; REPT-0737R-1; NOSC/CR-111) Avail: NTIS HC A04/MF A01 CSCL 10C

A test program was conducted to demonstrate safety under voltage reversal conditions of the Altus 1400 AH HEDB cell. Eight cells of an improve Anode Grid Design, all cathode (carbon) limited, were forced discharged for 150% of their normal capacity. Minor design variations were tested at 6 amp, 20 C and 12 amp, 0 C with a lithium reference electrode and separate monitoring of current through the internal reverse voltage current shunt feature. There were no ventings and no appreciable increase in cell temperature or internal pressure. Author (GRA)

N82-28795# New Hampshire Univ., Durham.
STUDY OF A WIND ENERGY CONVERSION SYSTEM IN NEW HAMPSHIRE Final Report
 J. LOCKWOOD, G. KRAFT, G. PREGENT, and L. SMUKLER Aug. 1981 156 p refs
 (Contract N00014-79-C-0725)
 (AD-A114418) Avail: NTIS HC A08/MF A01 CSCL 10B

Concern over conventional energy costs and supplies is currently strong, particularly in New England region where eighty percent of the total energy is oil based; furthermore, forty percent of this region's total energy is OPEC oil. These figures contrast with national averages of forty-seven and thirteen percent, respectively (1). The quest to develop alternative and renewable energy sources indigenous to New England is understandable in light of these figures. The wind is one such source. The study of wind energy can be divided into three basic areas; these are technical, legal-institutional, and financial. The technical area encompasses collection and analysis of wind data, selection and installation of wind turbines and peripheral equipment, and operation and maintenance. The legal-institutional area encompasses the resolution of such issues as land use policies, power contracts, and state and federal regulations. The financial area encompasses the examination of investment opportunities made available by various site-machine combinations and the selling of such opportunities to the investment community. Author (GRA)

N82-28798# Kirkwood (A. C.) and Associates, Kansas City, Mo.
SURVEY OF DIESEL GENERATION BY SMALL US UTILITIES Final Report
 B. J. KIRKWOOD Nov. 1981 109 p Sponsored by EPRI
 (DE82-901291; EPRI-AP-2113) Avail: NTIS HC A06/MF A01

The present and future use of diesel electric power generation is considered. Data and subjective comments provided a perception of both the advantages and the problems associated with these engines and what users see as the needs in future research efforts and equipment application and operation to enhance their use, if indeed such equipment is viable at all. The possibility of developing a data base for this type of generation facility and operation, similar to those existing on other primary generating equipment is considered. A rational potential for continuing this widespread use of generating diesels, if the primary problem of the high relative cost of fuels can be overcome is considered.

N82-28815# Mid-American Solar Energy Complex, Minneapolis, Minn.

ECONOMIC ANALYSIS OF SMALL WIND-ENERGY-CONVERSION SYSTEMS FOR TEN MASEC SITES

Sep. 1981 304 p refs
 (Contract DE-AC02-79CS-30150)
 (DE82-003976; MASEC-R-81-071) Avail: NTIS HC A14/MF A01

The economic feasibility of small wind energy conversion systems (SWECs) was evaluated for ten sites. A computer-based life cycle costing program was utilized in the economic evaluations. The wind energy model (WEM) is an interactive computer tool that may be used to perform economic analyses for many different scenarios. This program deals with information specific to investing in a wind turbine. The WEM uses information on electrical rates, turbine performance, power demand, and wind data to form intermediate quantities which are fed to a life cycle costing program. DOE

N82-28818# Sandia Labs., Albuquerque, N. Mex. Exploratory Batteries Div.

LITHIUM OXIDE IN THE LI(SI)/FES2 THERMAL BATTERY SYSTEM

J. Q. SEARCY, P. A. NEISWANDER, J. R. ARMIJO, and R. W. BILD Nov. 1981 14 p refs
 (Contract DE-AC04-76DP-00789)
 (DE82-005114; SAND-81-1705) Avail: NTIS HC A02/MF A01

The performance degradation caused by Li₂O and the acceptable level of Li₂O that can be used to define required dryness of battery parts and allowable leak rates were determined. Pellets preconditioned with Li₂O were used in single cells or in batteries. Their performance was compared with discharges made using pellets with no Li₂O added. The actual Li₂O present in anode pellets at various stages during fabrication was determined by using 14 MeV neutron activation analysis. Results show that thermal battery production controls should be designed in such a manner that not more than 15 wt.% of the Li(Si) is oxidized at the end of the desired self life. Furthermore, the formation of a Li₂O layer equivalent to the oxidation of 6.0 wt.% of the anode on the surface facing the current collector must be prevented. Battery designers must allow for a drop in coulombic efficiency as the Li(Si) reacts, and the effect on performance of Li₂O in the separator must be considered. DOE

N82-28834# Allis-Chalmers Mfg. Co., York, Pa. Hydro Turbine Div.

POWERHOUSE-GATE: CONCEPT DEFINITION STUDY

H. A. MAYO, JR. 30 Nov. 1981 110 p refs
 (Contract DE-FC07-80ID-12200)
 (DE82-006226; DOE/ID-12200/T1) Avail: NTIS HC A06/MF A01

The powerhouse-gate concept combines the benefits of standardized hydroelectric generating units and shop fabrication of a structural steel powerhouse which, when in normal operating position, serves as a gate to replace conventional gates and can be raised as a complete assembly above flood levels so that existing structures may be used for the designed spillway purposes. Factors considered include a head range of from 6 to 10 ft; powerhouses including 1, 3, or 4 turbines; structural analysis of the basic powerhouse (3 units) concept without dynamic hydraulic loads; and powerhouse cost and economic evaluation. A computer analysis of the structure with appropriate minor revisions confirmed its structural adequacy and suitability for the application. Estimates of the structure fabrication cost with the addition of standard turbines indicate the potential economic feasibility of the concept. Results to date justify further application studies. DOE

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N82-29188# Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.

TOKAMAKS WITH HIGH-PERFORMANCE RESISTIVE MAGNETS: ADVANCED TEST REACTORS AND PROSPECTS FOR COMMERCIAL APPLICATIONS

L. BROMBERG, D. R. COHN, J. E. C. WILLIAMS, H. BECKER, R. LECLAIRE, and T. YANG Oct. 1981 8 p refs Presented at the 9th Symp. on Eng. Probl. of Fusion Res., Chicago, 26 Oct. 1981

(Contract DE-AC02-78ET-51013)

(DE82-007366; DOE/ET-51013/24; PFC/CP-81-1;

CONF-811040-147) Avail: NTIS HC A02/MF A01

Tokamak reactors with high performance resistive magnets which maximize advantages gained from high field operation and reduced shielding requirements, and minimize resistive power requirements were studied. High field operation provide very high values of fusion power density and $n \tau_{\text{sub } e}$ while the resistive power losses can be kept relatively small. Relatively high values of $Q' = \text{Fusion Power/Magnet Resistive Power}$ can be obtained. The use of high field also facilitates operation in the DD-DT advanced fuel mode. The engineering and operational features of machines with high performance magnets are discussed. The production of fissile fuel, electricity generation with and without fissioning blankets and synthetic fuel production are also discussed. DOE

N82-29235*# Mechanical Technology, Inc., Latham, N. Y. Stirling Engine Systems Div.

AUTOMOTIVE STIRLING ENGINE DEVELOPMENT PROGRAM Quarterly Technical Progress Report, 1 Apr. - 30 Jun. 1981

S. PILLER, A. RICHEY, M. DOWDY, and K. MATHER May 1982 111 p refs

(Contract DEN3-32; EC-77-A-31-10040)

(NASA-CR-167907; DOE/NASA/0032-15; NAS 1.26:167907;

MTI-91ASE229QT13) Avail: NTIS HC A06/MF A01 CSCL 13F

The background and history of the Stirling engine, the technology, materials, components, controls, and systems, and a technical assessment of automotive stirling engines are presented. Author

N82-29236# New Zealand Energy Research and Development Committee, Auckland.

FEASIBILITY OF ELECTRIC VEHICLES IN NEW ZEALAND. APPENDICES Progress Report

J. NOBLE May 1981 71 p Prepared in cooperation with the Liquid Fuels Trust Board, Wellington, New Zealand (DE82-901431; NZERDC-LF-2009-APP; R-61; ISSN-0110-1692; ISSN-0110-1191) (US Sales Only) HC A04/MF A01; DOE Depository Libraries

The feasibility of electric vehicles in New Zealand was reported. The 13 appendices are on the following subjects: hybrid electric vehicles, trolley buses, electric vehicle drive systems, separately excited dc motor efficiency tests, ac motor efficiency test, driving tests - NEEV vehicle, dynamometer tests - NEEV Vehicle, performance variations with differing parameters, questionnaire on vehicle use and performance, vehicle drive cycles, drive pattern report, national benefit analysis, and summary of review comments. DOE

N82-29713*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

VERTICAL SHAFT WINDMILL Patent Application

D. C. GRANA and S. V. INGE, JR., inventors (to NASA) 28 May 1982 8 p

(NASA-CASE-LAR-12923-1; US-PATENT-APPL-SN-383063)

Avail: NTIS HC A02/MF A01 CSCL 10A

A vertical shaft windmill that automatically controls its maximum rotational speed in high winds is disclosed. Several equally spaced blades are mounted on the vertical shaft. Each blade consists of an inboard section attached to the shaft and an outboard section skew hinged to the inboard section. The outboard sections automatically adjust their positions with respect to the fixed inboard sections with changes in velocity of the relative wind. When the

wind reaches a certain velocity the inboard sections and the outboard sections form flat surfaces. Hence, any further increase in the wind velocity will not increase the rotational speed of the shaft. With the outboard sections in downward positions any abrupt changes in wind will move most of the outboard sections upward releasing part of the load and protecting the windmill. NASA

N82-29717*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TECHNIQUES FOR ENHANCING DURABILITY AND EQUIVALENCE RATIO CONTROL IN A RICH-LEAN, THREE-STAGE GROUND POWER GAS TURBINE COMBUSTOR

D. F. SCHULTZ 1982 14 p refs Presented at 1982 Joint Power Generation Conf., Denver, 17-21 Oct. 1982; sponsored by ASME

(Contract DE-AI01-77ET-10350)

(NASA-TM-82922; DOE/NASA/10350-33-E-1313; NAS

1.15:82922) Avail: NTIS HC A02/MF A01 CSCL 10A

Rig tests of a can-type combustor were performed to demonstrate two advanced ground power engine combustor concepts: steam cooled rich-burn combustor primary zones for enhanced durability; and variable combustor geometry for three stage combustion equivalence ratio control. Both concepts proved to be highly successful in achieving their desired objectives. The steam cooling reduced peak liner temperatures to less than 800 K. This offers the potential of both long life and reduced use of strategic materials for liner fabrication. Three degrees of variable geometry were successfully implemented to control airflow distribution within the combustor. One was a variable blade angle axial flow air swirler to control primary airflow while the other two consisted of rotating bands to control secondary and tertiary or dilution air flow. B.W.

N82-29718*# Institute of Gas Technology, Chicago, Ill. Engineering Research Div.

STABILIZING PLATINUM IN PHOSPHORIC ACID FUEL CELLS Final Report, Dec. 1980 - Mar. 1982

R. J. REMICK Jul. 1982 47 p refs

(Contract DEN3-208; DE-AI01-80ET-17088)

(NASA-CR-165606; DOE/NASA/0208-4; NAS 1.26:165606;

REPT-61051) Avail: NTIS HC A03/MF A01 CSCL 10A

Platinum sintering on phosphoric acid fuel cell cathodes is discussed. The cathode of the phosphoric acid fuel cell uses a high surface area platinum catalyst dispersed on a conductive carbon support to minimize both cathode polarization and fabrication costs. During operation, however, the active surface area of these electrodes decreases, which in turn leads to decreased cell performance. This loss of active surface area is a major factor in the degradation of fuel cell performance over time. S.L.

N82-29721*# Aerospace Corp., El Segundo, Calif.

ENVIRONMENTAL ASSESSMENT OF THE 40 KILOWATT FUEL CELL SYSTEM FIELD TEST OPERATION Final Report

G. BOLLENBACHER May 1982 160 p refs

(Contract NASA ORDER C-42701D; DE-AI01-80ET-17088)

(DOE/NASA/2701-1; NASA-CR-167923) Avail: NTIS HC

A08/MF A01 CSCL 10A

This environmental assessment examines the potential environmental consequences, both adverse and beneficial, of the 40 kW fuel cell system field test operation. The assessment is of necessity generic in nature since actual test sites were not selected. This assessment provides the basis for determining the need for an environmental impact statement. In addition, this assessment provides siting criteria to avoid or minimize negative environmental impacts and standards for determining candidate test sites, if any, for which site specific assessments may be required. S.L.

N82-29725# Army Engineer District, Louisville, Ky.
STAGE 2 HYDROPOWER STUDY: CAGLES MILL LAKE, INDIANA

Jul. 1981 51 p refs
 (AD-A112150) Avail: NTIS HC A04/MF A01 CSCL 10B

The principle planning objective was the development of a renewable resource energy production facility for Cagles Mill Lake and the surrounding study area to be of benefit for a 100-year period of analysis. All plans studied are economically infeasible due primarily to the cost of the conveyance system needed to deliver the water to the powerhouse. The maximum capability of a house power unit in the center gate opening of the control tower is almost 250 KW. It is recommended that the study of the feasibility of small scale hydropower at Cagles Mill Lake, Indiana be terminated. It is recommended that a small station power unit, having an installed capacity of about 250 KW, be designed and installed in the existing tower at the earliest possible date to provide power for project facilities. Author (GRA)

N82-29732# Arizona Solar Energy Commission, Phoenix.
 Geothermal Commercial Team.

GEOHERMAL DEVELOPMENT PLAN: PIMA COUNTY

D. H. WHITE 1981 51 p refs Prepared in cooperation with Arizona Univ.

(Contract DE-FC03-80RA-50076)
 (DE82-006759; DOE/RA-50076/T12) Avail: NTIS HC A04/MF A01

Geothermal development for Pima County which is located entirely within the Basin and Range physiographic province in which geothermal resources are known to occur was investigated. Continued growth as indicated by such factors as population growth, employment and income will require large amounts of energy. Geothermal energy can provide some of the energy that will be needed. Potential users of geothermal energy within the county are identified. DOE

N82-29740# United Technologies Corp., South Windsor, Conn.
 Fuel Cell Operations Dept.

SPECIFICATION FOR DISPERSED FUEL-CELL GENERATOR

L. M. HANDLEY and R. COHEN Nov. 1981 100 p

(Contract EPRI PROJ. 1777-1)
 (DE82-901284; EPRI-EM-2123) Avail: NTIS HC A05/MF A01

A general description and performance definition for a standard 11-mw fuel cell power plant designed for electric utility dispersed-generation applications are provided. Additional features available at the option of the purchaser are also described. The power plant can operate singly or grouped with other power plants to produce larger multi-megawatt power stations. A 33-mw station is discussed as representative of multiple power plant installations. The power plant specification defines power rating, heat rate, fuels, operating modes, siting characteristics, and available options. A general description included in the attachments covers equipment, typical site arrangement, auxiliary subsystems, maintenance, fuel flexibility, and general fluid and electrical schematics. DOE

N82-29750# Michigan State Univ., East Lansing. Div. of Engineering Research.

OPERATIONS MODEL FOR UTILITIES USING WIND-GENERATOR ARRAYS

R. A. SCHLUETER, G. L. PARK, J. DORSEY, M. LOTFALIAN, and A. SHAYANFAR 30 May 1981 40 p refs

(Contract DE-AC02-79ET-23168)
 (DE82-005300; DOE/ET-23168/80/2) Avail: NTIS HC A03/MF A01

The effects that various combinations of wind regime, array configuration and penetrations, and system characteristics have on system variables such as area control error, frequency, interchange power and spinning reserve are discussed. The characteristics of the combinations causing system operating stress or operating problems are denoted and methods for estimating effects on a simplified and on a detailed simulation basis are reported. Methods for reducing operating problems are suggested

and involve array configurations, penetration, unit commitment and dispatch changes, and wind generator controls. T.M.

N82-29760# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SMALL-WIND-TURBINE PRODUCTION EVALUATION AND COST ANALYSIS

V. W. GREAVER, J. THORNTON, J. F. BRITT, H. L. DAVEY, D. A. MCCARROLL, and K. J. WYSOCKI Dec. 1981 207 p refs

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
 (DE82-010675; SERI/TR-09049-1-VOL-1) Avail: NTIS HC A10/MF A01

The development factory cost for the production of a 10 kilowatt wind energy conversion system was studied. Three production levels are evaluated, 1000 units per year, 10,000 units per year and 100,000 units per year. Wind turbine design analysis and production analysis are reported. DOE

N82-29761# Thermo Electron Corp., Waltham, Mass.

DOE ADVANCED THERMIONIC TECHNOLOGY PROGRAM

Progress Report, Jul. - Aug. - Sep. 1981

1981 37 p refs

(Contract DE-AC02-76ET-112892)

(DE82-010482; TE-4258-158-82; COO-3056-48; PR-48) Avail: NTIS HC A03/MF A01

Improvement of thermionic performance to the level that thermionic performance to the level that thermionic topping of fossil fuel powerplants becomes technically possible and economically attractive was studied. The operation of a thermionic module in a powerplant during the mid 1980's is also studied. Reliable thermionic operation in a combustion environment is demonstrated. Significant accomplishments include: (1) continuing stable output from the combustion test of the one inch diameter hemispherical silicon carbide diode at an emitter temperature of 17300 K for a period of over 9800 hours; (2) measurement of a barrier index of 2.15 eV (two inch diameter torispherical silicon carbide diode); and (3) successful thermal cycle test of a CVD silicon carbide coating inside a sintered molybdenum tube. E.A.K.

N82-30090# Stanford Univ., Calif. Lab. of High Temperature Gasdynamics.

HIGH-MAGNETIC-FIELD MHD-GENERATOR PROGRAM

Quarterly Report, 1 Apr. - 30 Jun. 1981

T. NAKAMURA, R. H. EUSTIS, M. MITCHNER, S. A. SELF, J. K. KOESTER, and C. H. KRUGER Jul. 1981 86 p refs

(Contract DE-AC01-80ET-15611)

(DE82-005215; DOE/ET-15611/6) Avail: NTIS HC A05/MF A01

Progress in an experimental and theoretical program designed to investigate MHD channel phenomena which are important at high magnetic fields is described. The areas of research include nonuniformity effects, boundary layers, Hall field breakdown, the effects of electrode configuration and current concentrations, and studies of steady-state combustion disk and linear channels in an existing 6 Tesla magnet of small dimensions. In the study of the effects of nonuniformities, experiments were performed to test a multi-channel, fiber optics diagnostic system that yields time-resolved temperature profiles in an MHD channel. For the study of magneto-acoustic fluctuation phenomena, a one dimensional model was developed to describe the performance of a non-ideal MHD generator with a generalized electrical configuration. A two dimensional MHD computer code was developed which predicts the dependence on electrode and insulator dimensions of the onset of interelectrode Hall field breakdown, as initiated either by breakdown in the insulator or in the plasma. DOE

05 ENERGY CONVERSION

N82-30102# Tennessee Univ., Tullahoma. Space Inst. **TWO-DIMENSIONAL COUPLED FLUID AND ELECTRODYNAMIC CALCULATIONS FOR A MHD DCW CHANNEL WITH SLAG LAYERS**

B. L. LIU Jan. 1982 40 p refs
(Contract DE-AC02-79ET-10815)
(DE82-010654; DOE/ET-10815/67; TR-7.2.4-81-01) Avail: NTIS HC A03/MF A01

A fully coupled, two dimensional numerical method of modeling linear, coal-fired MHD generators is developed for the case of a plasma flow bounded by a slag layer on the channel walls. The governing partial differential equations for the plasma flow, slag layer and electrostatics are presented and their coupling discussed. An iterative, numerical procedure employing non-uniform computational meshes and appropriate tri-diagonal matrix solution schemes for the equations is presented. The method permits the investigation of the mutual plasma flow-slag layer development for prescribed wall temperatures, electrode geometry, slag properties and channel loading. In particular, the slag layer-plasma interface properties which require prior specification in an uncoupled analysis comprise part of the solution in the present approach. Results are presented for a short diagonally connected generator channel and include contour plots of the electric potential and current stream function as well as transverse and axial profiles of pertinent plasma properties. The results indicate that a thin electrode slag layer can be maintained in the presence of reasonable current density levels. DOE

N82-30357# Mound Lab., Miamisburg, Ohio. **INHIBITING THE CO/CO₂ REACTION BETWEEN CARBON AND PLUTONIA AT ELEVATED TEMPERATURES**

E. W. JOHNSON 1981 7 p refs Presented at the 9th DOE Compatibility Meeting, St. Petersburg, Fla., 27 Oct. 1981
(Contract DE-AC04-76DP-00053)
(DE82-002593; MLM-2872-OP; CONF-811076-4) Avail: NTIS HC A02/MF A01

One of the problems associated with the sometimes protracted, ground storage of space PuO radioisotopic thermoelectric generators (RTG) devices is the ingrowth of carbon dioxide and carbon monoxide in the gas phase due to the cyclical reaction established between the fuel (238 PuO₂) and the carbon impact body. This ingrowth proceeds according to the two equations: $x\text{CO} + \text{PuO}_2 = x\text{CO}_2 + \text{PuO}_{2-x}$ (1) and $x\text{CO}_2 + x\text{C} = 2x\text{CO}$, etc. (2) This reaction stops after launch because the two solid-phase reactants are physically separated when the inside of the RTG is evacuated to space for performance reasons. When the RTG is stored on the ground, however, the product gases become established and can cause degradation of the solid-state thermoelectric elements. Controlling the reduction of the plutonia to such an extent that reaction (1) becomes thermodynamically unfavorable minimizes the continued generation of CO and CO₂. The conditions necessary to maintain plutonia at a substoichiometric level are being determined. These test conditions are described and are supported with data from previous heat source studies. A facility to perform the necessary treatment is described. DOE

N82-30372*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EVALUATION OF CANDIDATE STIRLING ENGINE HEATER TUBE ALLOYS AT 820 DEG AND 860 DEG C Final Report

J. A. MISENICK Jun. 1982 43 p refs
(Contract DE-AI01-77CS-51040)
(NASA-TM-82837; E-1204; DOE/NASA/51040-39; NAS 1.15:82837) Avail: NTIS HC A03/MF A01 CSCL 11F

Seven commercial alloys were evaluated in Stirling simulator materials rigs. Five iron base alloys (N-155, A-286, Incoloy 800, 19-9DL, and 316 stainless steel), one nickel base alloy (Inconel 718), and one cobalt base alloy (HS-188) were tested in the form of thin wall tubing in a diesel fuel fired test rig. Tubes filled with hydrogen or helium at gas pressure of 21.6 MPa and temperatures of 820 and 860 C were endurance tested for 1000 and 535 hours, respectively. Results showed that under these conditions hydrogen

permeated rapidly through the tube walls, thus requiring refilling during each five hour cycle. Helium was readily contained, exhibiting no measurable loss by permeation. Helium filled tubes tested at 860 C all exhibited creep-rupture failures within the 535 hour endurance test. Subsequent tensile test evaluation after removal from the rig indicated reduced room temperature ductility for some hydrogen-filled tubes compared to helium-filled tubes, suggesting possible hydrogen embrittlement in these alloys. S.L.

N82-30668 Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

VALUE ANALYSIS OF WIND ENERGY SYSTEMS TO ELECTRIC UTILITIES

D. PERCIVAL and J. HARPER *In* ASME Solar Eng., 1981 p 515-522 1981 refs

Avail: Issuing Activity

A method was developed for determining the value of utility-operated wind energy systems to electric utilities. The analysis is performed by a package of computer models that interface with most conventional utility planning models. Weather data are converted to wind turbine output powers, which are used to modify the utility load representation. Execution of the utility planning models with both the original and modified load representation yields the gross and marginal value (\$/rated kW) of the added wind energy systems. This value is then compared with cost estimates to determine if for economic reasons the wind energy systems should be included in future generation plans. M.G.

N82-30670 Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.

COST ANALYSIS OF DAWT INNOVATIVE WIND ENERGY SYSTEMS

K. M. FOREMAN *In* ASME Solar Eng., 1981 p 532-540 1981 refs Sponsored in part by Midwest Research Inst.

Avail: Issuing Activity

The results of a diffuser augmented wind turbine (DAWT) preliminary design study of three constructional material approaches and cost analysis of DAWT electrical energy generation are presented. Costs are estimated assuming a limited production run (100 to 500 units) of factory-built subassemblies and on-site final assembly and erection within 200 miles of regional production centers. It is concluded that with the DAWT the (busbar) cost of electricity (COE) can range between 2.0 and 3.5 cents/kW-hr for farm and REA cooperative end users, for sites with annual average wind speeds of 16 and 12 mph respectively, and 150 kW rated units. No tax credit incentives are included in these figures. For commercial end users of the same units and site characteristics, the COE ranges between 4.0 and 6.5 cents/kW-hr. M.G.

N82-30705*# Engelhard Industries, Inc., Edison, N.J.

DEVELOPMENT AND TEST FUEL CELL POWERED ON-SITE INTEGRATED TOTAL ENERGY SYSTEMS. PHASE 3: FULL-SCALE POWER PLANT DEVELOPMENT Quarterly Report, Nov. 1981 - Jan. 1982

A. KAUFMAN 21 Jun. 1982 61 p refs
(Contract DEN3-241; DE-AI01-80ET-17088)
(NASA-CR-167898; DOE/NASA/0241-4; NAS 1.26:167898; QR-4) Avail: NTIS HC A04/MF A01 CSCL 10B

The on-site system application analysis is summarized. Preparations were completed for the first test of a full-sized single cell. Emphasis of the methanol fuel processor development program shifted toward the use of commercial shell-and-tube heat exchangers. An improved method for predicting the carbon-monoxide tolerance of anode catalysts is described. Other stack support areas reported include improved ABA bipolar plate bonding technology, improved electrical measurement techniques for specification-testing of stack components, and anodic corrosion behavior of carbon materials. Author

N82-30709*# Tanksley (W. L.) and Associates, Inc., Brook Park, Ohio.

VIBRATION ANALYSIS OF THREE GUYED TOWER DESIGNS FOR INTERMEDIATE SIZE WIND TURBINES

R. J. CHRISTIE Mar. 1982 113 p refs

(Contract NAS3-21900)

(NASA-CR-165589; DOE/NASA/1900-1; NAS 1.26:165589)

Avail: NTIS HC A06/MF A01 CSCL 10A

Three guyed tower designs were analyzed for intermediate size wind turbines. The four lowest natural frequencies of vibration of the three towers concepts were estimated. A parametric study was performed on each tower to determine the effect of varying such tower properties as the inertia and stiffness of the tower and guys, the inertia values of the nacelle and rotor, and the rotational speed of the rotor. Only the two lowest frequencies were in a range where they could be excited by the rotor blade passing frequencies. There two frequencies could be tuned by varying the guy stiffness, the guy attachment point on the tower, the tower and mass stiffness, and the nacelle/rotor/power train masses.

Author

N82-30710*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EXPERIENCE AND ASSESSMENT OF THE DOE-NASA MOD-1 2000-KILOWATT WIND TURBINE GENERATOR AT BOONE, NORTH CAROLINA Final Report

J. L. COLLINS, R. K. SHALTENC, R. H. POOR (General Electric, Philadelphia), and R. S. BARTON (General Electric, Philadelphia)

Apr. 1982 55 p refs

(Contract DE-AI01-76ET-20366)

(NASA-TM-82721; E-1020; DOE/NASA/20366-2; NAS

1.15:82721) Avail: NTIS HC A04/MF A01 CSCL 10A

The Mod 1 program objectives are defined. The Mod 1 wind turbine is described. In addition to the steel blade operated on the wind turbine, a composite blade was designed and manufactured. During the early phase of the manufacturing cycle of Mod 1A configuration was designed that identified concepts such as partial span control, a soft tower, and upwind teetered rotors that were incorporated in second and third generation industry designs. The Mod 1 electrical system performed as designed, with voltage flicker characteristics within acceptable utility limits. Power output versus wind speed equaled or exceeded design predictions. The wind turbine control system was operated successfully at the site and remotely from the utility dispatcher's office. During wind turbine operations, television interference was experienced by the local residents. As a consequence, operations were restricted. Although not implemented, two potential solutions were identified. In addition to television interference, a few local residents complained about objectionable sound, particularly the 'thump' as the blade passed behind the tower. To eliminate objections, the sound generation level was reduced by 10 dB by reducing the rotor speed from 35 rpm to 23 rpm. Bolts in the drive train fractured. A solution was identified but not implemented. The public reaction toward the Mod 1 wind turbine program was overwhelmingly favorable.

S.L.

N82-30712*# Westinghouse Research and Development Center, Pittsburgh, Pa.

CELL MODULE AND FUEL CONDITIONER DEVELOPMENT Final Report, Oct. 1979 - Jan. 1982

D. Q. HOOVER, JR. Feb. 1982 393 p

(Contract DEN3-161; DE-AI01-80ET-17088)

(NASA-CR-165193; DOE/NASA/0161-10; NAS 1.26:185193;

WEC-82-901-MARED-R1) Avail: NTIS HC A17/MF A01 CSCL 10A

The phosphoric acid fuel cell module (stack) development which culminated in an 80 cell air-cooled stack with separated gas cooling and treed cooling plates is described. The performance of the 80 cell stack was approx. 100 mV per cell higher than that attained during phase 1. The components and materials performed stably for over 8000 hours in a 5 cell stack. The conceptual design of a fuel conditioning system is described.

Author

N82-30714*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

ASSESSMENT OF A 40-KILOWATT STIRLING ENGINE FOR UNDERGROUND MINING APPLICATIONS

J. E. CAIRELLI, G. G. KELM, and J. G. SLABY Jun. 1982 75 p refs

(Contract DI-DM-JO-100026)

(NASA-TM-82822; E-1171; NAS 1.15:82822) Avail: NTIS HC

A04/MF A01 CSCL 08I

An assessment of alternative power sources for underground mining applications was performed. A 40-kW Stirling research engine was tested to evaluate its performance and emission characteristics when operated with helium working gas and diesel fuel. The engine, the test facility, and the test procedures are described. Performance and emission data for the engine operating with helium working gas and diesel fuel are reported and compared with data obtained with hydrogen working gas and unleaded gasoline fuel. Helium diesel test results are compared with the characteristics of current diesel engines and other Stirling engines. External surface temperature data are also presented. Emission and temperature results are compared with the Federal requirements for diesel underground mine engines. The durability potential of Stirling engines is discussed on the basis of the experience gained during the engine tests.

Author

N82-30722*# National Bureau of Standards, Washington, D.C. Metallurgy Div.

NON-NOBLE CATALYSTS AND CATALYST SUPPORTS FOR PHOSPHORIC ACID FUEL CELLS Final Report, Oct. 1979 - Sep. 1981

A. J. MCALISTER Sep. 1981 38 p refs

(Contract NASA ORDER C-46229-D; DE-AI01-80ET-17088)

(NASA-CR-165289; DOE/NASA/6229-2; NAS 1.26:165289)

Avail: NTIS HC A03/MF A01 CSCL 10A

Tungsten carbide, which is active for hydrogen oxidation, is CO tolerant and has a hexagonal structure is discussed. Titanium carbide is inactive and has a cubic structure. Four different samples of the cubic alloys W sub x-Ti sub XC sub 1-y were found to be active and CO tolerant. When the activities of these cubic alloys are weighted by the reciprocal of the square to those of highly forms of WC. They offer important insight into the nature of the active sites on W-C anode catalysts for use in phosphoric acid fuel cells.

E.A.K.

N82-30732# Oak Ridge National Lab., Tenn. Energy Div.

OPERATIONAL CONCEPTS FOR LARGE WIND-TURBINE ARRAYS

T. W. REDDOCH, P. R. BARNES, J. S. LAWLER (Tennessee Univ., Knoxville), and J. C. SKROSKI (DOE, Washington) 1981 11 p refs Presented at the 5th Biennial Wind Energy Conf.

and Workshop, Washington, 5 Oct. 1981

(Contract W-7405-ENG-26)

(DE82-002876; CONF-811043-6) Avail: NTIS HC A02/MF A01

A primary application of wind electric generation which will be large clusters or arrays of megawatt-size wind turbines connected to the utility transmission network is discussed. Array output power variations due to the uncontrolled nature of the wind resource can cause undesirable dynamic impacts on the utility system. Consequently, spinning reserve, unloadable generation, and load following requirements and their associated economic penalties tend to increase as wind electric generation is added to the system. However, if array power variations are limited and/or anticipated, the associated operation and economic penalties can be significantly reduced. Operational concepts which have the potential to enhance the effectiveness of wind turbine arrays in the utility system are considered.

GFA

05 ENERGY CONVERSION

N82-30736# Cairo Univ. (Egypt). Dept. of Mechanical Engineering.

PARAMETRIC STUDY OF TORNADO-TYPE WIND-ENERGY SYSTEMS

S. S. AYAD Oct. 1981 15 p refs Presented at the 5th Bien. Wind Energy Conf. and Workshop, Washington, D.C., 5 Oct. 1981 (Contract DE-AC02-77CH-00178; EG-77-C-01-4042) (DE82-001795; SERI/TP-211-1391; CONF-811043-3) Avail: NTIS HC A02/MF A01

The tornado-type wind energy system uses the pressure drop created by an intense vortex. The vortex is generated in a tower mounted at the turbine exit. The tower serves as a low pressure exhaust for the turbine. The effects of embedding the tower in an atmospheric boundary layer varying the tower height to diameter ratio, and varying tower diameter using the same system geometry and approach flow conditions are explored. The results indicate a reduction of approx. 28% in power output. DOE

N82-30741# Argonne National Lab., Ill. Applied Geoscience and Engineering Group.

COMPARISON OF LIMITED MEASUREMENTS OF THE OTEC-1 PLUME WITH ANALYTICAL MODEL PREDICTIONS

R. A. PADDOCK and J. D. DITMARS Jul. 1981 18 p refs (Contract W-31-109-ENG-38) (DE82-003917; ANL/OTEC-EV-1) Avail: NTIS HC A02/MF A01

Testing of 1-MWe heat exchangers at the ocean thermal energy-1 (OTEC-1) facility aboard the vessel Ocean Energy Converter moored off the island of Hawaii is described. The warm and cold waters used by the OTEC-1 facility were combined prior to discharge from the vessel to create a mixed discharge condition. A limited field survey of the mixed discharge plume using fluorescent dye as a tracer was conducted as part of the environmental studies at OTEC-1. Results of that survey were compared with analytical model predictions of plume behavior. Although the predictions were in general agreement with the results of the plume survey, inherent limitations in the field measurement precluded complete description of the plume or detailed evaluation of the models. DOE

N82-30762# Battelle Inst., Frankfurt am Main (West Germany). Hauptabt. Energie- und Transportsysteme.

THE BEHAVIOR OF A LONG TERM HEAT STORAGE SYSTEM IN CONNECTION WITH A WIND ENERGY CONVERTER (PHASE 1) Final Report, May 1980

F. AUER, H. BLEY, and M. MUELLER Bonn Bundesministerium fuer Forschung und Technologie Apr. 1982 65 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-057; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 13,50

The technical and economical feasibility of heating a museum on the Wasserkuppe mountain (950 m) in the Rhoen hills by wind energy is affirmed. It is possible to recover the capital cost within a period of 15 to 19 years if the service life of the wind energy converter (WEC) and of the heat storage system is between 20 and 30 years. At a maximum thermal load of 120 kW, the minimum cost will be achieved with a WEC power output of 120 kW and a two day storage system. This combination permits 60% of the heat demand to be covered by wind energy. The balance has to be supplied by conventional energy sources. The wind energy fraction of the total energy demand thus is about twice as high as the solar fraction in the case of solar heating systems and about 15% higher than the fraction of ambient heating energy in the case of electric heat pumps used in bivalent operation. The wind price per kWh is already comparable to that expected for the future large wind energy converters (GROWIAN) to be produced in series. Author (ESA)

N82-31065# Los Alamos Scientific Lab., N. Mex.

PERFORMANCE OF LARGE MAGNETS UNDER TRANSIENT VOLTAGES

P. CHOWDHURI and M. ANDERSON 1981 5 p refs Presented at the 9th Symp. on Eng. Probl. of Fusion Res., Chicago, 26-29 Oct. 1981 (Contract W-7405-ENG-36) (DE82-002380; LA-UR-81-3107) Avail: NTIS HC A02/MF A01

Studies were performed to determine the severity of transient electrical stresses in two superconducting energy storage coils. One is a 300 kJ single layer coil and the other is a 30 MJ pancake coil. The resonant space harmonics of the coils were measured at room temperature and confirmed by analysis. The first space harmonic of the 300 kJ coil was measured at 577 kHz, and its peak amplitude was about 12 times the input signal. The first space harmonic of the 30 MJ coil was measured at 7.3 kHz. The nonuniform initial voltage distribution along the 30 MJ coil was analyzed theoretically for a step-function input voltage by use of the standing-wave theory. The analysis was performed for two cases with metal and insulating dewars. The transient voltage across the first two turns of the coil with the metal dewar was almost three times as much as that with an insulating dewar. This increased voltage signifies the influence of the distributed capacitance between the coil and the dewar. DOE

N82-31379# Sorapec, Fontenay sous Bois (France).

DEVELOPMENT OF A FUEL CELL [DEVELOPPEMENT D'UNE PILE A COMBUSTIBLE]

D. DONIAT *in* CNES The Future of Launchers in Europe p 489-496 1982 In FRENCH; ENGLISH summary Avail: NTIS HC A99/MF A01

High power cells in Aerospace technology are discussed. Triple contact porous gas diffusion electrodes using nickel foam were developed. Depending on temperature, and quantity of catalyst (platinum based) current density varies from 0.3 to 1A/sqcm. The feasibility to obtain a power density higher than 800 mW/cm² is investigated. Author (ESA)

N82-31626# Argonne National Lab., Ill. Fusion Power Program. **DEVELOPMENT, ANALYSIS AND CONTROL OF THE INDUCTOR-CONVERTER BRIDGE** Ph.D. Thesis

M. EHSANI and R. L. KUSTOM Aug. 1981 361 p refs (Contract W-31-109-ENG-38) (DE82-001611; ANL/FPP/TM-144) Avail: NTIS HC A16/MF A01

The inductor-converter bridge (ICB) is a solid state dc-ac-dc power converter system for bidirectional, controllable, energy transfer between two high Q magnet coils. The ICB is suitable for supplying large pulsed power to such magnets as the superconducting equilibrium field (EF) coil of the proposed tokamak power reactors, from another superconduction energy storage coil. This report presents work on the analysis and control the ICB system. The process of energy transfer between the coils is explained on the basis of a simple one line equivalent circuit. This circuit is the topological dual of the one line diagram of the nonsalient pole synchronous generator, connected to the infinite bus through its synchronous reactance. The changes in the average power, average coil currents, and voltages, as functions of time, are calculated by the conventional Fourier method of analysis. DOE

N82-31701# Brobeck (William M.) and Associates, Berkeley, Calif.

REVIEW OF TESTING AND EVALUATION OF AN IMPROVED STEAM ENGINE

Dec. 1981 49 p refs (Contract DE-FG01-80CS-50225) (DE82-011258; DOE/NBM-1000) Avail: NTIS HC A03/MF A01

An experimental steam engine was tested and evaluated. The purpose of the project was to improve the thermal efficiency of a small steam power system. A thermal efficiency of 24% was achieved, based on a net system power output of 28 horsepower. While this was a noteworthy improvement over 22% achieved a

year earlier, it was short of the goal of 27%. Analysis has shown that 27% is attainable with further engineering development. Design modifications which can lead to improved efficiency are discussed. DOE

N82-31703# Stanford Univ., Calif. Guidance and Control Lab.
CLOSED LOOP CONTROL OF AUTOMOTIVE ENGINES Final Report, Feb. 1978 - Jun. 1980

J. D. POWELL, K. RANDALL, R. HOSEY, and J. D. POWELL
Washington DOT Dec. 1981 316 p refs
(Contract DOT-TSC-1466)
(PB82-164088; DOT-TSC-NHTSA-81-12; DOT-HS-805874) Avail:
NTIS HC A14/MF A01 CSCL 13F

The application of optimization theory to develop control laws for use in closed loop control strategies to minimize the effect of fuel/air ratio and spark advance variables in internal combustion engines is considered. The automated dynamometer facility developed for the acquisition of engine mapping data is described. This data was used to develop analytical functions describing the fuel consumption and emissions at each of 10 torque/RPM points. The functions were used by an optimization procedure to arrive at control strategies and driving cycle predictions of fuel consumption and emissions. The optimum schedules were then used to determine a closed loop control strategy. GRA

N82-31776*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

GAS TURBINE CRITICAL RESEARCH AND ADVANCED TECHNOLOGY (CRT) SUPPORT PROJECT Annual Report, Fiscal Year 1980

E. R. FURMAN, D. N. ANDERSON, M. A. GEDWILL, C. E. LOWELL, and D. F. SCHULTZ Jul. 1982 47 p refs
(Contract DE-AI01-77ET-10350)
(NASA-TM-82872; E-1247; NAS 1.15:82872) Avail: NTIS HC A03/MF A01 CSCL 10A

The technical progress to provide a critical technology base for utility gas turbine systems capable of burning coal-derived fuels is summarized. Project tasks include the following: (1) combustion - to investigate the combustion of coal-derived fuels and the conversion of fuel-bound nitrogen to NO_x; (2) materials - to understand and prevent the hot corrosion of turbine hot section materials; and (3) system studies - to integrate and guide the technological efforts. Technical accomplishments include: an extension of flame tube combustion testing of propane - Toluene Fuel Mixtures to vary H₂ content from 9 to 18 percent by weight and the comparison of results with that predicted from a NASA Lewis General Chemical Kinetics Computer Code; the design and fabrication of combustor sector test section to test current and advanced combustor concepts; Testing of Catalytic combustors with residual and coal-derived liquid fuels; testing of high strength super alloys to evaluate their resistance to potential fuel impurities using doped clean fuels and coal-derived liquids; and the testing and evaluation of thermal barrier coatings and bond coatings on conventional turbine materials. Author

N82-31795# General Electric Co., Philadelphia, Pa.
EVALUATION OF TECHNICAL FEASIBILITY OF CLOSED-CYCLE NON-EQUILIBRIUM MHD POWER GENERATION WITH DIRECT COAL FIRING Final Report

Nov. 1981 164 p refs
(Contract DE-AC01-78ET-10818)
(DE82-007104; DOE/ET-10818/T2-VOL-2-APP) Avail: NTIS HC A08/MF A01

Program accomplishments in a continuing effort to demonstrate the feasibility of direct coal-fired, closed-cycle magnetohydrodynamic (MHD) power generation are reported. A user's manual for a two-dimensional MHD generator code and performance estimates for a nominal 30 MW argon segmented heater are given. The feedwater cooled Brayton cycle is discussed as well as the application of closed cycle MHD in an industrial cogeneration environment. Preliminary design for shell and tube primary heat exchanger and plant efficiency as a function of output

power for open and closed cycle MHD power plants are also discussed. DOE

N82-31800# Grumman Aerospace Corp., Bethpage, N.Y.
PRELIMINARY DESIGN AND ECONOMIC INVESTIGATIONS OF DIFFUSER-AUGMENTED WIND TURBINES (DAWT). EXECUTIVE SUMMARY Final Report, 15 May 1979 - 31 Mar. 1980

K. M. FOREMAN Dec. 1981 26 p refs Prepared in cooperation with Midwest Research Inst.
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-008515; SERI/TR-98073-1A) Avail: NTIS HC A03/MF A01

A preferred design and configuration approach for the diffuser augmented wind turbine (DAWT) innovative wind energy conversion system is suggested. A preliminary economic assessment is made for limited production rates of units between 5 and 150 kW rated outputs. Nine point designs are used to arrive at the conclusions regarding best construction material for the diffuser and busbar cost of electricity (COE). It is estimated that for farm and cooperative end users, the COE can range between 2 and 3.5 cents pr kWh for sites with annual average wind speeds of 16 and 12 mph (25.7 and 19.3 km/h) respectively, and 150 kW rated units. No tax credits are included in these COE figures. For commercial end users of these 150 kW units, the COE ranges between 4.0 and 6.5 cents per kWh for 16 and 12 mph sites. These estimates in 1971 dollars are lower than department of energy goals set in 1978 for the rating size and end applications. Recommendations are made for future activities to maintain steady, systematic progress toward mature development of the DAWT. DOE

N82-31805# New Mexico State Univ., Las Cruces. Solar Energy Inst.

DATA REPORT FOR THE SOUTHWEST RESIDENTIAL EXPERIMENT STATION, NOVEMBER 1981

M. LIEBERMAN, O. Y. HAI, G. HOCKING, and C. WHITAKER
18 Dec. 1981 22 p refs
(Contract DE-AC02-76ET-20279)
(DE82-011197; DOE/ET-20279/176) Avail: NTIS HC A02/MF A01

The Southwest Residential Experiment Station (SW RES) is operated in Las Cruces, New Mexico. Physical performance data obtained from the photovoltaic energy systems under test at the SW RES are tabulated. DOE

N82-31812# Little (Arthur D.), Inc., Cambridge, Mass.
DEMONSTRATION OF SCROLL MOTOR ADVANTAGES FOR ULTRA LOW-HEAD HYDROELECTRIC POWER GENERATION Final Report, Sep. 1980 - Nov. 1981

J. E. MCCULLOUGH and J. T. DIEKMANN Feb. 1982 95 p
(Contract DE-FC07-80ID-12202)
(DE82-009792; DOE/ID-12202/T1; C-85464) Avail: NTIS HC A05/MF A01

The potential advantages of an ultra low head hydroelectric power generator utilizing a scroll motor were investigated. The model scroll motor was designed, built, and tested at fluid heads up to 10 ft and speeds up to 270 RPM. The maximum shaft power output of the motor was 400 W. Hydraulic power was converted to shaft power with efficiencies between 30% and 40% with maximum efficiency achieved at a 10 ft head at 175 RPM. Internal leakage losses and friction in the speed increasing gear box as accounting for 50 to 75% of the power losses were identified. Design modifications in the prototype are recommended to reduce these losses. Further efficiency improvements are projected for larger sizes of scroll hydraulic motors. Improvements are recommended for the laboratory model to reduce leakage and speed increaser losses. DOE

05 ENERGY CONVERSION

N82-31816# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

EXERGY OF THE OCEAN THERMAL RESOURCE AND THE SECOND LAW EFFICIENCY OF IDEALIZED OCEAN THERMAL ENERGY CONVERSION POWER CYCLES

D. H. JOHNSON Feb. 1982 41 p refs
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)
(DE82-009138; SERI/TR-252-1420) Avail: NTIS HC A03/MF A01

A formula is developed to compute the maximum amount of work which can be extracted from a given combined mass of warm and cold ocean water (a quantity called the exergy of the ocean thermal resource). The second law efficiencies of various proposed ocean thermal energy conversion power cycles are compared to determine which best utilizes the exergy of the ocean thermal resource. The second law efficiencies of the multicomponent working fluid cycle, the Beck cycle, and the open and closed single and multiple stage Rankine cycles are compared. These types of OTEC power plants are analyzed in a consistent manner which assumes that all deviations from a plant making use of all the exergy (one with a second law efficiency of 100%) occurs because of irreversible transfer of heat across a finite temperature difference. Conversion of thermal energy to other forms is assumed to occur reversibly. The comparison of second law efficiencies of various OTEC power cycles shows that the multistage Rankine open cycle with just three stages has the potential of best using the exergy of the ocean thermal resource.

DOE

N82-31821# Eidgenossisches Flugzeugwerk, Emmen (Switzerland). Research and Testing Dept.

DEVELOPMENT OF A REVERSE-RANKINE CYCLE HEAT PUMP FOR SPACE USE: DESIGN AND TESTING OF THE ENGINEERING MODEL OF THE VAPOR COMPRESSOR Final Report

F. BERNER, H. OESCH, and K. GOETZ Sep. 1981 80 p refs
(Contract ESA-4094/79/NL-AK(SC))
(F+W-FO-1568; ESA-CR(P)-1590) Avail: NTIS HC A05/MF A01

An installation for testing a vapor compressor under operating conditions in a heat pump loop, and the testing of the vapor compressor in this installation are described. The installation is a closed freon 12 loop, like that of a reverse Rankine cycle heat pump. It is demonstrated that the compressor operates satisfactorily under the most extreme conditions, including ingestion of liquid refrigerant during high speed operation, and operation of the compressor in different attitudes. It is shown that volumetric efficiency and isentropic compression efficiency are practically dependent on the compression ratio only, and are rather high for this size of compressor. A heat pump incorporating the vapor compressor cools payloads down to -40C. Maximum cooling rate is over 400W when payload temperature is 10C. Compressor power consumption never exceeds 120W.

Author (ESA)

N82-32120# International Energy Systems Corp., San Jose, Calif.

ALTERNATIVE NUCLEAR TECHNOLOGIES Final Report

E. SCHUBERT Oct. 1981 118 p refs Sponsored by Electric Power Research Inst.
(Contract EPRI-TPS-78-817)
(DE82-900974; EPRI-P-2073) Avail: NTIS HC A06/MF A01

The lead times required to develop a select group of nuclear fission reactor types and fuel cycles to the point of readiness for full commercialization are compared. Along with lead times, fuel material requirements and comparative costs of producing electric power were estimated. A conservative approach and consistent criteria for all systems were used in estimates of the steps required and the times involved in developing each technology. The impact of the inevitable exhaustion of the low- or reasonable-cost uranium reserves in the United States on the desirability of completing the breeder reactor program, with its favorable long-term result on fission fuel supplies, is discussed. The long times projected to bring the most advanced alternative converter reactor technologies

the heavy water reactor and the high-temperature gas-cooled reactor into commercial deployment when compared to the time projected to bring the breeder reactor into equivalent status suggest that the country's best choice is to develop the breeder. The perceived diversion-proliferation problems with the uranium plutonium fuel cycle have workable solutions that can be developed which will enable the use of those materials at substantially reduced levels of diversion risk.

DOE

N82-32155# California Univ., Livermore. Lawrence Livermore Lab.

DESIGN CONSIDERATIONS FOR AN INTERNAL CONFINEMENT FUSION REACTOR POWER PLANT

J. V. MASSEY and J. E. SIMPSON 10 Aug. 1981 4 p refs
Presented at the Am. Nucl. Soc., San Francisco, 29 Nov. 1981
Prepared in cooperation with Bechtel Corp., San Francisco
(Contract W-7405-ENG-48)
(DE81-030646; UCRL-15377) Avail: NTIS HC A02/MF A01

A conceptual design study to further define the engineering and economic concerns for inertial confinement fusion reactors is presented. Alternatives to the Livermore HYLIFE concept were examined and information from liquid metal cooled fast breeder reactor power plant studies was incorporated into the design. Laser and target physics models were employed in a reactor design with a low coolant flowrate and a high driver repetition rate. An example of such a design is the JADE concept. In addition to a power plant design developed using the JADE example, the applicability of the energy absorbing gas lithium ejector concept was investigated.

DOE

N82-32287# Joint Publications Research Service, Arlington, Va. PROSPECTS FOR POWER ENGINEERING IN SPACE

V. S. AVDUYEVSKIY, S. D. GRISHIN, L. V. LESKOV, V. K. ABLEKOV, and A. F. YEVICH *In its* USSR Rept.: Space, No. 17 (JPRS-81552) p 62-70 17 Aug. 1982 Transl. into ENGLISH from Zemlya Vseleennaya (USSR), no. 6, Nov. - Dec. 1981 p 2-6
Avail: Issuing Activity

Methods for producing electric power in space, including satellite solar power stations, nuclear breeder reactors, and thermonuclear reactors are examined in terms of estimated costs and power production capabilities. Mass reduction of power stations, the transport of components into space, and the delivery of assemblies into a geosynchronous orbit are discussed. The advantages of using electric rocket engines for interorbital delivery 'tugs' are outlined and the feasibility of using laser engine launch vehicles with Earth based laser energy sources is explored.

M.G.

N82-32294# Joint Publications Research Service, Arlington, Va. PLAN FOR EXTENSIVE ENERGY PROJECT WITH FORTY WINDMILLS

In its West Europe Rept.: Sci. and Technol., No. 99 (JPRS-80536) p 15-16 9 Apr. 1982 Transl. into ENGLISH from NRC Handelsblad (Netherlands), 1 Mar. 1982 p 3
Avail: NTIS HC A04

Dutch electricity production companies have highly advanced plans for an extensive wind energy project. They call for a 'park' of thirty to forty middle sized windmills which would have to produce a total of 10,000 kilowatts of electricity.

Author

N82-32295# Joint Publications Research Service, Arlington, Va. DANISH-SWEDISH WINDPOWER COMPANY FOUNDED IN DENMARK

M. HOLMSTROM *In its* West Europe Rept.: Sci. and Technol., No. 99 (JPRS-80536) p 17-18 9 Apr. 1982 Transl. into ENGLISH from Y Tek. (Sweden), 4 Feb. 1982 p 3
Avail: NTIS HC A04

The Swedish General Electric Co. (ASEA) has founded a windpower company in cooperation with the Danish state and a Danish company. They expect to build 250 windpower plants through 1984. If a Swedish market opens a similar partner company is planned in Sweden.

Author

N82-32843*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

REACTANT PRESSURE DIFFERENTIAL CONTROL FOR FUEL CELL GASES Patent Application

A. P. GRASSO, inventor (to NASA) (Hamilton Standard, Windsor Locks, Conn.) 1 Jul. 1982 8 p Sponsored by NASA (NASA-CASE-MS-C-20127-1; US-PATENT-APPL-SN-394344)

Avail: NTIS HC A02/MF A01 CSCL 10A

A pair of valves connected in tandem are balanced between pressure of reactant gases supplied to a fuel cell power plant to control the pressure differences between the gases so as to maintain those pressure substantially in the proportions necessary for operation of the fuel cell. NASA

N82-32860# Department of Energy, Oak Ridge, Tenn. Technical Information Center.

DIRECT ENERGY CONVERSION, A CURRENT AWARENESS BULLETIN

30 Aug. 1982 20 p

(PB82-946616; DOE/DEC-82/16) Avail: NTIS HC A02/MF A01 CSCL 10A

This bulletin contains 94 abstracts and bibliographic citations of scientific and technical reports, journal articles, conference proceedings, patents, books, and other published literature on all aspects of direct energy conversion. A subject index and a report number index are provided. This information is selected from the DOE/TIC Energy Data Base. J.M.S.

N82-32868# EIC, Inc., Newton, Mass.

LITHIUM CYCLING IN POLYMETHOXYMETHANE SOLVENTS

J. S. FOOS and J. MCVEIGH Jun. 1982 17 p refs Submitted for publication

(Contract N00014-77-C-0155; NR PROJ. 359-638)

(AD-A116790; TR-7) Avail: NTIS HC A02/MF A01 CSCL 10C

Solutions of LiAsF₆ in dimethoxymethane (DMM) and trimethoxymethane (TMM) are shown to be conductive and capable of cycling Li in high efficiency in half-cells. Inspection of electrolytes stored at 70 C in the presence and absence of Li indicated that TMM is more stable than DMM. However, DMM cycles Li much better than TMM after storage. GRA

N82-32869# Northeastern Univ., Boston, Mass. Dept. of Mechanical Engineering.

NOVEL APPROACH TO THE EXPLOITATION OF THE TIDAL ENERGY. VOLUME 1: SUMMARY AND DISCUSSION Final Report

A. M. GORLOV Dec. 1981 77 p refs

(Contract DE-AS02-79ER-10469)

(DE82-010829; DOE/ER-10469/1-VOL-1) Avail: NTIS HC A05/MF A01

The hydropneumatic concept in the approach to harnessing low tidal hydropower is discussed. The energy of water flow is converted into the energy of an air jet by a specialized air chamber which is placed on the ocean floor across a flowing watercourse. Water passes through the chamber where it works as a natural piston compressing air in the upper part of the closure. Compressed air is used as a new working plenum to drive air turbines. The kinetic energy of an air jet provided by the air chamber is sufficient for stable operation of industrial air turbines. It is possible to use light plastic barriers instead of conventional rigid dams (the water sail concept). It is confirmed that the concept can result in a less expensive and more effective tidal power plant project than the conventional hydroturbine approach. DOE

N82-32876# North Dakota Univ., Grand Forks. Engineering Experiment Station.

DESIGN AND DEVELOPMENT OF A SPLIT-EVAPORATOR HEAT-PUMP SYSTEM

M. H. SOMERVILLE and S. G. PENONCELLO Dec. 1981 242 p refs Sponsored in part by the Northern States Power Co., Ottertail Power Cooperative, Minnkota Power Cooperative, and the Westinghouse Electric Corp.

(Contract W-7405-ENG-26)

(DE82-007112; ORNL/SUB-7434/1) Avail: NTIS HC A11/MF A01

Three types of multiple source heat pumps are presented. The three designs are the parallel evaporator, the series evaporator, and the parallel evaporator with active subcooling, with the parallel evaporator with the active subcooling showing the most promise for solving the problem of defrosting of air evaporators. The models are based upon the refrigerant flow rate, rather than the refrigeration effect of the evaporator. It is shown that the temperature of the air surrounding the flat plate ice maker plays a dominant role in the rate of ice formation. A weather analysis for forty cities throughout the nation was completed. These data were processed to allow easy computation of thermal storage requirements, such as off peak air conditioning. The results of an ice storage system that is thermally coupled to the Earth are described. An economic and energy comparison of multiple source heat pumps with ACES, and air-to-air heat pump systems is presented. DOE

N82-32882# Hawaii Univ., Honolulu. Hawaii Natural Energy Inst.

OCEAN THERMAL ENERGY CONVERSION: A REVIEW

P. C. YUEN Oct. 1981 178 p refs

(DE82-901167; HNEI-81-03) Avail: NTIS HC A09/MF A01

The OTEC principle along with general system and cycle, types, specific OTEC designs, OTEC applications, and the ocean thermal resource are discussed. The historic development of OTEC is reviewed, and the status of French, Japanese, EUROCEAN, and US programs is assessed. Power system components of the more technically advanced closed cycle OTEC concept are examined. These include: heat exchangers, corrosion and biofouling countermeasures, working fluids, ammonia power systems, and on platform seawater systems. Several open cycle features are also discussed. The ocean engineering aspects of OTEC power systems are reviewed. Major subsystems such as platform, cold water pipe, mooring system, dynamic positioning system, power transmission cable system are assessed for their relationships with the ocean environment and with each other. Possible environmental and social effects of OTEC development are discussed. DOE

N82-32885# SRI International Corp., Menlo Park, Calif.

HYDROCARBON REFORMING FOR HYDROGEN FUEL CELLS: A STUDY OF CARBON FORMATION ON AUTOHERMAL REFORMING CATALYSTS Final Report

J. G. MCCARTY, D. M. SHERIDAN, H. WISE, and B. J. WOOD Dec. 1981 157 p refs

(Contract DE-AC21-79MC-11323)

(DE82-010461; DOE/MC-11323/T2) Avail: NTIS HC A08/MF A01

The mechanism of carbon formation on nickel autothermal steam reforming catalysts was studied by temperature programming, thermogravimetric and electron microscopic techniques. Temperature programmed surface reaction (TPSR) studies of carbon deposited on nickel reforming catalysis by the decomposition of C₂H₄ and C₂H₂ exhibit seven forms of carbon that are distinguished by their characteristic reactivity with H₂ and 3.0-vol % H₂O/He. Similar carbon states are found on all nickel catalysts including Ni/(BETA)-Al₂O₃ and Ni/MgO-Al₂O₃ which suggests that the support has little effect on carbon deposit formation and reactivity. The reactivity of the carbon states is not altered by exposure to steam in C₂H₄-H₂O mixtures, but the amount of carbon desorbed decreases to zero as H₂O/C increases past a critical ratio. DOE

05 ENERGY CONVERSION

N82-32888# Maschinenfabrik Augsburg-Nuernberg A.G., Oberhausen (West Germany).

LIQUEFIED NATURAL GAS VAPORIZATION AND ELECTRICITY GENERATION, USING CLOSED CYCLE GAS TURBINES Final Report, Jun. 1981

D. WEBER and M. WALOCH Bonn Bundesministerium fuer Forschung und Technologie Mar. 1982 352 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-035; ISSN-0340-7608) Avail: NTIS HC A16/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 49,60

The energy released during the vaporization of liquefied natural gas (LNG), which represents an annual potential for thermal power that amounts to 1 500 MW worldwide, was investigated. A plant was developed for LNG vaporization and electricity generation using closed cycle gas turbines for the economic utilization of this energy. The following design data are given: LGN mass flow (101.1 kg/sec); natural gas volumetric flowrate (STP: 431,410 cu m/hr); power at terminals (100 MW); fuel consumption (natural gas: 16,070 cu m/hr); efficiency at terminals (55%); and total utilization (electricity plus LNG vaporization heat: 93%). Author (ESA)

N82-33247# California Univ., Livermore. Lawrence Livermore Lab.

ENGINEERING PROBLEMS OF TANDEM-MIRROR REACTORS

R. W. MOIR, W. L. BARR, B. M. BOGHOSIAN, G. A. CARLSON, R. S. DEVOTO, J. N. DOGGETT, G. W. HAMILTON, B. M. JOHNSON, W. N. KUMAI, J. D. LEE et al. 22 Oct. 1981 6 p refs Presented at the IEEE Symp. on Nucl. Sci., San Francisco, 21 Oct. 1981

(Contract W-7405-ENG-48)

(DE82-002581; UCRL-86810; CONF-811040-63) Avail: NTIS HC A02/MF A01

A comparative evaluation of several end plug configurations for tandem mirror fusion reactors with thermal barriers is presented. The axi-cell configuration was selected for further study and will be the basis for a detailed conceptual design study to be carried out over the next two years. The axi-cell end plug has a simple mirror cell produce by two circular coils followed by a transition coil and a yin-yang pair, which provides for MHD stability. Scientific and technological understanding and innovation are needed in the area of thermal barrier pumping - a process by which unwanted particles are removed (pumped) from certain regions of velocity and real space in the end plug. Removal of exhaust fuel ions, fusion ash and impurities by action of a halo plasma and plasma dump in the mirror end region is another challenging engineering problem discussed. DOE

N82-33830*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THEORETICAL AND EXPERIMENTAL POWER FROM LARGE HORIZONTAL-AXIS WIND TURBINES

L. A. VITERNA and D. C. JANETZKE Sep. 1982 21 p refs Presented at the 5th Biennial Conf. and Workshop on Wind Energy, Washington D.C., 5-7 Oct. 1981

(Contract DE-AI01-76ET-20320)

(NASA-TM-82944; E-1346; DOE/NASA/20320-41; NAS 1.15:82944) Avail: NTIS HC A02/MF A01 CSCL 10A

A method for calculating the output power from large horizontal-axis wind turbines is presented. Modifications to the airfoil characteristics and the momentum portion of classical blade element-momentum theory are given that improve correlation with measured data. Improvement is particularly evident at low tip-speed ratios where aerodynamic stall can occur as the blade experiences high angles of attack. Output power calculated using the modified theory is compared with measured data for several large wind turbines. These wind turbines range in size from the DOE/NASA 100 kW Mod-0 (38 m rotor diameter) to the 2000 kW Mod-1 (61 m rotor diameter). The calculated results are in good agreement with measured data from these machines. Author

N82-33831# Eagle-Picher Industries, Inc., Joplin, Mo.

CALCIUM INORGANIC ELECTROLYTE BATTERY DEVELOPMENT Final Report, Apr. - Oct. 1981

D. CARR, E. HEATON, and B. HIGGINS Wright-Patterson AFB, Ohio AFWAL Mar. 1982 78 p

(Contract F33615-77-C-2020; AF PROJ. 3145)

(AD-A115956; AFWAL-TR-82-2013) Avail: NTIS HC A05/MF A01 CSCL 10C

Eighteen 2000 ampere hour and eight 200 ampere hour calcium thionyl chloride cells of a low surface area design were fabricated and performance tested. The tests covered: (1) electrolyte volume optimization; (2) characterization of discharge capacity vs. rate and temperature; (3) intermittent discharging characterization; and (4) reversed polarity abuse. Author (GRA)

N82-33833# Army Electronics Technology and Devices Lab., Fort Monmouth, N. J.

HIGH ENERGY SURFURYL CHLORIDE BATTERIES

S. GILMAN, W. WADE, JR., and M. BINDER 18 Jun. 1982 11 p refs Presented at the Army Sci. Conf., 15-18 Jun. 1982

(AD-A117106) Avail: NTIS HC A02/MF A01 CSCL 10C

There is no practical alternative to the use of primary batteries to power man portable electronic equipment for communications, surveillance, target acquisition, and night vision applications. For an increasing percentage of such newly developed equipments, power and energy density requirements are so high that only the most energetic electrochemical couples can be considered for the purpose. Cells utilizing sulfuryl chloride as the cathode reactant are the latest and most energetic of the liquid cathode cells resulting from research initiated at the Electronics Technology and Devices Laboratory in the early 1970s. GRA

N82-33841# Copenhagen Univ. (Denmark). Lab. for Physics.

OPTIMAL STAGING OF ENDOREVERSIBLE HEAT ENGINES

M. H. RUBIN (Maryland Univ. Baltimore County) and B. ANDRESEN 1980 25 p refs

(DE82-900742; KU-HCOE-FL2-R-80-10) Avail: NTIS (US Sales Only) HC A02/MF A01; DOE Depository Libraries

Two endoversible engines were put in series to form a single engine, whose power output is maximized. The interface between the two stages, which for the present model is the intermediate temperature and the relative timing of the two engines, is arbitrary and can be used to satisfy other, nonthermodynamic constraints. Adding any constraint on the volume of the working gas does not lift this indeterminacy. The optimum composite system is equivalent to a single endoreversible engine. DOE

N82-33847# FWG Associates, Inc., Tullahoma, Tenn.

GUIDELINES FOR SITING WECS RELATIVE TO SMALL-SCALE TERRAIN FEATURES Final Report

W. FROST and C. F. SHIEH Dec. 1981 215 p refs

(Contract DE-AC06-76ET-20242; EY-76-C-06-2443)

(DE82-009124; DOE/ET-20242/78-1) Avail: NTIS HC A10/MF A01

Guidelines for siting wind energy conversion systems (WECS) relative to small-scale terrain features are presented to assess the influence of small or microscale terrain features on a proposed wind turbine site. Three categories of terrain were considered: (1) protrusions, topographical features that protrude well above the general level of their neighboring terrain; (2) depressions, valleys, canyons, or passes; and (3) complex terrain, so rugged or irregular that no well defined protrusion or depression can be easily distinguished. The optimum site on a protrusion is always at the highest point. The smoother the peak of the protrusion and the more gentle the slopes on all sides the more optimum the site, providing the geometry and orientation of the depression are such that full advantage can be taken of existing strong valley winds or outflow. Where the terrain is very complex and tortuous, the highest point of the topography will be the optimum site. DOE

N82-33849# Oak Ridge National Lab., Tenn. Engineering Technology Div.

STIRLING ENGINE WITH ONE ADIABATIC CYLINDER

C. D. WEST Mar. 1982 57 p refs
(Contract W-7405-ENG-26)

(DE82-009606; ORNL/TM-8022) Avail: NTIS HC A04/MF A01

It is shown that integration around the P-V loop of a Stirling-like cycle with an adiabatic expansion or compression space is possible through careful application of the ideal gas laws. The result is a set of closed-form solutions or the work output, work input, and efficiency for ideal gases. Previous analyses yielded closed-form solutions only for machines in which all spaces behave isothermally, or that have other limitations that simplify the arithmetic but omit important aspects of real machines. The results of this analysis, although still far removed from the exact behavior of real, practical engines, yield important insights into the effects observed in computer models and experimental machines. These results are especially illuminating for machines intended to operate with fairly small temperature differences. Heat pumps and low-technology solar-powered engines might be included in this category. DOE

N82-33854# Grumman Aerospace Corp., Bethpage, N.Y.
PRELIMINARY DESIGN AND ECONOMIC INVESTIGATIONS OF DIFFUSER AUGMENTED WIND TURBINES (DAWT) Final Report, 15 May 1979 - 31 Mar. 1980

K. M. FOREMAN Dec. 1981 249 p refs

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)

(DE82-008475; SERI/TR-98073-1B) Avail: NTIS HC A11/MF A01

A preferred design and configuration approach for the diffuser augmented wind turbines (DAWT) innovative wind energy conversion system is proposed. A preliminary economic assessment for limited production rates of units between 5 and 150 kw rated output was made. It is estimated that for farm and REA cooperative end users, the COE can range between 2 and 3.5 cents/kWh for sites with annual average wind speeds of 16 and 12 mph respectively and 150 kW rated units. No tax credits are included in these COE figures. For commercial end users of these 150 kW units the COE ranges between 4.0 and 6.5 cents/kWh for 16 and 12 mph sites. These estimates in 1979 dollars are lower than DOE goals set in 1978 for the rating size and end applications. DOE

N82-33869# Stanford Univ., Calif. High Temperature Gasdynamics Lab.

SYSTEM STUDY OF AN MHD/GAS TURBINE COMBINED-CYCLE BASELOAD POWER PLANT

K. D. ANNEN Aug. 1981 199 p refs

(Contract DE-AC01-80ET-15611)

(DE82-015215; DOE/ET-15611/T3; SU-HTGL-134) Avail: NTIS HC A09/MF A01

The magnetohydrodynamics (MHD) gas turbine systems were modeled with sufficient detail, using realistic component specifications and costs, so that the thermal and economic performance of the systems could be accurately determined. Three cases of MHD gas turbine systems were studied, with Case I being similar to a MHD steam system so that a direct comparison of the performances could be made, with Case II being representative of a second generation MHD system, and with Case III considering oxygen enrichment for early commercial applications. The results show that the MHD gas turbine system has very good thermal and economic performances while requiring either little or no cooling water. Compared to the MHD steam system which has a cooling tower heat load of 720 MN, the Base Case I MHD/gas turbine system has a heat rate which is 13% higher and a cost of electricity which is only 7% higher while requiring no cooling water. Case II results show that an improved performance can be expected from second generation MHD gas turbine systems. Case III results show that an oxygen enriched MHD gas turbine system may be attractive for early commercial applications in dry regions of the country. DOE

N82-33881# United Technologies Corp., South Windsor, Conn.
EVALUATION OF NATURAL GAS MOLTEN CARBONATE FUEL CELL POWER PLANTS Final Report, 1 Mar. 1980 - 1 May 1981

J. M. KING, A. H. LEVY, L. L. VANDINE, and R. J. WERTHEIM Aug. 1981 157 p refs Sponsored by Gas Research Inst.

(PB82-181272; FCR-3522-2; GRI-81/0038) Avail: NTIS HC A08/MF A01 CSCL 10B

Three advanced molten carbonate fuel cell power plant concepts designed to provide greater quantities of high quality reject heat show significant advantage over both advanced phosphoric acid systems and conventional molten carbonate systems for industrial cogeneration with natural gas. Cost and energy savings with the best system (internal reforming) are 20 and 15 percent respectively when compared to a conventional utility approach with purchased power. The other advanced systems, anode exhaust recycle through an adiabatic reformer and steam separator, also show significant savings. Technology goals and cell stack sizes are consistent with the objectives of other programs meeting both cost and endurance goals, all of which are important to the success of the industrial cogeneration application. GRA

N82-33975# Coastal Engineering Research Center, Fort Belvoir, Va.

IRREGULAR WAVE RUNUP ON SMOOTH SLOPES

J. P. AHRENS 20 Dec. 1981 27 p refs

(AD-A113648; CERC-CETA-81-17) Avail: NTIS HC A02/MF A01 CSCL 08C

The results of several laboratory studies have been used to develop a method to estimate the wave runup and rundown on plane, smooth slopes caused by irregular wave action. Curves and equations are presented which can be used to compute the 2% runup, significant runup, mean runup, and approximate lower limit of rundown. A procedure is suggested for adapting the smooth slope results to wave runup on rough and porous slopes. Example problems illustrate the use of the material presented.

Author (GRA)

N82-34261# Pacific Northwest Lab., Richland, Wash.
DEVELOPMENT OF MATERIALS FOR OPEN CYCLE MHD Quarterly Report, period ending Mar. 1981

J. L. BATES and D. D. MARCHANT Jan. 1982 59 p refs

(Contract DE-AC06-76RL-01830)

(DE82-008777; PNL-4001-1) Avail: NTIS HC A04/MF A01

The development and fabrication of the HfO₂-RE sub x/O sub Y electrodes and HfO₂-RE sub x/o sub Y-In₂O₃ current leadouts for testing in MHD facilities is discussed. The electrical conductivity of some potential HfO₂-RE sub x O sub Y refractory electrodes was measured and preliminary results analyzed in relationship to structure and composition. Six potential air preheater materials, tested in the Montana State University heat exchanger, were characterized and evaluated. The potential mechanisms for orrosion/erosion are discussed. Electrochemical corrosion of platinum in molten coal slag was also measured. Possible corrosion mechanisms are discussed. DOE

N82-34267# General Atomic Co., San Diego, Calif.
FUSION ENGINEERING DEVICE. VOLUME 1: MISSION AND PROGRAM SUMMARY

J. R. GILLELAND and J. M. RAWLS, ed. Oct. 1981 134 p refs 6 Vol.

(DE82-008931; DOE/TIC-11600-VOL-1) Avail: NTIS HC A07/MF A01

A Tokamak reactor core was chosen as the basis of the FED design by virtue of the superior containment and heating achieved in present generation devices, the vigorous ongoing Tokamak research program whose strengths can be brought to bear on the design issues facing FED, and the intrinsic potential of Tokamaks as commercial reactors. The FED concepts was formulated under the premise that it is essential for the device to be based on a confinement approach compatible with an attractive reactor embodiment. This premise is predicated on the perceived needs

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both to maximize the efficient utilization of limited program resources and to minimize the potential for distortion of program balance commonly associated with large construction projects.

DOE

**N82-34311*# Mechanical Technology, Inc., Latham, N. Y.
AUTOMOTIVE STIRLING ENGINE MOD 1 DESIGN REVIEW,
VOLUME 1 Final Report**

Aug. 1982 654 p refs Presented at Automotive Stirling Engine (ASE) Mod 1 Engine Design Review, Cleveland, 22-23 May 1980 3 Vol.

(Contract DEN3-32; DE-AI01-77CS-51040)
(NASA-CR-167935; DOE/NASA/0032-16-VOL-1; NAS 1.26:167935; MTI-80ASE142DR1-VOL-1) Avail: NTIS HC A99/MF A01 CSCL 13F

Risk assessment, safety analysis of the automotive stirling engine (ASE) mod 1, design criteria and materials properties for the ASE mod 1 and reference engines, combustion are flower development, and the mod 1 engine starter motor are discussed. The stirling engine system, external heat system, hot engine system, cold engine system, and engine drive system are also discussed.

N.W.

**N82-34312*# Mechanical Technology, Inc., Latham, N. Y.
AUTOMOTIVE STIRLING ENGINE MOD 1 DESIGN REVIEW,
VOLUME 3 Final Report**

Aug. 1982 362 p refs Review held in Cleveland, 22-23 May 1980 3 Vol.

(Contract DEN3-32; DE-AI01-77CS-51040)
(NASA-CR-167397; DOE/NASA/0032-18-VOL-3; NAS 1.26:167397; REPT-80ASE142DR1-VOL-3) Avail: NTIS HC A16/MF A01 CSCL 13F

Engineering drawings for the stirling engine, external heat, hot and cold engine, engine drive, and control systems and auxiliaries are provided. Vehicle integration is also illustrated.

N.W.

06

ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

Includes transport of fuels by pipelines, tubes, etc., microwave power transmission, and superconducting power transmission.

**A82-41403
OPERATING A PILOT PLANT CIRCUIT FOR ENERGY
TRANSPORT WITH HYDROGEN-RICH GAS**

H. FEDDERS and B. HOEHLEIN (Kernforschungsanlage Juelich GmbH, Institut fuer Reaktorbauelemente, Juelich, West Germany) International Journal of Hydrogen Energy, vol. 7, no. 10, 1982, p. 793-800. refs

The aim of our presentation on energy transport with hydrogen-rich gas is to discuss the initial results achieved in a pilot plant developed at the Nuclear Research Centre at Juelich (F.R.G.). Our pilot plant circuit comprises the following processes: (1) endothermic steam reforming of methane (EVA) which requires a large amount of energy at a temperature level of ca 950 C (helium heated in an electric heater simulating the high temperature gas-cooled reactor), and (2) exothermic methanation of CO/CO₂ in combination with H₂ (ADAM) where heat is set free over a wide range of temperatures. Thus, the energy taken up in EVA is transformed into a cold hydrogen-rich gas which is transported to ADAM, where heat is released according to the requirements of the heat market; the resulting product gas (CH₄) is then transported back to the energy source where the circuit is continued with new energy.

(Author)

A82-42100

AN EXPERIMENTAL STUDY OF THE TEMPERATURE PROFILES AND HEAT TRANSFER COEFFICIENTS IN A HEAT PIPE FOR A HEAT EXCHANGER

B. S. LARKIN (National Research Council, Div. of Mechanical Engineering, Ottawa, Canada) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 177-191.

This paper describes an experimental study of a heat pipe to be used as a component in an air-to-air heat recovery heat exchanger. The two fluids used are water and Refrigerant 22, over a temperature range from 20 C to 100 C. Temperature profiles and heat transfer coefficients are given for heat fluxes from 500 watts to 1100 watts, showing the effect of the fluid quantity used. Results were obtained for a smooth surface and for a surface with a circumferential capillary groove. The heat pipe was inclined at 5-deg to the horizontal.

(Author)

A82-42101

HEAT RECOVERY IN VERTICAL SYSTEMS

H. HETTERER and H.-H. BATH (Deutsche Bauakademie, Berlin, East Germany) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 193-199.

In this paper, the most important results in the framework of developing and testing gravity-type heat pipes in a large-space stable are reported. These results involve the optimum volume of the heat-transfer medium (ammonia), the course of efficiency in dependence on the temperature differential between exhaust air and outside air, and the annual quantity of recovered heat.

(Author)

A82-42102

HEAT TRANSFER EFFECTIVENESS OF HEAT PIPES

R. PERETZ (Iasi, Institutul Politehnic, Iasi, Rumania) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 201-211.

Heat transfer effectiveness (recovery factor) - HTE - of one heat pipe (HP) is defined as the function of two dimensionless groups of NTU type (Number of Transfer Units) from the evaporator and the condenser. In the case of the HP heat exchanger it is demonstrated that the HTE is a function made up of only three elements, viz: the HTE of the single component HP; the number of rows parallel to the flow of the two fluids; and the ratio of the heat capacities of the two fluids. The optimization consists in the selection of the values of the NTU groups in order to obtain an optimum HTE for the HP. This optimum is defined in a subjective way using a percentage method. The modeling equations are deduced for the optimum values of NTU in all cases that have been analyzed.

(Author)

A82-42108

THERMODYNAMIC ANALYSIS OF HEAT PIPE OPERATION

L. L. VASILEV and S. V. KONEV (Akademii Nauk Belorusskoi SSR, Institut Teplo- i Massoobmena, Minsk, Belorussian SSR) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 313-325. refs

Operation of heat pipes as closed thermodynamic multi-component systems is analyzed. The expressions are obtained for transported thermal energy in the dry, moist and superheated vapor as well as in supercooled fluid phase. Different thermodynamic operating conditions of heat pipes are compared with the experimental data. The energy balance is used to obtain the expressions for the thermodynamic efficiency of heat pipes. The thermodynamic analysis of the efficiencies of a gas laser-heat pipe is given.

(Author)

A82-42128

INVESTIGATION OF A VARIABLE CONDUCTANCE HEAT PIPE AS A GAS DIODE

C. J. SAVAGE (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) and J. P. MATHIEU (Societe Anonyme Belge de Constructions Aeronautiques, Brussels, Belgium) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 619-639. refs

When a variable conductance heat pipe (VCHP) is used to avoid backward conductance in the event of overheating in the cooler which it is being used to control, it is said to be operating as a gas diode. An attempt is made to characterize gas diode behavior with attention to the low thermal energy and thermal inertia required to achieve blockage with them. While liquid diodes may shut down at any temperature within their heat pipe range, conventional VCHPs offer only a limited range for diode operation and, when a VCHP overheats, its control gas tends to remain trapped in the reservoir. Diffusion is then the only available means to migrate toward the evaporator and effect blockage. This problem may be overcome through the incorporation of a channel within the VCHP which allows the free circulation of gas from the reservoir to the evaporator, as can be demonstrated by an ammonia working fluid VCHP, whose diode shutdown temperature was extended almost to the critical point of the working fluid. (Author)

A82-42129

LARGE SCALE EHD HEAT PIPE EXPERIMENTS

K. KIKUCHI, T. TAKETANI, M. SHIRAIISHI, and T. YAMANISHI (Government Mechanical Engineering Laboratory, Sakura, Ibaraki, Japan) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 643-650. refs

An experiment of flat plate EHD heat pipe was performed in order to investigate the maximum heat transport capability and dry out conditions. The result indicates that relatively stable and high performance devices are possible. The EHD tent flow structures at evaporator and condenser sections were observed in order to investigate the effect of a variation of flow structures by heat transport and applied voltage on the dry out heat flux at an evaporator. The dry out of liquid flow at the evaporator caused by a variation of cross-sectional area of EHD flow structure exerts a considerable effect to heat pipe performance. (Author)

A82-42131

HEAT TRANSFER CHARACTERISTICS AND CONSTRUCTIVE PECULIARITIES OF HEAT PIPES UTILIZING THE EFFECT OF ELECTRIC FIELDS

V. D. SHKILEV and M. K. BOLOGA (Akademiiia Nauk Moldavskoi SSR, Institut Prikladnoi Fiziki, Kishinev, Moldavian SSR) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 663-672. refs

Different constructions and heat transfer characteristics of heat pipes utilizing the effect of electric fields were adduced. The application of each type of heat pipe to cooling of high-voltage thermal and power equipment was analyzed. (Author)

A82-42132

DEVICE FOR PASSIVE DOWNWARD HEAT TRANSPORT - DESIGN CRITERIA AND OPERATIONAL RESULTS

G. DE BENI, R. FRIESEN, H. THOMA, and R. VENERONI (Commission of the European Communities, Joint Research Centre, Ispra, Italy) In: Advances in heat pipe technology; Proceedings of the Fourth International Heat Pipe Conference, London, England, September 7-10, 1981. Oxford, Pergamon Press, 1981, p. 673-683. refs

A semi-continuous device for passive downward heat transport has been designed, built and operated. Heat is transported as latent heat of vaporization as in a heat pipe; the return of the liquid is obtained through the action of an energy accumulator

containing an inert gas and charged by the vapour itself during the transport of heat. The capability of winning the difference in level is exchanged with a difference of a few degrees centigrade between evaporator and condenser. The laboratory device worked with a difference in level of 1.7 m. Working under pressure, differences in level of 10 meters and more can be attained. A typical application can be the storage of heat available from solar collectors. (Author)

A82-44979

ASSESSMENT OF THE EFFECTS OF DISTRIBUTED PHOTOVOLTAIC SYSTEMS ON UTILITY SUBTRANSMISSION AND DISTRIBUTION NETWORKS

P. F. DEDUCK, R. W. NEAL (JBF Scientific Corp., Wilmington, MA), and H. W. ZAININGER (Zaininger Engineering Co., San Jose, CA) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 299-304. Research supported by the Electrical Power Research Institute.

A methodology was developed and applied in selected examples to assess potential impacts on transmission and distribution (T&D) systems associated with the installation and operation of distributed photovoltaic (PV) units. PV systems were introduced in both subtransmission and distribution circuits as lumped generation. Established analytical techniques, consisting of power flow analysis and voltage drop calculations were used to assess the operation and performance of the circuits as influenced by various PV system operating conditions. The T&D assessment has identified categories of potential impacts which may result if distributed PV systems are installed. The magnitude of potential impacts is closely related to PV penetration and the correlation of insolation to the T&D system load. (Author)

A82-45174

ANALYSIS OF UTILITY PROTECTION PROBLEMS ASSOCIATED WITH SMALL WIND TURBINE INTERCONNECTIONS

J. B. PATTON and D. CURTICE (Systems Control, Inc., Palo Alto, CA) (Institute of Electrical and Electronics Engineers, Winter Meeting, New York, NY, Jan. 31-Feb. 5, 1982.) IEEE Transactions on Power Apparatus and Systems, vol. PAS-101, Oct. 1982, p. 3957-3964; Discussion, p. 3965, 3966. Research supported by the U.S. Department of Energy. refs

This paper is an analysis of several protection coordination problems that may result from the integration of small wind turbines (less than 100 kVA) into the electric distribution system. Such problems include the characteristic contributions of fault current, fault detection ability, effects of increased short-circuit capacities, interaction with line reclosers, and islanding of dispersed generators. Examples are shown using actual utility line and equipment data. The wind turbines considered include small synchronous and induction generators as well as generation sources utilizing line-commutated or force-commutated inverter interfaces. (Author)

A82-46240

TRANSMISSION OF MICROWAVE BEAMED-POWER FROM AN ORBITING SPACE STATION TO THE GROUND

R. M. WELCH (Mainz, Universitaet, Mainz, West Germany), J. M. DAVIS, and S. K. COX (Colorado State University, Fort Collins, CO) Space Solar Power Review, vol. 3, no. 2, 1982, p. 99-119. refs

(Contract NSF OCD-74-21678; NSF ATM-77-15369)

Transmission efficiencies and surface power densities are calculated from the interaction of a 10 GW microwave beam with rain clouds. Computations are made as a function of frequency (2.45 to 10 GHz); beam nadir angle; raindrop size distribution, and cloud shape. Scattered surface power densities outside of the receiving rectenna do not exceed 10 microwatt/sq cm for frequencies of 2.45 and 3.3 GHz, even for extremely heavy rainfall rates. At higher frequencies exposure levels outside of the rectenna may reach 100 microwatt/sq cm, or two orders of magnitude less than the U.S. safety standard. From the standpoint of public health

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and safety, the scattering of microwaves by rain clouds is not a serious problem, with scattered fluxes outside of the rectenna much smaller than sidelobe fluxes. Beam losses due to absorption in rain clouds are significant in some cases, with absorption losses far more important than scattering losses. The amount of scattering increases with increasing microwave frequency, increasing drop size and drop concentration, and increasing nadir angle of the beam.
(Author)

A82-46242

A PARAMETRIC STUDY OF MINIMAL COST SPS SYSTEMS

A. W. LOVE (Rockwell International Corp., Satellite Systems Div., Seal Beach, CA) Space Solar Power Review, vol. 3, no. 2, 1982, p. 133-143. refs

An analytical model for conditions which will minimize the kW cost of an SPS system is presented, with a focus on the magnetron-powered configuration. It is shown that minimization occurs when the beam power density is in the range 3.2-3.7 mW/sq cm, allowing for sidelobe levels between -17.6 to -31.3 dB. Costs of installed power are projected to be \$1990/kW, using current baseline system plans.
M.S.K.

N82-28578*# Rockwell International Corp., Downey, Calif.

TESTING OF A HIGH CAPACITY RESEARCH HEAT PIPE Final Report

May 1982 74 p refs

(Contract NAS9-16399)

(NASA-CR-167625; NAS 1.26:167625) Avail: NTIS HC A04/MF A01 CSCL 20D

Tests were performed on a high-capacity channel-wick heat pipe to assess the transport limitations of v-grooves and the effects of boiling. The results showed that transport can vary significantly (less than 50 W) under similar conditions and the continuous boiling was observed at power levels as low as 40 W. In addition, some evidence was found to support the predictions using a groove transport model which shows that transport increases with lower groove densities and longer evaporators. However, due to transport variations, these results were not consistent throughout the program. When a glass fiber wick was installed over the grooves, a relatively low transport level was achieved (80 to 140 W). Based on these results and the identification of some potential causes for them, several design suggestions were recommended for reducing the possibility of boiling and improving groove transport.
Author

N82-28585# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

AN EXPERIMENTAL AND NUMERICAL STUDY OF AN AIR-TO-AIR HEAT EXCHANGER USING LIQUID RESERVOIR VARIABLE CONDUCTANCE HEAT PIPES Final Scientific Report, 1 Feb. 1981 - 31 Jan. 1982

S. DROUILHET and J. M. BUCHLIN 1982 97 p refs

(Contract AF-AFOSR-120-81; AF PROJ. 2301)

(AD-A113354; EOARD-TR-82-9) Avail: NTIS HC A05/MF A01 CSCL 13A

This report documents a study of a prototype air-to-air heat exchanger of which the thermal conductivity is governed by the reservoir temperature of the heat pipes. The work is introduced with a brief review of the basic operating principles of heat pipes and of the various existing schemes for variable conductance. An experimental facility, incorporating a computerized data acquisition system, was developed to investigate the steady state performance characteristics of the heat exchanger over a wide range of air inlet temperatures, mass flow rates, and reservoir temperatures. Some tests were conducted imposing a single operating temperature on all of the heat pipes, while in others the heat pipe rows were allowed to operate independently. The results are expressed in terms of heat exchanger effectiveness versus normalized reservoir temperature for various values of the ratio of the mass flow rates of the air streams. Conclusions are drawn as to the internal behaviour of this type of heat pipes under various operating regimes. An original computer model is presented which combines quasi analytical solution for the air and fin temperature

profiles in the heat exchanger with a heat pipe simulation routine based on the hydrodynamic equations involved in the working fluid cycle. Computational results are shown, and a brief comparison with the experiments is made. Possible modifications that would improve the accuracy and the versatility of the program are discussed.
GRA

N82-28597# Stuttgart Univ. (West Germany). Abteilung Energiewandlung und Waermetechnik.

INVESTIGATION OF THE LONG TERM BEHAVIOR OF HEAT PIPES Ph.D. Thesis [UNTERSUCHUNGEN UEBER DAS LANGZEITBETRIEBSVERHALTEN VON WAERMEROHREN]

W. D. MUENZEL Aug. 1981 125 p refs In GERMAN; ENGLISH summary

(IKE-5-215; ISSN-0173-6892) Avail: NTIS HC A06/MF A01

For two typical applications of heat pipes, i. e. spacecraft temperature control and waste heat recovery from industrial processes, some potential working fluid/container material combinations were studied, covering the respective temperature ranges. They were subjected to compatibility tests under heat pipe operating conditions. During these tests, the axial temperature distribution along each of the heat pipes was monitored periodically. From a change in temperature differences versus time at constant test conditions, any long term materials incompatibility are detected. Rising temperatures in the evaporator section due to an increase of the radial thermal resistance results from deposits of solid corrosion products, whereas an increasing temperature drop at the end of the condenser section indicates generation of gaseous corrosion products.
Author (ESA)

N82-28821# Oak Ridge National Lab., Tenn. Engineering Technology Div.

EVALUATION OF NONELECTRICAL ENERGY-TRANSMISSION OPTIONS

T. K. STOVALL, S. A. REED, J. G. DELENE, and R. L. GORTON (Kansas State Univ.) Oct. 1981 178 p refs

(Contract W-7405-ENG-26)

(DE82-000886; ORNL/TM-7662) Avail: NTIS HC A09/MF A01

The possibility of substituting nonelectrical energy forms (generated at central nuclear plants) for prime fuels (gas and oil) was evaluated. Steam and combustible gases are considered appropriate energy forms for delivery to industrial users. The energy transport mechanisms evaluated include molten salt, hot oil, open and closed loop chemical heat pipes, and hydrogen. Nonnuclear options including medium-Btu gas and hydrogen (both from coal) provide a comparative base for nuclear alternatives. All economic evaluations are presented in constant 1980 dollars for plant startups in the year 1990 and 2000. The delivered-energy cost is provided for each option as a function of delivery distance for a common set of economic ground rules. Environmental, institutional, and other intangible factors are discussed for each energy transport option and for very high temperature reactors.
DOE

N82-29478# Naemnden foer Energiproduktionsforskning, Stockholm (Sweden).

STUDY OF THE ECONOMICS OF INTRODUCING GAS AS AN ENERGY CARRIER

Mar. 1981 211 p In SWEDISH

(DE82-900915; NE/TO-81/6) Avail: NTIS (US Sales Only) HC A10/MF A01; DOE Depository Libraries

At present, Sweden does not have any infrastructure for handling and transportation of fuel gas. The investment and operating costs for transportation through networks of different sizes from a gas producer to the consumers is estimated. The model used includes a coal gasification plant situated in the vicinity of a harbor on the Swedish North Sea coast. The scenarios include production of gas of different quality (high-low Btu values, city gas) and distribution nets of varying lengths. The techniques and equipment utilized for gas distribution are described.
DOE

ENERGY STORAGE

N82-29583# Fermi National Accelerator Lab., Batavia, Ill.
ENERGY DOUBLER CRYOLOOP TEMPERATURE MONITOR SYSTEM

G. PUCCI and D. HOWARD Oct. 1981 11 p
(Contract DE-AC02-76CH-03000)
(DE82-004409; DOE/CH-03000/T6) Avail: NTIS HC A02/MF A01

The cryoloop temperature monitor system is a fully electronic system designed to monitor temperature at key points in the energy doubler cryoloop system. It is used for cryoloop diagnostics, temperature studies, and cooldown valve control. DOE

N82-30693 Sandia Labs., Albuquerque, N. Mex.
A FIRST AND SECOND LAW ANALYSIS OF STEAM STEADILY FLOWING THROUGH CONSTANT DIAMETER PIPES

M. E. FEWELL *In* ASME Solar Eng., 1981 p 712-718 1981 refs
(Contract DE-AC04-76DP-00789)
Avail: Issuing Activity

A mathematical model for the steady flow of subcritical, superheated steam through constant diameter pipes is discussed. The model numerically integrates a set of three simultaneous, first order, ordinary differential equations that include the pressure drop due to friction, elevation changes, and acceleration; thermal effects on the fluid properties. The irreversibility due to thermal losses and pressure drop is calculated so that the loss in the ability to produce useful work is determined. This model may be used to design piping for power conversion systems. Author

N82-32627# Siemens A.G., Erlangen (West Germany).
Forschungslab.**A15 PHASE SUPERCONDUCTORS WITH HIGH CURRENT CAPACITIES Final Report, Mar. 1981**

G. RUPP, M. WILHELM, and K. WOHLLEBEN Bonn Bundesministerium fuer Forschung und Technologie Feb. 1982 63 p refs *In* GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-033; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 13,45

Development of Nb₃Sn filamentary conductors, produced by the solid diffusion process, was continued, aiming at homogeneous properties over long length. Conductor types with stabilizing copper in the cross section were developed which are suited for cabling to conductors with high current capacities. Cables were made: all of them were fully transposed and highly compacted; length up to 2300 m and currents up to 2300 amps at 10 T and 4.2 K. The reaction conditions for Nb₃Sn conductors were investigated. When hydrogen was in the annealing atmosphere, there is a change in the field dependence of the current density. The filament diameter also varies the critical current density. An apparatus was constructed and tested to spool reacted conductors. The conductors were tested on their homogeneous properties in solenoids which were made by the wind and react technique. With a NbTi coil (7 T) in a free bore of 40 mm, 15 T at 4.2 K is attained. Author (ESA)

Includes flywheels, heat storage, underground air storage, compressed air, storage batteries, and electric hybrid vehicles.

A82-38175**THE OUTLOOK FOR THE USE OF BATTERY-DRIVEN CARS AND TRUCKS [PERSPEKTIVY PRIMENENIIA AKKUMULIATORNYKH ELEKTROMOBILEI]**

O. A. STAVROV Akademiia Nauk SSSR, Izvestiia, Energetika i Transport, May-June 1982, p. 114-121. *In* Russian.

The necessity of designing electric cars in which the ratio of the battery weight to the total car weight has a high value is stressed. It is pointed out that such designs could be used with the batteries available today and could also accommodate batteries having a higher energy capacity. Even with improved batteries, however, only a small-scale use of electric cars and trucks will be warranted economically. Significant reductions in the need for petroleum and in air pollution will not be possible until batteries can deliver 100 watt-hours per kg. C.R.

A82-38946#**MAGNETIC BEARING MOMENTUM WHEELS - IMPACT OF BEARING DESIGN ON THE NUTATIONAL STABILITY OF SATELLITES**

G. HEIMBOLD (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, West Germany) *In*: Guidance and Control Conference, San Diego, CA, August 9-11, 1982, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1982, p. 187-194. refs (AIAA 82-1526)

A linearized mathematical model of a three-axes-stabilized symmetric satellite equipped with a magnetic bearing momentum wheel is presented. By an approximative analysis a closed form solution of the eigenvalue problem is derived which permits a quantitative assessment of bearing compliance impact on the satellite nutation. This nutational motion may become unstable due to rotor energy losses. Two design concepts of magnetic suspension systems, i.e. passive and active magnetic bearings, are investigated for analyzing this effect. The theoretical results are verified by air bearing tests, indicating that actively controlled magnetic bearings can be designed to avoid the nutational instability. (Author)

A82-39184**CRYOGENIC COOLING OF INFRARED DETECTORS**

D. N. CAMPBELL (Hymatic Engineering Co., Ltd., Redditch, Worcs., England) *In*: Advanced infrared detectors and systems; Proceedings of the Symposium, London, England, October 29, 30, 1981. London, Institution of Electrical Engineers, 1981, p. 48-54. Research sponsored by the Ministry of Defence.

It is pointed out that the cooling of infrared detectors in service applications may often differ considerably from the cooling used during detector development. The time required to bring equipment into service can, therefore, be considerably shortened by an early consideration of the cooling interface. The present investigation provides an aid for such a consideration by examining a number of the systems currently used for cooling detectors. The characteristics of stored energy systems are listed in a table, taking into account a standard load of 1 watt. The stored energy is in the form of liquid cryogen or high pressure gas. A table listing the properties of powered, continuous running cooling systems is also provided. Attention is given to the applications which match these systems, and the interfacing of the detector with a suitable cooling system. G.R.

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A82-40296

PLASTIC-BONDED ELECTRODES FOR NICKEL-CADMIUM ACCUMULATORS. VIII - STUDY OF OXYGEN RECOMBINATION RATE ON PLASTIC-BONDED CADMIUM ELECTRODES PROVIDED WITH ACTIVE CARBON CATALYST

J. MRHA, M. MUSILOVA, J. JINDRA, M. POLYDOROVA, J. PEIZKER (Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia), J. GARCHE, and M. HAUPTMANN (Dresden, Technische Universitaet, Dresden, East Germany) (International Conference on Electrochemical Power Sources, 2nd, Zilina, Czechoslovakia, June 22-26, 1981.) Journal of Power Sources, vol. 8, July 1982, p. 3-8. refs

A82-40297

OPTIMISATION OF ACTIVE MATERIAL FOR POSITIVE ELECTRODES OF NI-CD ACCUMULATORS

K. MICKA, Z. ZABRANSKY, and M. SVATA (Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia) (International Conference on Electrochemical Power Sources, 2nd, Zilina, Czechoslovakia, June 22-26, 1981.) Journal of Power Sources, vol. 8, July 1982, p. 9-16. refs

The conditions for the preparation of the active material for positive plastic-bonded electrodes of Ni-Cd alkaline accumulators were investigated in order to obtain the maximum discharge capacity. It was shown that nickel hydroxide precipitated from a neutral medium is superior to that precipitated from a strongly alkaline medium. This, together with the choice of a conducting component and other conditions of preparation served as a basis for obtaining an active material which does not require an additional doping, e.g., with cobalt, its discharge capacity being comparable with the 'classical' active materials doped with cobalt. (Author)

A82-40321

INVESTIGATION OF THE NICKEL-ZINC TRACTION BATTERY FOR ELECTRIC AUTOMOBILES [ISSLEDOVANIE TIAGOVOI NIKEL'TSINKOVOI BATAREI DLIA ELEKTROMOBILIA]

V. A. RYCHKOV, S. L. DENICHENKO, and A. I. KOZLOV (AvtoVAZ, Tolyatti, USSR) Tekhnicheskaja Elektrodinamika, May-June 1982, p. 102-105. In Russian.

Experimental results are presented on the active component of the total internal resistance and on the emf of the NTs-125 nickel-zinc battery. An analysis of the data shows that the internal resistance of this battery depends significantly on temperature and has a minimum value at 23-28 C. Analytical relationships are obtained which can be used in the design of power sources for electric automobiles. B.J.

A82-41102

AN ASSESSMENT OF SUPERCONDUCTIVE ENERGY STORAGE FOR CANADIAN FREIGHT RAILWAYS [UNE EVALUATION D'UN SYSTEME SUPERCONDUCTEUR D'EMMAGASINAGE D'ENERGIE POUR LE TRANSPORT FERROVIAIRE CANADIEN]

A. R. EASTHAM, D. M. PRINGLE, and P. R. AUSTIN (Queen's University, Kingston, Ontario, Canada) Canadian Electrical Engineering Journal, vol. 7, July 1982, p. 3-12. Research supported by Transport Canada. refs

The technical feasibility and economic viability of a superconductive wayside energy storage system (SM WESS), which would store the braking energy of loaded freight trains in order to peak-shave the subsequent power demand of an electrified railway, are assessed with reference to an alternative, flywheel storage system. Consideration of superconducting magnet technology leads to the determination that while the WESS magnet would be larger than any existing one, it would be considerably smaller than magnets proposed for utility load leveling. The initial and annual costs of a system comprising magnetic, cryogenic and electrical equipment for a 5.5 MWh usable storage capacity are \$33.2 million plus or minus 5 million and \$270,000, respectively. The magnitude of the initial cost is judged likely to preclude further development of the SM WESS concept. O.C.

A82-41139

SESSILE DROP STUDIES ON POLYBROMIDE/ZINC-BROMINE BATTERY ELECTROLYTE

K. KINOSHITA and S. C. LEACH (SRI International, Menlo Park, CA) Electrochemical Society, Journal, vol. 129, Aug. 1982, p. 1747-1749. Research supported by the Electric Power Research Institute. refs

The sessile drop method was employed to examine the interfacial tension and contact angle of polybromide oil drops. Bromine in equilibrium with an aqueous phase and a polybromide oil phase were added to a battery cell with a ruthenized titanium electrode with the electrode surface facing up. A polybromide oil drop was placed on the electrode surface while the height of the drop was measured with a cathetometer and 35 mm photographs were taken of the drop profiles. The sessile drop was analyzed to find the interfacial tension and contact angle of the drop. Interfacial tensions were calculated which were lower than reported for two-phase systems having organic and aqueous phases. The results are regarded as significant for applications of zinc-bromine batteries, indicating that small polybromide oil phase drops can enhance the mass transfer of bromine from a polybromide to the electrode. M.S.K.

A82-42454

AN EXPERIMENTAL STUDY OF THE STRESS-STRAIN STATE AND LOAD-BEARING CAPACITY OF ENERGY-STORAGE FLYWHEEL MODELS MADE OF COMPOSITE MATERIALS [EKSPERIMENTAL'NOE ISSLEDOVANIE NAPRIAZHENNO-DEFORMIROVANNOGO SOSTOIANIIA I NESUSHCHEI SPOSOBNOSTI MODELEI MAKHOVIKOV ENERGOONAKOPITELEI IZ KOMPOZITNYKH MATERIALOV]

I. A. KOZLOV, V. M. LESHCHENKO, and A. B. IUDIN (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti, Aug. 1982, p. 22-25. In Russian.

A82-42850

INTERNATIONAL CONFERENCE ON UNDERGROUND PUMPED HYDRO AND COMPRESSED AIR ENERGY STORAGE, SAN FRANCISCO, CA, SEPTEMBER 20-22, 1982, COLLECTION OF TECHNICAL PAPERS

Conference sponsored by the American Institute of Aeronautics and Astronautics and Electric Power Research Institute. New York, American Institute of Aeronautics and Astronautics, 1982. 322 p. MEMBERS, \$40; NONMEMBERS, \$50

Topics discussed include an assessment of the market potential of compressed air energy storage (CAES) systems, turbocompressor considerations in CAES plants, subsurface geological considerations in siting an underground pumped hydro (UPH) project, and the preliminary assessment of waste heat recovery system for CAES plants. Also considered are CAES caverns design for leakage, simulation of the champagne effect in CAES plants, design of wells and piping for an aquifer CAES plant, various aspects of the Hunter CAES facility, low-pressure CAES, subsurface instrumentation plan for the Pittsfield CAES field test facility, and the feasibility of UPH storage in the Netherlands. B.J.

A82-43691

ON THE USE OF ROCKING CHAIR CONFIGURATIONS FOR CYCLABLE LITHIUM ORGANIC ELECTROLYTE BATTERIES

B. DI PIETRO, M. PATRIARCA, and B. SCROSATI (Roma, Universita, Rome, Italy) Journal of Power Sources, vol. 8, Sept.-Oct. 1982, p. 289-299. Research supported by the Consiglio Nazionale delle Ricerche. refs

The characteristics of concentration cells based on two electrodes having different lithium activity have been evaluated by examining the performance of various systems. The results indicate that with the selection of appropriate electrode materials, lithium 'rocking chair' cells having high voltage and good discharge and cycling behavior can be developed. (Author)

A82-43692

REVIEW OF FLYWHEELS FOR ENERGY STORAGE WITH REFERENCE TO THEIR POTENTIAL FOR USE IN SPACE

J. MYATT (Atomic Energy Research Establishment, Electronics and Applied Physics Div., Harwell, Oxon., England) *Journal of Power Sources*, vol. 8, Sept.-Oct. 1982, p. 311-324. Research supported by the European Space Agency. refs

The current status of flywheel energy storage systems is reviewed, and their potential for use in space, where the requirements are similar to those of the electric vehicles (compact, light-weight, long-lived reliable secondary power units), is assessed. It is noted that vacuum and zero gravity are advantages peculiar to space which will reduce some of the current problems. Careful design, however, will be needed to minimize the precessional effects of the gyroscopic forces. It is concluded that even though the system appears to have potential for cycle lives well in excess of 20,000 at energy densities up to 50 W h/kg, developments are not as yet sufficiently advanced to make it worth considering a dedicated unit for space. C.R.

A82-44180

MASS TRANSFER AT LONGITUDINALLY VIBRATING VERTICAL ELECTRODES

M.-B. LIU, G. M. COOK, N. P. YAO (Argonne National Laboratory, Argonne, IL), and E. M. RUDNICK (Electrochemical Society, Journal, vol. 129, Sept. 1982, p. 1955-1959. Research supported by the U.S. Department of Energy. refs

The increase in mass transfer rates as a result of longitudinal vibrations applied to vertical, flat plate electrodes was determined by limiting current measurements, for the cases of three electrode active area lengths, three vibration amplitudes, and vibration frequencies in the 13-36 Hz range. The current is the sum of a small ac current and a large dc current, and the ac current profile, which has a 90 deg phase lag, depends on the location of the electrode active area and the vibration parameters. Under the present experimental conditions, the average mass transfer coefficients are in the 0.00028-0.0014 cm/sec range. This represents a 1.2-5 factor increase for the average free convective mass transfer coefficient. The prediction of the mass transfer coefficient on the basis of electrode active area and vibration parameters is accomplished by a correlation similar to that derived from boundary layer theory for forced convection over a flat plate. O.C.

A82-44189

PHOTOELECTROCHEMICAL CHARACTERIZATION OF THE n-INP/ROOM TEMPERATURE MOLTEN SALT ELECTROLYTE INTERFACE

R. THAPAR, J. DUBOW, and K. RAJESHWAR (Colorado State University, Fort Collins, CO) *Electrochemical Society, Journal*, vol. 129, Sept. 1982, p. 2009-2015. refs
(Contract XS-0-9272-1)

A study of the photoelectrochemical aspects of the n-InP/AICl₃-butyl pyridinium chloride (BPC) interface is presented. While the features of this system are in semiquantitative accord with the simple model for semiconductor/electrolyte interfaces of Gerischer (1979) and Frank and Bard (1975), departures from ideal behavior caused by specific interactions of electroactive species with the electrode surface are noted for the case of neat AICl₃-BPC electrolytes. Chloraluminat electrolyte systems are shown to be useful mechanistic probes for checking such anomalies and for determining the efficiency of a given photovoltaic electrode/electrolyte combination. O.C.

A82-44350#

AN EVALUATION OF LIGHTWEIGHT CONCRETE VESSELS FOR THERMAL ENERGY STORAGE

G. G. ELIA and R. W. BUCKMAN, JR. (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, PA) In: *Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results*, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 610-615. refs

(Contract EM-78-C-02-47003-A000)

Lightweight concrete vessels were designed, fabricated and tested for thermal energy storage. The study was conducted to develop a hot water storage system made with pre-cast or cast-on-site lightweight concrete capable of easy assembly and integration with residential or other structures. The predicted and measured thermal behavior (heat loss) of the vessels is compared. Experimental work resulted in the development of a temperature decay test to measure vessel heat loss. (Author)

A82-44357*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

METAL-HALIDE MIXTURES FOR LATENT HEAT ENERGY STORAGE

K. CHEN and R. MANVI (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: *Solar engineering - 1981; Proceedings of the Third Annual Conference on Systems Simulation, Economic Analysis/Solar Heating and Cooling Operational Results*, Reno, NV, April 27-May 1, 1981. New York, American Society of Mechanical Engineers, 1981, p. 667-674. Research sponsored by the U.S. Department of Energy and NASA. refs

Alkali metal and alkali halide mixtures are identified which may be suitable for thermal energy storage at temperatures above 600 C. The use of metal-halides is appropriate because of their tendency to form two immiscible melts with a density difference, which reduces scale formation and solidification on heat transfer surfaces. Also, the accumulation of phase change material along the melt interface is avoided by the self-dispersing characteristic of some metal-halides, in particular Sr-SrCl₂, Ba-BaCl₂, and Ba-BaBr₂ mixtures. Further advantages lie in their high thermal conductivities, ability to cope with thermal shock, corrosion inhibition, and possibly higher energy densities. A.B.

A82-44927

ADVANCED BATTERIES FOR LOAD-LEVELING - THE UTILITY PERSPECTIVE ON SYSTEM INTEGRATION

J. L. DELMONACO, P. A. LEWIS, H. T. ROMAN, and J. ZEMKOSKI (Public Service Electric and Gas Co., Newark, NJ) (Institute of Electrical and Electronics Engineers, Winter Meeting, New York, NY, Jan. 31-Feb. 5, 1982.) *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-101, Sept. 1982, p. 3315-3321. refs

Rechargeable battery systems for applications as utility load-leveling units, particularly in urban areas, are discussed. Particular attention is given to advanced lead-acid, zinc-halogen, sodium-sulfur, and lithium-iron sulfide battery systems, noting that battery charging can proceed at light load hours and requires no fuel on-site. Each battery site will have a master site controller and related subsystems necessary for ensuring grid-quality power output from the batteries and charging when feasible. The actual interconnection with the grid is envisioned as similar to transmission, subtransmission, or distribution systems similar to cogeneration or wind-derived energy interconnections. Analyses are presented of factors influencing the planning economics, impacts on existing grids through solid-state converters, and operational and maintenance considerations. Finally, research directions towards large scale battery implementation are outlined. M.S.K.

07 ENERGY STORAGE

A82-45027* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE EFFECTS OF CONTROLS AND CONTROLLABLE AND STORAGE LOADS ON THE PERFORMANCE OF STAND-ALONE PHOTOVOLTAIC SYSTEMS

R. C. CULL (NASA, Lewis Research Center, Cleveland, OH) and A. H. ELTIMSAHY (Toledo, University, Toledo, OH) In: Photovoltaic Specialists Conference, 15th, Kissimmee, FL, May 12-15, 1981, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 621-626. NASA-supported research.

Stand-alone photovoltaic systems have been modeled and analyzed from sunlight in to consumer product out. By including the consumer product in the analysis, concepts such as 'product storage' (a storage tank for water or cold-plates for refrigeration) and loads controllable by the system controller have been added to the system analysis. From a controls analysis viewpoint, this adds state variables to the system. The result is that the system controller can make operating control decisions on the energy flow between these various system elements to optimize system performance and reduce system cost. The effects on system performance of various control schemes employing these concepts are presented. Analysis of water pumping and/or refrigeration systems show possible performance improvements of greater than 15% with the addition of controllable loads with product storage.

(Author)

A82-46438

EXPERIMENTAL STUDIES ON THE BEHAVIOURS OF HYDRIDE HEAT STORAGE SYSTEM

M. KAWAMURA, S. ONO (National Chemical Laboratory for Industry, Tsukuba, Ibaraki, Japan), and S. HIGANO (Mitsubishi Steel Manufacturing Co., Tokyo, Japan) Energy Conversion and Management, vol. 22, no. 2, 1982, p. 95-102.

Experimental examinations and a lumped system model are used to describe the heat transfer characteristics in the design of a single tube type metal hydride heat storage vessel. The apparatus studied was fed heat by water vaporized by an electric furnace with a 3 kWh x 2 capacity. An annular tube in the middle of the reactor vessel contained the metal hydride (Mg₂Ni), which was washed with hydrogen gas. Measurements were taken of the heat transfer medium temperature, H₂ flow rate, and temperature responses at sites in the hydride bed. The numerical model was constructed assuming that no pressure gradient was present in the heat storage medium bed, the temperature was uniform throughout the bed, and material characteristics were independent of pressure and temperature encountered. The bed temperature was found to be uniform in the generation and absorption phases, although the latter took longer to stabilize. The lumped parameter model developed is shown to acceptably model the performance of a single tube type heat storage vessel in terms of heat transfer efficiency.

M.S.K.

A82-46504

CERAMIC SEPARATORS FOR LI-AL/IRON SULFIDE BATTERIES

G. BANDYOPADHYAY, R. B. SWAROOP, and J. E. BATTLES (Argonne National Laboratory, Argonne, IL) Electrochemical Society, Journal, vol. 129, Oct. 1982, p. 2187-2194. Research supported by the U.S. Department of Energy. refs

Woven fabric, felt, powder, and sintered ceramic separators have been considered for application in Li-Al/FeS(x) cells. The performances of representative samples of these separator types in laboratory and engineering-size Li-Al/FeS cells were analyzed to correlate in a quantitative manner the relationship among separator characteristics (tortuosity, thickness, and porosity), current density, and active material utilization. A similar approach can be used to develop a quantitative relationship for larger size cells from a limited number of well-characterized experiments and should be of considerable value to cell designers. The results from post-test examinations of laboratory-size cells indicate that BN felt, MgO powder, and sintered MgO separators are chemically and mechanically stable in the cell environment.

(Author)

A82-46505

LITHIUM CLOSORBORANE ELECTROLYTES. III - PREPARATION AND CHARACTERIZATION

J. W. JOHNSON and J. F. BRODY (Exxon Research and Engineering Co., Linden, NJ) (Electrochemical Society, Meeting, Hollywood, FL, Oct. 5-10, 1980.) Electrochemical Society, Journal, vol. 129, Oct. 1982, p. 2213-2219. refs

The lithium closoborane salts Li₂B₁₀Cl₁₀ and Li₂B₁₂Cl₁₂ were prepared from decaborane, purified, and dissolved in 1,2-dimethoxyethane (DME)/1,3-dioxolane mixtures. The solubility behavior is complex, as the salts are insoluble in either solvent alone, and concentrated solutions separate into two liquid phases upon dilution. Electrolyte resistivity measurements as a function of temperature and concentration are reported. These electrolytes have resistivities of approximately 150 ohm-cm at room temperature and are quite stable, making them attractive candidates for applications in lithium cells.

(Author)

A82-47049#

WHEEL ENERGY STORAGE SYSTEMS FOR SATELLITE POWER CONDITIONING AND ATTITUDE CONTROL

M. CLERMONT and F. LEGRAND (Societe Nationale Industrielle Aerospatiale, Paris, France) International Astronautical Federation, International Astronautical Congress, 33rd, Paris, France, Sept. 27-Oct. 2, 1982, 11 p. Research sponsored by the International Telecommunications Satellite Organization. refs (IAF PAPER 82-400)

Potential applications for the Wheel Energy Storage Systems (WESS) for satellite power conditioning and attitude control are reviewed, stressing the main system requirements of low orbit or geostationary satellites. Based on rotation tests at 28,000 rpm, flywheel performance is evaluated and radial elongation measurements show good correlation with expected values (approximately 1.6 m), and 30,000 rpm is attainable. Electromechanical assembly performance (rotation tests at 33,000 rpm) shows a steady state power consumption not greater than 15 watts. WESS is defined to be capable of the following functions: wheel command such that the torques can be nulled at any time during the charge/discharge periods, the generation of required attitude control torques, and the regulation of the bus voltage. Mass gains resulting from WESS use are about 200 kg (NiCd cells) and 80 kg (NiH₂ cells) in low orbit, and in geostationary orbit, gains are 90 kg (NiCd cells) and 60 kg (NiH₂ cells).

A82-48259

ANALYTICAL SIMULATION IN HEAT STORAGE SYSTEMS

G. SPIGA and M. SPIGA (Bologna, Universita, Bologna, Italy) Wärme- und Stoffübertragung, vol. 16, no. 4, 1982, p. 191-198. refs

Packed bed heat exchangers for thermal energy storage systems are investigated using two phase heat transfer models. Attention is paid to the fluid to solid volume heat capacity ratio. The analytical solutions are not restricted to a bed with uniform initial temperature, holding even for a spatially nonuniform initial temperature distribution of both fluid and solid phases, such as are expected to occur in most operational modes. Both the initial value problem, relevant to the analysis of a storage plant during the transient regime when operation is started, and the 'steady state' regime of the system, in which the inlet temperature of the fluid is subjected to periodic variations taking place repeatedly for a very long time, are taken into account.

C.D.

A82-48261

HEAT TRANSFER CHARACTERISTICS OF A VERTICAL POROUS HEAT STORAGE SATURATED BY A LIQUID AND SPHERICAL SOLID PARTICLES

H. INABA (Kitami Institute of Technology, Kitami, Hokkaido, Japan) and N. SEKI (Hokkaido University, Sapporo, Japan) Wärme- und Stoffübertragung, vol. 16, no. 4, 1982, p. 209-217. refs

Fundamental information pertaining to the design of a sensible porous heat storage is presented, including heat transfer characteristics influenced by natural convection occurring in the storage. The effects of various fundamental factors on the transient

heat transfer of the porous heat storage are clarified, including the heat flux as heat input, the porosity as determined by the texture of the porous medium, the physical properties of the porous medium, and the dimensional ratio height/width of the rectangular cavity. It is shown that the natural convection occurring in the storage thermally homogenizes the porous layer and shortens the time to reach a quasi-steady state. It is concluded that the storage composed of a fluid and a solid phase is superior to a single phase storage, due to the control it permits over the time period from start to quasi-steady state and over the amount of heat stored. C.D.

N82-28793# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
THERMAL ENERGY STORAGE IN PHASE CHANGE MATERIAL
Final Scientific Report, 1 Feb. 1981 - 31 Jan. 1982
 P. WHITE and J. M. BUCHLIN Mar. 1982 83 p refs
 (Contract AF-AFOSR-0119-81; AF PROJ. 2301)
 (AD-A113355; EOARD-TR-82-8) Avail: NTIS HC A05/MF A01
 CSDL 13A

The present study deals with an experimental investigation of low temperature thermal storage based on macroencapsulation of Phase Change Material (PCM). The storage performance capabilities of capsule bed, tube bank and tubular single-pass heat exchanger are compared. The tests are conducted on the VKI Solar Utility Network (SUN) which is a closed loop facility designed to study air heating systems. An original data acquisition chain based on two conversing microprocessors is developed to carry out mass flow, pressure drop and temperature measurements. The experimental results are interpreted on the basis of comparison with numerical predictions and they allow to draw the following conclusions. Each type of matrix has its own range of operation for practical application but from a heat transfer standpoint, the PCM capsule packing unit is strongly recommended. It is suggested to extend this investigation to the effect of Reynolds number to find optimum range for thermomechanical efficiency. GRA

N82-28797# Franklin Research Center, Philadelphia, Pa.
SURVEY OF COMMERCIAL THERMAL-STORAGE
INSTALLATIONS IN THE UNITED STATES AND CANADA
 H. G. LORSCH and M. A. BAKER 1981 7 p refs Presented at Ann. Contractors' Rev. Meeting on Thermal and Chem. Storage, Washington, D.C., 14-16 Sep. 1981
 (Contract W-7405-ENG-26)
 (DE82-000131; CONF-810940-14) Avail: NTIS HC A02/MF A01

Nearly 300 thermal energy storage installations in the United States and Canada were identified by a mail and telephone survey. Information was obtained on approximately 220 installations. For 175 installations of hot, cold, and combination hot/cold storage, sufficient quantities of technical information were obtained to warrant inclusion in the report. Water is the most prevalent medium of energy storage. Although almost all respondents indicated satisfaction with the performance of their storage systems, hardly any could provide detailed performance records. Operational and construction cost data were either unobtainable or were not specified sufficiently to be useful. Author

N82-28819# Sandia Labs., Albuquerque, N. Mex.
 Thermal/Hydraulic Analysis Div.
DEVELOPMENT OF A RELAP MODEL FOR THE BARSTOW
THERMAL-STORAGE SUBSYSTEM
 R. K. BYERS and L. N. KMETIK Oct. 1981 63 p
 (Contract DE-AC04-76DP-00789)
 (DE82-006828; SAND-81-1831) Avail: NTIS HC A04/MF A01

A systems effects plant model was developed to study operational transient response in the Barstow solar-electric pilot power plant, using the nuclear power plant systems program RELAP. A finite-difference, predictor-corrector, numerical technique was included in RELAP to solve for fluid and solid temperature distributions in one-dimensional flow through the dual-media storage tank's packed bed. Nominal flow operating conditions were calculated from zero-power cold- and hot-oil startups for the charging and extraction modes, respectively. T.M.

N82-28822# United Technologies Research Center, East Hartford, Conn.

TECHNICAL AND ECONOMIC ASSESSMENT OF FLUIDIZED-BED-AUGMENTED COMPRESSED-AIR ENERGY-STORAGE SYSTEM. VOLUME 1: EXECUTIVE SUMMARY

A. J. GIRAMONTI, R. D. LESSARD, D. MERRICK (Coal Processing Consultants Ltd.), and M. J. HOBSON (Acres American, Inc., Columbia, Md.) Sep. 1981 42 p refs Prepared for Pacific Northwest Lab.

(Contract DE-AC06-176RL-01830)
 (DE82-001894; PNL-3686-VOL-1; UTRC/R80-954490-20) Avail: NTIS HC A03/MF A01

An energy storage system for electric utility peak load applications is a modified gas turbine power system utilizing underground storage of very high pressure air. The compressed air energy storage (CAES) concept involves using off peak electricity generated from indigenous coal or nuclear sources to compress air, storing the air in large underground facilities, and withdrawing the air during peak load periods when it would be heated by combustion and expanded through gas turbines to generate power. The attractiveness of the CAES concept is based upon its potential to supply competitively priced peaking energy, to reduce peak load power plant dependence on petroleum based fuels, and to provide a means for leveling the utility system load demand. Therefore, a technical and economic assessment of coal fired fluidized bed combustor/compressed air energy storage systems was performed and is described. DOE

N82-28823# Acres American, Inc., Columbia, Md.
CONCEPTUAL DESIGN AND ENGINEERING STUDIES OF ADIABATIC COMPRESSED AIR ENERGY STORAGE (CAES) WITH THERMAL ENERGY STORAGE
 M. J. HOBSON Nov. 1981 216 p refs
 (Contract DE-AC06-76RL-01830)
 (DE82-005483; PNL-4115) Avail: NTIS HC A10/MF A01

An adiabatic CAES system using water compensated hard rock caverns for compressed air storage was designed. The conceptual plant design features underground containment for thermal energy storage and water compensated hard rock caverns for high pressure air storage. Other design constraints include the selection of turbomachinery designs that require little development and therefore are available for near term plant construction and demonstration. The design is based upon the 231 MW/unit conventional CAES plant design prepared for a site in Maryland. The project, its findings, and the recommendations of the study team are summarized. The development and optimization of the plant heat cycle, and the selection and thermal design of the thermal energy storage system are presented. The selection of turbomachinery and estimated plant performance and operational capability is discussed describes; the control system concept is described, and the conceptual design of the adiabatic CAES plant, the cost estimates and economic evaluation, and an assessment of technical and economic feasibility are also summarized. DOE

N82-28826# California Univ., Livermore. Lawrence Livermore Lab.
RAPIDLY-REFUELABLE 167-CM(2) ALUMINUM-AIR POWER CELL
 R. V. HOMS Y Nov. 1981 44 p refs
 (Contract W-7405-ENG-48)
 (DE82-006251; UCID-19244) Avail: NTIS HC A03/MF A01

The rapidly-refuelable, 167-cm(2) aluminum-air power was tested both as a single cell and as a two cell stack. The electrolyte and is designed for rapid replacement of the anode and easy construction. A maximum power density of 4.2 kW/m(2) was measured. Cathode polarization is negligibly affected by air flow rate and air electrolyte differential pressure across the air cathode. DOE

07 ENERGY STORAGE

N82-28827# Century West Engineering Corp., Spokane, Wash. REGIONAL ASSESSMENT OF AQUIFERS FOR THERMAL ENERGY STORAGE. VOLUME 1: REGIONS 1 THROUGH 6

Jun. 1981 220 p refs 3 Vol.

(Contract DE-AC06-76RL-01830)

(DE82-002507; PNL-3995-VOL-1) Avail: NTIS HC A10/MF A01

The geologic and hydrologic framework, major aquifers, aquifers which are suitable and unsuitable for annual thermal energy storage (ATES) and the ATES potential of the western mountains, alluvial basins, Columbia LAVA plateau, Colorado plateau, high plains, and glaciated central region are discussed. DOE

N82-28828# Century West Engineering Corp., Spokane, Wash. REGIONAL ASSESSMENT OF AQUIFERS FOR THERMAL-ENERGY STORAGE. VOLUME 2: REGIONS 7 THROUGH 12

Jun. 1981 213 p refs 3 Vol.

(Contract DE-AC06-76RL-01830)

(DE82-002506; PNL-3995-VOL-2) Avail: NTIS HC A10/MF A01

The geologic and hydrologic framework, major aquifers, aquifers which are suitable and unsuitable for annual thermal energy storage (ATES) and the ATES potential of the unglaciated central region, glaciated Appalachians, unglaciated Appalachians, coastal plain, Hawaii, and Alaska are discussed. DOE

N82-28829# Century West Engineering Corp., Spokane, Wash. REGIONAL ASSESSMENT OF AQUIFERS FOR THERMAL-ENERGY STORAGE. VOLUME 3: APPENDICES

Jun. 1981 146 p refs 3 Vol.

(Contract DE-AC06-76RL-01830)

(DE82-002505; PNL-3995-VOL-3) Avail: NTIS HC A07/MF A01

The aquifers in the 12 geographic regions of the USA are listed. Each is characterized as containing sands and gravels or limestones or volcanic rock. The hydrologic characteristics of each aquifer are tabulated. DOE

N82-28832# Lincoln Lab., Mass. Inst. of Tech., Lexington. APPLICATION, SIZING, TESTING AND PERFORMANCE OF THE PHOTOVOLTAIC BATTERY SUBSYSTEM AT NATURAL BRIDGES NATIONAL MONUMENT, UTAH

B. L. BRENCH Nov. 1981 50 p

(Contract DE-AC02-76ET-20279)

(DE82-007040; DOE/ET-20279/153) Avail: NTIS HC A03/MF A01

During the two years from 24 May 1978 to 7 June 1980, the battery subsystem for the 100-kW peak photovoltaic power system for Natural Bridges National Monument was designed, modified, tested, installed, retested and again modified. The subsystem includes 224 lead-acid (with calcium alloy) cells, hydrogen recombiners, an air-lift pump system and electrolyte level indicators. Problems and solutions related to these subsystem components are discussed. Further details concerning the battery selection, design, tests and performance throughout the battery's life are also included. DOE

N82-29728# Styrelsen foer Teknisk Utveckling, Stockholm (Sweden).

LONGTIME CYCLING TEST OF A SALTMELT HEAT STORE BASED ON CALCIUM CHLORIDE

J. HETENYI, G. JOHANSSON, and K. O. LAGERKVIST 1981

18 p refs In SWEDISH

(DE82-900881; SP-RAPP-1981:12; STU-79-6324) Avail: NTIS

(US Sales Only) HC A02/MF A01; DOE Depository Libraries

A long time test of the Thermol 81 Energy Storage rods is reported. The plastic rods containing $\text{CaCl}_2 \times 6\text{H}_2\text{O}$ passed through 1000 eight hour cycles with 60 C and 10 C as temperature extremes. The thermal storage capacity of tested rods did not deteriorate appreciable during the test period, nor was the crystal structure significantly changed. DOE

N82-29744# Concentration Specialists, Inc., Andover, Mass. TESTING A DIRECT-CONTACT CRYSTALLIZER FOR COLD THERMAL ENERGY STORAGE USING SODIUM SULFATE Final Report

Oct. 1981 37 p refs

(Contract DE-AC03-78ET-11347)

(DE82-001985; DOE/ET-11347/T1) Avail: NTIS HC A03/MF A01

Thermal energy storage systems have the potential permitting more economical and efficient use of intermittent energy sources and off-peak electrical power for applications where energy supply and demand do not coincide. One such application is space cooling of residential buildings. This program investigated a novel approach to an aqueous sodium sulfate system wherein water evaporating directly from the salt solution provides the cooling. A circulation pump outside the combination crystallizer-thermal energy storage tank discharges through nozzles inside the tank to maintain agitation of the crystal slurry. The concept was evaluated analytically and tested experimentally. DOE

N82-29755# Sandia Labs., Livermore, Calif. ANALYSIS OF BATTERY STORAGE IN WIND-ENERGY SYSTEMS FOR COMMERCIAL BUILDINGS

D. L. CASKEY, J. BROEHL (Battelle Columbus Lab.), and J. SKELTON (Battelle Columbus Lab.) 30 Sep. 1981 52 p refs

(Contract DE-AC04-76DP-00789)

(DE82-010875; SAND-81-7171) Avail: NTIS HC A04/MF A01

The performance of wind energy systems in commercial buildings was analyzed with and without storage to assess the economic value of storage. The SOLSTOR program used in the simulations is briefly described. Life-cycle energy cost and performance measures were calculated for different wind turbine and storage capacity levels. The analyses focused on Dodge City (average wind speed of 5.8 m/s) and Washington, DC (wind speed 2.9 m/s). Levelized system costs are computed for warehouse and office applications. To assess the sensitivity of the system performance measures and cost, two series of sensitivity tests were performed. The first determined the increase in system cost for an increase of storage capacity, and the second examined the effect of doubling the battery cost for the office building application. DOE

N82-29764# California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Molecular Research Div.

IMPROVED BETA ALUMINA ELECTROLYTES FOR ADVANCED STORAGE BATTERIES Interim Report, Dec. 1981

L. C. DEJONGHE Dec. 1981 87 p refs

(Contract W-7405-ENG-48; EPRI PROJ. 252-3)

(DE82-010989; EPRI-EM-2160) Avail: NTIS HC A05/MF A01

Investigations on the factors determining the mechanisms of electrochemical failure initiation and propagation of polycrystalline sodium beta and beta'' alumina are reported. The investigations led to the distinction between two modes of failure. Mode I failure involved a cathode plating of sodium into a pre-existing crack. Mode II degradation involved the internal plating of sodium into a pre-existing crack. Mode II degradation involved the internal precipitation of sodium. The Mode I initiation current density thresholds were determined using acoustic emission detection. Experiments below and above the melting point of sodium were carried out. The results are reported in the form of Weibull failure probability plots. Below the melting point of sodium, the average current density threshold for initiation of Mode I failure depended on temperature, with an activation energy of about 4 kcal/mol. At 3500 C, it was found that a significant grain size dependence existed, in which large grained material exhibited lower average critical current density thresholds for Mode I initiation than fine grained material. DOE

N82-29770# Odense Univ. (Denmark).
PROJECT ELECTROCHEMICAL ENERGY STORAGE SYSTEMS
 1. JAN. 1980 - 31. DEC. 1980. REPORT FOR THE MINISTRY
 OF ENERGY, FEBRUARY 1981

J. JENSEN Feb. 1981 83 p refs In DANISH
 (DE82-900845; NP-2900845) Avail: NTIS (US Sales Only) HC
 A05/MF A01; DOE Depository Libraries

Fabrication and properties of solid electrolytes, fast ion
 conductors, characterization and performance of solid solution
 electrodes, and battery applications studies and battery assessment
 are studied. The electrochemical research investigates materials
 with improved ionic conductivity - lithium nitrides and iodides,
 zeolites, and sodium ion conductors. Crystalline electrolytes (of
 TiS₂/Li₃N type) are investigated. Efficient batteries for propulsion
 purposes were evaluated from the economic and energy
 conservation point of view. DOE

N82-30679 Westinghouse Electric Corp., Pittsburgh, Pa.
 Advanced Energy Systems Div.
**AN EVALUATION OF LIGHTWEIGHT CONCRETE VESSELS FOR
 THERMAL ENERGY STORAGE**

G. G. ELIA and R. W. BUCKMAN, JR. In ASME Solar Eng.,
 1981 p 610-615 1981 refs
 (Contract EM-78-C-02-47003)
 Avail: Issuing Activity

Lightweight concrete vessels for thermal energy storage were
 tested. A hot water storage system made with precast or cast on
 site lightweight concrete capable of easy assembly and integration
 with residential or other structures was developed. The predicted
 and measured thermal behavior (heat loss) of the vessels is
 compared. A temperature decay test to measure vessel heat loss
 is also developed. E.A.K.

N82-30686* Jet Propulsion Lab., California Inst. of Tech.,
 Pasadena.
**METAL-HALIDE MIXTURES FOR LATENT HEAT ENERGY
 STORAGE**

K. CHEN and R. MANVI In ASME Solar Eng., 1981 p 667-674
 1981 refs Sponsored in part by DOE in agreement with NASA
 Avail: Issuing Activity CSCL 10C

Some candidates for alkali metal and alkali halide mixtures
 suitable for thermal energy storage at temperatures 600 C are
 identified. A solar thermal system application which offer
 advantages such as precipitation of salt crystals away from heat
 transfer surfaces, increased thermal conductivity of phase change
 materials, corrosion inhibition, and a constant monotectic
 temperature, independent of mixture concentrations. By using the
 lighters, metal rich phase as a heat transfer medium and the
 denser, salt rich phase as a phase change material for latent
 heat storage, undesirable solidification on the heat transfer surface
 may be prevented, is presented. E.A.K.

N82-30715*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.
SYNTHETIC BATTERY CYCLING TECHNIQUES

H. F. LEIBECKI and L. H. THALLER 1982 8 p refs Proposed
 for presentation at the 4th ESTEC Spacecraft Power Conditioning
 Seminar, Noordwijk, Netherlands, 9-11 Nov. 1982; sponsored by
 ESA
 (NASA-TM-82945; E-1351; NAS 1.15:82945) Avail: NTIS HC
 A02/MF A01 CSCL 10C

Synthetic battery cycling makes use of the fast growing
 capability of computer graphics to illustrate some of the basic
 characteristics of operation of individual electrodes within an
 operating electrochemical cell. It can also simulate the operation
 of an entire string of cells that are used as the energy storage
 subsystem of a power system. The group of techniques that as a
 class have been referred to as Synthetic Battery Cycling is
 developed in part to try to bridge the gap of understanding that
 exists between single cell characteristics and battery system
 behavior. Author

N82-30716*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.

NICKEL-HYDROGEN BIPOLAR BATTERY SYSTEMS

L. H. THALLER 1982 9 p refs Proposed for presentation at the
 4th ESTEC Spacecraft Power Conditioning Seminar, Noordwijk,
 Netherlands, 9-11 Nov. 1982; sponsored by ESA
 (NASA-TM-82946; E-1352; NAS 1.15:82946) Avail: NTIS HC
 A02/MF A01 CSCL 10A

Nickel-hydrogen cells are currently being manufactured on a
 semi-experimental basis. Rechargeable nickel-hydrogen systems
 are described that more closely resemble a fuel cell system than
 a traditional nickel-cadmium battery pack. This has been stimulated
 by the currently emerging requirements related to large manned
 and unmanned low earth orbit applications. The resultant
 nickel-hydrogen battery system should have a number of features
 that would lead to improved reliability, reduced costs as well as
 superior energy density and cycle lives as compared to battery
 systems constructed from the current state-of-the-art
 nickel-hydrogen individual pressure vessel cells. B.W.

N82-30745# Aerospace Corp., Germantown, Md.
**ELECTROCHEMICAL STORAGE SYSTEMS PROGRAM
 SUMMARY**

Jun. 1981 239 p Presented at the 4th DOE Battery and
 Electrochem. Contractor's Conf., Washington, D.C., 2-4 Jun. 1981
 (Contract DE-AI01-79ET-25204)
 (DE82-000076; CONF-810642-SUMM) Avail: NTIS HC A11/MF
 A01

Battery technology and electrochemistry are discussed. Topics
 include electric batteries, solar applications, electric vehicles, and
 photovoltaic technology. DOE

N82-30747# Castle Technology Corp., Woburn, Mass.
RECYCLE OF BATTERY COMPONENTS Final Report

J. P. PEMSLER and R. A. SPITZ 1981 109 p refs
 (Contract DE-AC02-80ET-25206)
 (DE82-003659; DOE/ET-25206/1) Avail: NTIS HC A06/MF A01

The recycle disposal scenario for the batteries nickel/zinc,
 nickel/iron, zinc/chlorine, zinc/bromine, sodium/sulfur and
 lithium-aluminum/metal sulfide was considered. Flowsheets are
 presented which include disassembly, materials handling, melting
 or solubilization, liquid/solid separations, purifications and waste
 handling. Material and energy balances are provided for all major
 streams and capital and operating costs for typical plant sizes are
 presented. Recycle is a viable option in all cases.
 Recommendations are made for the best process options and for
 additional studies on the sodium/sulfur and lithium-aluminum/metal
 sulfide batteries. E.A.K.

N82-31459*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.

DESIGN FLEXIBILITY OF REDOX FLOW SYSTEMS

N. H. HAGEDORN and L. H. THALLER 1982 18 p refs
 Presented at the Intersoc. Energy Conversion Eng. Conf., Los
 Angeles, 8-13 Aug. 1982
 (Contract DE-AI04-80AL-12726)
 (NASA-TM-82854; E-1223; NAS 1.15:82854;
 DOE/NASA/12726-16) Avail: NTIS HC A02/MF A01 CSCL
 10C

The characteristics inherent in Redox flow systems permit
 considerable latitude in designing systems for specific storage
 applications. The first of these characteristics is the absence of
 plating/deplating reactions with their attendant morphology
 changes at the electrodes. This permits a given Redox system to
 operate over a wide range of depths of discharge and
 charge/discharge rates. The second characteristic is the separation
 of power generating components (stacks) from the energy storage
 components (tanks). This results in cost effective system design,
 ease of system growth via modularization, and freedom from sizing
 restraints so that the whole spectrum of applications, from utilities
 down to single residence can be considered. The final characteristic
 is the commonality of the reactant fluids which assures that all
 cells at all times are receiving reactants at the same state of

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charge. Since no cell can be out of balance with respect to any other cell, it is possible for some cells to be charged while others are discharging, in effect creating a DC to DC transformer. It is also possible for various groups of cells to be connected to separate loads, thus supplying a range of output voltages. Also, trim cells can be used to maintain constant bus voltage as the load is changed or as the depth of discharge increases. The commonality of reactant fluids also permits any corrective measures such as rebalancing to occur at the system level instead of at the single cell level. S.L.

N82-31780# Sveriges Lantbruksuniv., Lund. Inst. fuer Lantbrukets Byggnadsteknik.

PREPARATORY EXPERIMENTS ON SEASONAL STORAGE IN EARTH OF EXCESS HEAT FROM GREENHOUSE

M. ARESKOUG and P. WIGSTROEM 1980 50 p refs In SWEDISH

(DE82-900623; SLU-LBT-11) Avail: NTIS (US Sales Only) HC A03/MF A01; DOE Depository Libraries

An earth heat accumulator, directly beneath an experimental greenhouse, with possibilities for collecting excess solar heat by pumps and utilization of low temperature heat was investigated. Heat exchange with the accumulator is made by a system of buried polyethylene pipes. The heat accumulator was loaded by excess solar heat from the greenhouse, using heat pumps, during two summer months. A theoretical model for the heat flow in the accumulator was used to study the heat balance in the accumulator and its interaction with surrounding soil and greenhouse. The heat flow through the soil surface is utilized by the greenhouse giving a higher root zone temperature and a higher air temperature. It is suggested that a heat accumulator should be placed deeper beneath the soil surface. Its extension in depth should be larger, (about 10 to 15 m) in the specific boulder clay investigated. It is concluded that the method which uses buried horizontal pipes is not usable, and a technique for vertical pipe systems with high heat transfer must be investigated. DOE

N82-31787# California Univ., Livermore. Lawrence Livermore Lab.

AUTOMOBILE FLYWHEEL ENERGY STORAGE: PRACTICAL VACUUM REQUIREMENTS

D. N. FRANK and N. MILLERON 23 Oct. 1981 19 p refs Presented at the Am. Vacuum Soc. Natl. Symp., Anaheim, Calif., 2-6 Nov. 1981

(Contract W-7405-ENG-48)
(DE82-003151; UCRL-86822; CONF-811113-31) Avail: NTIS HC A02/MF A01

For passenger automobiles with 1367 kg curb weight during typical driving conditions in city traffic, fuel efficiency improvements of 50 to 100% (5 to 7 km) can be realized by proper utilization of a flywheel energy storage unit (0.2 kWh) and a heat engine. The pros and cons of flywheels compared to other energy storage options are discussed. Discussion is then given regarding a serious concern of composite flywheel energy storage for vehicles, that of a suitable vacuum environment for the rotating, composite flywheel. To be practical, a vacuum system for such an environment must be reliable, safe and economical to manufacture, monitor, maintain and repair. Each embodiment of flywheel energy storage may be sufficiently unique to require a vacuum environment tailored to suit it. A general discussion of the important vacuum parameters and practical vacuum systems is followed by examples of candidate designs. DOE

N82-31796# Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.

FUNDAMENTAL HEAT-TRANSFER PROCESSES RELATED TO PHASE-CHANGE THERMAL-STORAGE MEDIA

E. M. SPARROW Jan. 1982 15 p refs

(Contract DE-AS02-79ER-10343)
(DE82-007944; DOE/ER-10343/03) Avail: NTIS HC A02/MF A01

Fundamental heat transfer processes which occur in phase change thermal storage systems is described. Five interrelated

research problems are described. The first two of the problems deal with phase change which occurs inside a vertical tube. The encapsulated storage concept whereby the phase change medium is contained within a sealed tube while the flowing heat transfer fluid passes over the outside of the tube were studied. The results included the heat extracted (for freezing), and heat input (for melting), and the separate contributions of the latent heat energy and of the sensible heat energies of the liquid and the solid phases. The shapes of the freezing and melting fronts were measured directly. Convection has a strong effect on the melting results, the freezing results are little affected by natural convection. A finite difference method was formulated to solve two dimensional phase changes in the freezing problem which occurs when a coolant carrying tube passes through a phase change medium. The natural convection heat transfer coefficients associated with freezing outside a cooled vertical tube was determined. It is found that the coefficients are insensitive to the thickness of the frozen layer. This legitimizes the use of a time independent local heat transfer coefficient in the analysis of the timewise growth of the frozen layer. DOE

N82-31808# Pacific Northwest Lab., Richland, Wash. Div. of Environmental Science and Engineering.

TECHNOLOGY ASSESSMENT REPORT FOR THE SOYLAND POWER COOPERATIVE, INC. COMPRESSED AIR ENERGY STORAGE SYSTEM (CAES)

Jan. 1982 106 p refs

(Contract DE-AC06-76RL-01830)

(DE82-011710; PNL-4077) Avail: NTIS HC A06/MF A01

The design and operational features of compressed air energy storage systems (CAES) in general and, specifically, of a proposed 220 MW plant being planned by the Soyland Power Cooperative, Inc., in Illinois are described. The need for peaking capacity, CAES requirements for land, fuel, water, and storage caverns, are discussed, and the costs, environmental impacts and licensing requirements of CAES are compared with those of power plants using simple cycle or combined cycle combustion turbines. It is concluded that during the initial two years of CAES operation, the CAES would cost more than a combustion turbine or combined cycle facility, but thereafter the CAES would have a increasing economic advantage. The overall environmental impact of a CAES plant is minimal, and there should be no great difficulties with CAES licensing. DOE

N82-31809# Pacific Northwest Lab., Richland, Wash.

AIR-STORAGE SYSTEMS

T. J. DOHERTY Oct. 1981 15 p refs Presented at the Intern. Energy Storage Conf., Seattle, 19 Oct. 1981

(Contract DE-AC06-76RL-01830)

(DE82-005805; PNL-SA-9438; CONF-811066-9) Avail: NTIS HC A02/MF A01

The air storage system, the critical component making compressed air energy storage technically economically feasible, is described in three of its forms. All have geological containments and reflect economics of scale requiring fairly large plant ratings and storage capacities. All three systems also are based on good precedent experience and there are a number of willing bidders in the engineering and construction field attesting to the readiness of the technology. The salient features of each storage system type are summarized. Hard rock caverns have the widest siting opportunity with a variety of geology, are well within construction capability in good quality rock with maximum control of system design through engineering, and have the highest cost of the storage system options study. They have the potential for longest time to startup and are difficult and expensive to expand for increased storage or plant rating. The salt-solutioned cavern has limited siting opportunities, is a very economical storage system, and storage increase is possible through cavern additions. DOE

N82-31810# Inco Europe Ltd., Birmingham (England).
GMC NICKEL HYDROXIDE ELECTRODE Final Report
 T. S. TURNER, J. W. OLDFIELD, D. M. TALLETT, and J. EDWARDS Feb. 1982 164 p
 (Contract DE-AC02-80CS-91001)
 (DE82-011859; DOE/CS-91001/T6) Avail: NTIS HC A08/MF A01

The ultimate objective of this work is the geometrical optimization of the CMG nickel hydroxide electrode. A proposal for jointly funded research, made in 1980 to the US Department of Energy, embraced two phases. The first covered investigation of the effect on discharged behavior of varying the hole pattern, electrode thickness and nickel hydroxide density. The properties observed were to be compared with the predictions of an existing mathematical model, whose deficiencies would then be identified, and improvements made. In the second phase, the following parameters were to be investigated: foil thickness, weight of active mass per unit area of foil, electrode size and shape. The results were to be applied to make further improvements in the model and to estimate trends in production costs. DOE

N82-32867# EIC, Inc., Newton, Mass.
THERMAL DECOMPOSITION OF DIMETHOXYMETHANE ELECTROLYTE SOLUTION

J. S. FOOS and V. MELTZ Jun. 1982 20 p refs Submitted for publication

(Contract N00014-77-C-0155; NR PROJ. 359-638)
 (AD-A116789; TR-8) Avail: NTIS HC A02/MF A01 CSCL 10C

The electrolyte solution prepared from LiAsF₆ and dimethoxymethane (DMM) was investigated for use in secondary lithium batteries. Storage tests were conducted at 70 C. In the presence of Li the best samples of electrolyte were stable to Li for more than one month. In the absence of Li, the electrolyte solution decomposed within days with loss of DMM, and formation of methyl formate and dimethyl ether in a 1:2 ratio. The products were identified and product ratio determined using IR and proton NMR spectroscopy. A chain reaction mechanism is proposed for the decomposition which postulates oxygen stabilized carbocation intermediates. Because the reaction may be impurity initiated and is quenched by Li metal, the importance of purification and storage of electrolyte with Li, is emphasized. Author (GRA)

N82-32884# Oak Ridge National Lab., Tenn.
UTILITY-CONTROLLED CUSTOMER-SIDE THERMAL-ENERGY-STORAGE TESTS: HEAT STORAGE

D. T. RIZY Feb. 1982 83 p refs
 (Contract W-7405-ENG-26)
 (DE82-007722; ORNL-5796) Avail: NTIS HC A05/MF A01

Customer side thermal energy storage was identified as a load management option available to the electric utility industry. Five heat storage tests are described to: collect reliable load research data; delineate and solve installation problems; establish maintainability; determine customer and utility acceptance; and generate cost data to determine the potential of utility controlled customer side storage as a load management option. The utilities tested four types of heat storage systems: central ceramic brick concrete slab heat pump with storage and pressurized hot water storage. Installation and operation the storage systems indicates that the residential heat storage systems are not fully commercial in their present state for use as a load management option and the technology requires further development. DOE

N82-32887# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensbereich Raumfahrt.
PHASE 1 DEVELOPMENT OF AN AQUIFER HEAT STORAGE FACILITY. PART 1: SUMMARY AND RESULTS Final Report, Feb. 1980

A. HARASIM and B. WEISSENBACH Bonn Bundesministerium fuer Forschung und Technologie Mar. 1982 189 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-032-PT-1; ISSN-0340-7608) Avail: NTIS HC A09/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 35,40

A surface aquifer pilot plan was defined. Several versions of construction were drafted and the costs were calculated for variable site conditions. Aquifer heat storage facilities larger than 5,000 cu m (water equivalent) are cheaper than any known storage concept. Simultaneous with technical and economic studies, problems of chemical mass transport in two typical soil materials (calcareous gravel water and red marl water) were investigated in lab tests. Special attention was paid to the biological behavior of a wet gravel bed in view of the possibility of clogging by slime. Recommendations are given to ensure safe operation of the storage plant. Corrosion in the storage facility was considered for various materials. Results show that cement structures are preferred. Author (ESA)

N82-33824*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

USE OF THE CHARGE/DISCHARGE (C/D) RATIO TO AUGMENT VOLTAGE LIMIT (V SUB T) CHARGE CONTROL IN THE ERBS SPACECRAFT

G. HALPERT 8 Jul. 1982 44 p
 (NASA-TM-83991; G82-0023-7; NAS 1.15:83991) Avail: NTIS HC A03/MF A01 CSCL 10C

A 50-ampere hour nickel cadmium cell test pack was operated in a power profile simulating the orbit of the Earth Radiation Budget Satellite (ERBS). The objective was to determine the ability of the temperature compensated voltage limit (V sub T) charge control system to maintain energy balance in the half sine wave-type current profile expected of this mission. The four-cell pack (50 E) was tested at the Naval Weapons Support Center (NWSC) at Crane, Indiana. The ERBS evaluation test consisted of two distinct operating sequences, each having a specific purpose. The first phase was a parametric test involving the effect of V sub T level, temperature, and Beta angle on the charge/discharge (C/D) ratio, an indicator of the amount of overcharge. The second phase of testing made use of the C/D ratio limit to augment the V sub T charge limit control. When the C/D limit was reached, the current was switched from the taper mode to a C/67 (0.75 A) trickle charge. The use of an ampere hour integrator limiting the overcharge to a C/67 rate provided a fine tuning of the charge control technique which eliminated the sensitivity problems noted in the initial operating sequence. Author

N82-33832# Eagle-Picher Industries, Inc., Joplin, Mo.
NICKEL-ZINC BATTERIES FOR RPV APPLICATIONS Final Technical Report, 15 Nov. 1979 - 15 Aug. 1981

D. DAPPER Wright-Patterson AFB, Ohio AFWAL Feb. 1982 161 p
 (Contract F33615-78-C-2058; AF PROJ. 3145)
 (AD-A115843; AFWAL-TR-82-2003) Avail: NTIS HC A08/MF A01 CSCL 10C

Final technical results are presented for a program dealing with the placement of nickel-zinc batteries in specific military applications, namely the BQM-34A and the PQM-102 Remotely Piloted Vehicles (RPV's). The nickel-zinc system was selected for these applications because RPV's demand a high quality secondary battery that offers a compromise between long life (calendar and cycle) and low weight and volume. GRA

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N82-33834# Army Electronics Technology and Devices Lab., Fort Monmouth, N. J.

PROPERTIES OF SOC12 ELECTROLYTE SOLUTIONS

M. SALOMON 18 Jun. 1982 10 p refs Presented at the Army Sci. Conf., 15-18 Jun. 1982

(AD-A117306) Avail: NTIS HC A02/MF A01 CSCL 10C

A number of types of lithium secondary and primary nonaqueous batteries are under development in the power sources division at Fort Monmouth. Military applications for portable power sources range from communications to laser designators and night vision devices. For the latter two applications, the lithium-thionyl chloride battery has been identified as a highly promising system. The battery was initially shown to be capable of providing very high energy densities at various rates of discharge. Since there are virtually no detailed studies on the general physical chemistry of electrolyte solutions in SOC12, the initial phase of the program to develop new electrolytes was to determine those factors which govern both conductivities and solubilities. GRA

N82-33836# Aerospace Corp., El Segundo, Calif. Chemistry and Physics Lab.

SHORT-CIRCUIT FORMATION DURING NiCd CELL REVERSAL

A. H. ZIMMERMAN and P. K. EFFA 20 May 1982 29 p refs (Contract F04701-81-C-0082)

(AD-A117912; TR-0082(2945-01)-2; SD-TR-82-26) Avail: NTIS HC A03/MF A01 CSCL 10C

The reduction of Cd(OH)₂ to cadmium at the nickel electrode in the NiCd cell has been found to compete with the hydrogen evolution reaction during cell reversal. This reduction reaction can lead to internal short circuits as cadmium dendrites bridge the separator. The cadmium metal short circuits are reoxidized when the cell is recharged and do not appear to have a significant short-term effect on cell performance. Author (GRA)

N82-33837# Geo-Centers, Inc., Newton, Mass.

COMPATIBILITY OF POLYACETYLENE WITH LITHIUM BATTERY MATERIALS

Jul. 1982 6 p refs (Contract N00014-82-C-2124)

(AD-A117684; GC-TR-82-288) Avail: NTIS HC A02/MF A01 CSCL 10C

The object of the research conducted under this contract is to evaluate polyacetylene (CH_x) as a replacement for carbon as the cathode material in primary lithium/thionyl chloride (Li/SOC12) and lithium/sulfur dioxide (Li/SO₂) batteries. The choice of the Li/SOC12 inorganic electrolyte cell is based on the fact that it is the highest energy density system known to date. By itself, the favorable ratio of obtainable work to weight is not sufficient. For Navy applications, the rate at which the cell supplies energy, the power density, is very important. CH_x is a lightweight material with extremely high effective surface area (60 m squared/g) and good electrical conductivity when doped, thus making it a good candidate for an electrode in a high power density cell. GRA

N82-33840# Rocket Research Corp., Redmond, Wash.

DEVELOPMENT OF A LONG-LIFE HIGH-TEMPERATURE CATALYST FOR THE SO₂/SO₃ ENERGY-STORAGE SYSTEM Final Report

E. W. SCHMIDT, D. J. DAY, G. S. FAIRFULL, D. H. GATES, C. H. LI, and D. R. POOLE Mar. 1982 134 p refs

(Contract DE-AC04-76DP-00789)

(DE82-009723; SAND-81-8182; RRC-80-R-697) Avail: NTIS HC A07/MF A01

Fifty new catalysts using 21 different active metals and a wide variety of catalyst carriers and preparation methods were tested for activity in SO₂/sub x/ reactions using differential isothermal reactors and pulsed microreactors. The most active catalyst, a 1% platinum on a lumina catalyst, was subjected to a 6 month accelerated life test at 11440 K (16000 F). The main degradation mechanism was identified as loss of carrier surface area by sintering and platinum active metal by volatilization. The temperature to which the catalyst was exposed during the life test was increased

to 11440 K to accelerate aging phenomena and to demonstrate margin. Activity remaining after 6 months at 11440. K was approximately half of that of fresh catalyst. A kinetic rate equation for the decomposition of undiluted SO₃ on a Pt catalyst at 10005 to 11350 K was derived from experimental data. A computer model was developed for the sizing of SO₃ decomposition reactors based on desired conversion and 10 other input variables. DOE

N82-33848# Los Alamos Scientific Lab., N. Mex.

SUPERCONDUCTING MAGNETIC ENERGY STORAGE (SMES)

PROGRAM Progress Report, 1 Jan. - 31 Dec. 1981

J. D. ROGERS, comp. Feb. 1982 32 p refs

(Contract W-7405-ENG-36)

(DE82-009083; LA-9208-PR) Avail: NTIS HC A03/MF A01

A 30 MJ superconducting magnetic energy storage (SMES) unit to stabilize power oscillations was developed. The 30 MJ superconducting coil manufacture is completed and the design of the seismic mounting of the coil to the nonconducting dewar lid and a concrete foundation is complete. An economic and technological evaluation of superconducting fault current limiter (SFCL) was completed and the results are reported. DOE

N82-33857# Oak Ridge National Lab., Tenn. Engineering Technology Div.

ENERGY STORAGE USING PHASE-CHANGE MATERIALS FOR ACTIVE SOLAR HEATING AND COOLING: AN EVALUATION OF FUTURE RESEARCH AND DEVELOPMENT DIRECTION

R. J. BORKOWSKI, T. K. STOVALL, R. J. KEDL, and J. J. TOMLINSON Apr. 1982 38 p refs

(Contract W-7405-ENG-26)

(DE82-014656; ORNL/TM-8098) Avail: NTIS HC A03/MF A01

The current state of the art and commercial potential of active solar heating and cooling systems for buildings, and the use of thermal energy storage with these systems are assessed. The need for advanced latent heat storage subsystems in these applications and priorities for their development are determined. Latent storage subsystems are advantageous in applications where their compactness may be exploited. It is suggested that subsystems could facilitate storage in retrofit applications in which storage would be physically impossible otherwise. DOE

N82-33871# Gould, Inc., Rolling Meadows, Ill.

STUDY OF THE FUNDAMENTAL THERMAL-MANAGEMENT ASPECTS OF THE LITHIUM-ALUMINIUM/IRON SULFIDE BATTERY Final Report

H. F. GIBBARD, C. C. CHEN, and D. M. CHEN 15 Jan. 1982 70 p refs

(Contract W-7405-ENG-48)

(DE82-014441; DOE/NBM-2014441) Avail: NTIS HC A04/MF A01

The results of a fundamental study of the rate of internal generation of thermal energy in 200-Ah LiAl FeS cells, and the temperature distribution in a 2.5-kWh LiAl FeS battery under a variety of operating conditions are given. The rate of thermal energy generation was measured by two independent methods. The first is an indirect method, using thermodynamic calculations based on precise measurements of the cell potential as a function of temperature and state of charge, combined with measurements of the cell voltage during discharge at various constant currents. The second is the direct measurement of the rate of heat generation using a new high-temperature battery calorimeter. The results obtained by these two methods are in excellent agreement. A description is presented of the advantages of the calorimetric method of determining internal energy generation rates and thermodynamic functions. Measurements of the surface temperature cells in an operating battery heat-up, discharge and cooling tests are also described. DOE

N82-33872# Pacific Northwest Lab., Richland, Wash.
GEOTECHNICAL ISSUES AND GUIDELINES FOR STORAGE OF COMPRESSED AIR IN EXCAVATED HARD ROCK CAVERNS
 R. D. ALLEN, T. J. DOHERTY, and A. F. FOSSUM Apr. 1982
 160 p refs

(Contract DE-AC06-76RL-01830)
 (DE82-015027; PNL-4180) Avail: NTIS HC A08/MF A01

The results of a literature survey on the stability of excavated hard rock caverns are presented. The objective was to develop geotechnical criteria for the design of compressed air energy storage (CAES) caverns in hard rock formations. These criteria involve geologic, hydrological, geochemical, geothermal, and in situ stress state characteristics of generic rock masses. Their relevance to CAES caverns, and the identification of required research areas, are identified. It is strongly suggested that the chief geotechnical issues for the development and operation of CAES caverns in hard rock are impermeability for containment, stability for sound openings, and hydrostatic balance. DOE

N82-33877# United Engineers and Constructors, Inc., Philadelphia, Pa.

PRELIMINARY DESIGN STUDY OF COMPRESSED-AIR ENERGY STORAGE IN A SALT DOME. VOLUME 1: EXECUTIVE SUMMARY Final Report

Jan. 1982 68 p 7 Vol.
 (Contract DE-AC01-77ET-29332; EPRI PROJ. 1081-2)
 (DE82-008345; DOE/ET-5054/1; EPRI-EM-2210-VOL-1) Avail:
 NTIS HC A04/MF A01

The preliminary design and cost estimate of a compressed air energy storage (CAES) plant located in the Middle South Utilities (MSU) system are summarized. The 220 MWe CAES plant stores air in two solution mined salt caverns. The facility criteria, site selection and the turbomachinery and auxiliaries, and an outline of the proposed procedure for developing the caverns are described. The preliminary CAES plant design was prepared and the capital cost estimate, cash low and project schedule were developed. A CAES plant does not appear to be economic in the MSU system before the mid 1990s which is due to the unique features of the MSU system. DOE

08

GENERAL

A82-39562

FUNDAMENTALS OF ENERGY PRODUCTION

E. L. HARDER New York, Wiley-Interscience, 1982. 383 p.
 refs
 \$39.50

The theory, methods of conversion, and costs of various energy sources, transformations, and production techniques are summarized. Specific attention is given to carbon-based fuels in liquid, gaseous, and solid forms and processes for producing synthetic fuels. Additional details are presented for hydrogen and biomass technologies, as well as nuclear fuel-based electricity production. Renewable energy methods are dealt with in terms of the potentials and current applications of tidal generating stations, hydroelectric installations, solar thermal and electrical energy production, and the development of large wind turbines. Consideration is given to the environmental effects of individual energy technologies, along with associated costs and transportability of the energy produced. M.S.K.

A82-47251

MAKING SPACE WORK FOR MANKIND; PROCEEDINGS OF THE NINETEENTH SPACE CONGRESS, COCOA BEACH, FL, APRIL 28-30, 1982

Congress sponsored by the Canaveral Council of Technical Societies. Cape Canaveral, FL, Canaveral Council of Technical Societies, 1982. 360 p.

Topics in the practical applications of space are discussed. General subjects considered include: space power systems; future Shuttle cargo programs; international Shuttle users; expendable vehicle payloads; space manufacturing operations; commercial space applications; energy choices of the future; special interest topics; space communications. Specific topics addressed include: the European REtrievable CArrier; future military spacecraft power systems; Space Platform solar array; European use of the Space Shuttle; Japanese satellites; the expendable launch vehicle and satellite development; space manufacturing; space manufacturing and the Space Operations Center; the Long Duration Exposure Facility; commerce and remote sensing; robots, progress in renewables; artificial intelligence in space missions; life support system considerations for space station. C.D.

N82-28786*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ROLLING RESISTANCE OF ELECTRIC VEHICLE TIRES FROM TRACK TESTS

M. O. DUSTIN and R. J. SLAVIK Jun. 1982 26 p refs
 Sponsored in part by NASA

(Contract DE-AI01-77CS-51044)
 (NASA-TM-82836; DOE/NASA/51044-24; NAS 1.15:82836)
 Avail: NTIS HC A03/MF A01 CSCL 13F

Special low-rolling-resistance tires were made for DOE's ETV-1 electric vehicle. Tests were conducted on these tires and on a set of standard commercial automotive tires to determine the rolling resistance as a function of time during both constant-speed tires and SAE J227a driving cycle tests. The tests were conducted on a test track at ambient temperatures that ranged from 15 to 32 C (59 to 89 F) and with tire pressures of 207 to 276 kPa (30 to 40 psi). At a contained-air temperature of 38 C (100 F) and a pressure of 207 kPa (30 psi) the rolling resistances of the electric vehicle tires and the standard commercial tires, respectively, were 0.0102 and 0.0088 kilogram per kilogram of vehicle weight. At a contained-air temperature of 38 C (100 F) and a pressure of 276 kPa (40 psi) the rolling resistances were 0.009 and 0.0074 kilogram per kilogram of vehicle weight, respectively. Author

N82-29229# Department of Energy, Oak Ridge, Tenn. Technical Information Center.

ENERGY DATA BASE: SUBJECT THESAURUS PERMUTATED LISTING

Oct. 1981 240 p
 (DE82-005770; DOE/TIC-7000/R5-APP) Avail: NTIS HC
 A11/MF A01

Entry to a large multidisciplinary thesaurus containing both single and multiword descriptors presents problems to the experienced as well as the new user. This permutated listing was prepared to alleviate these problems. Each descriptor was permutated according to each significant word in single and multiword entries and listed alphabetically. This type listing provides the user with the correct thesaurus entry and permits review of generically related descriptors separated by alphabetization in the Thesaurus. DOE

N82-32249# Office of Science and Technology, Washington, D. C.

SCIENCE AND TECHNOLOGY REPORT TO THE CONGRESS: 1981 Annual Report

21 Apr. 1982 174 p Prepared in Cooperation with NSF
 (SU-STAR-4) Avail: NTIS HC A08/MF A01

Progress in science and technology in 1981 is reported. Decisions regarding science and technology policy making are discussed. Federal research and development programs are reviewed. The research and development section of the United States Government Budget for 1983 is analyzed. R.J.F.

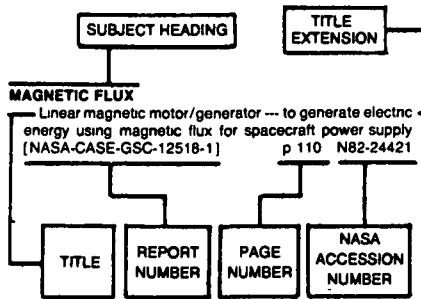
08 GENERAL

N82-32293# Joint Publications Research Service, Arlington, Va.
WEST EUROPE REPORT: SCIENCE AND TECHNOLOGY, NO.
99

9 Apr. 1982 55 p Transl. into ENGLISH from various West
European articles
(JPRS-80536) Avail: NTIS HC A04

New articles announcing recent European technological
developments are presented.

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title, and title extension if used, 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 page and accession numbers are located beneath and to the right of the title. Under any subject heading the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

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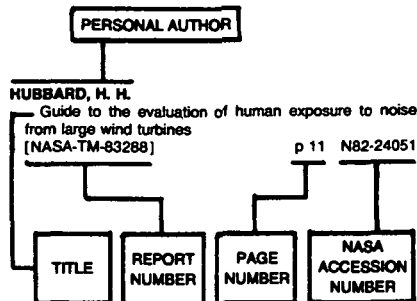
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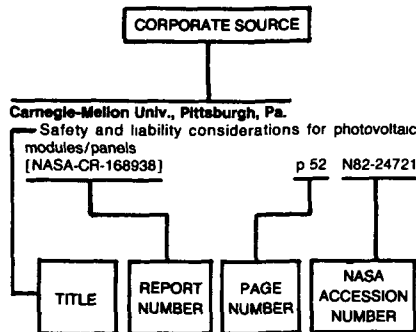
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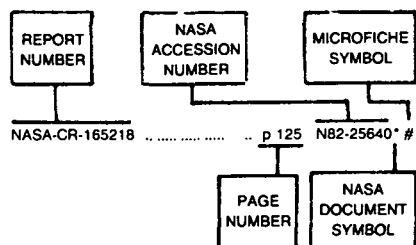
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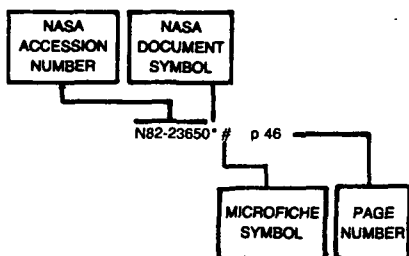
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