LIFE AND STABILITY TESTING OF PACKAGED LOW-COST ENERGY STORAGE MATERIALS

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PROJECT OUTLINE

Project Title: Life and Stability Testing of Packaged Low-Cost Energy Storage Materials

Principal Investigator: G. R. Frysinger

Organization: Institute of Energy Conversion
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Project Goals: Verify package integrity of the "chub" packaged materials system for storage of coolness with application to residential air conditioning; verify life and stability of packaged material by cycling and performance testing.

Determine that the moisture vapor retention characteristics of laminate film developed by DuPont is satisfactory for long-term chub performance. Determine stability, mechanical integrity, and thermal performance of chubs following mechanical shock, vibration, and temperature extremes. Carry out thermal performance tests of chubs following accelerated and dirunal thermal cycling.

Project Status: Activity has been completed. Based on acceptable moisture retention data, a thin film laminate was selected for the chubs. A 204-lb batch of chubs was cycled 405 times on an accelerated schedule. After cycling the heat of fusion was about 70 BTU/LB based on a 30°F temperature swing.

Contract Number: UCC 7585

Contract Period: September 1978 to November 1979

Funding Level: $146,000

Funding Source: Oak Ridge National Laboratory

PROJECT SUMMARY

Project Title

"Life and Stability Testing of Packaged Low-Cost Energy Storage Materials"

Name of Contractor:

Institute of Energy Conversion
University of Delaware
Newark, Delaware 19711

Name of Principal Investigator:

Dr. Galen R. Frysinger, Manager, Energy Systems

Current Contract Period:

September 1, 1978 - September 30, 1979

Objective:

The package integrity of the "CHUB" packaged materials was tested to experimentally verify the ability of the package to retain the moisture within the salt mixture. The life and stability of the packaged material was verified by thermal cycling and performance measurement.

Project Status:

Final report was submitted to Department of Energy on September 25, 1979, in draft form for review. Expected to be available for public distribution in early 1980.

Funding Level:

$146,000.00

Funding Source:

Department of Energy, Division of Energy Storage Systems.

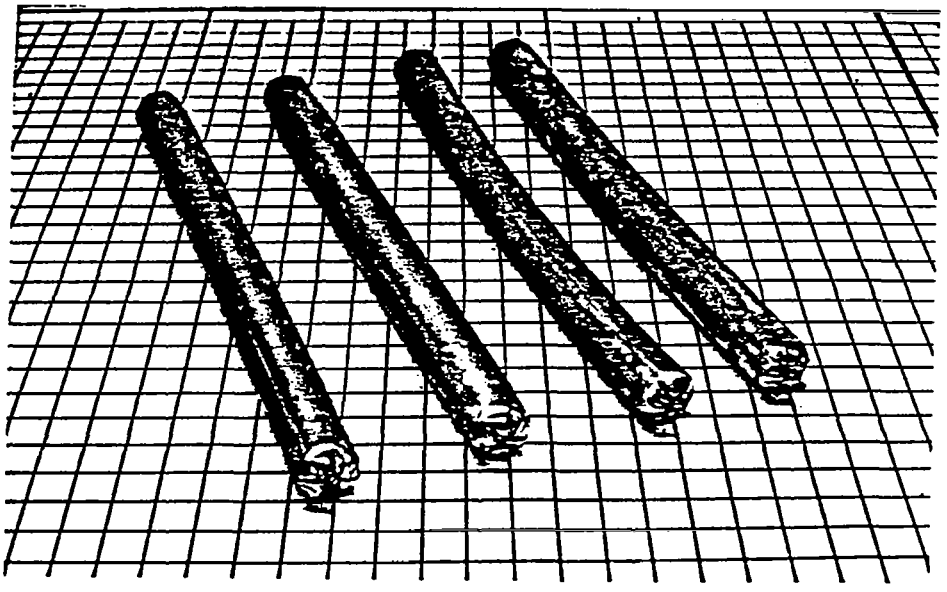
Concept of Thermal Energy Storage System

The "CHUB" (see first illustration) low-cost thermal energy storage component has a wide range of applications as an air stream integral heat exchange/storage unit. The second illustration indicates examples of storage assisted air conditioning and heat pump applications which make effective utilization of off-peak electrical power for heating/cooling thus saving the utility fuel and generation facility costs. The "CHUB" may also be used with active air solar collector systems for daytime storage of heat to provide extended house heating during periods of no solar insolation. Likewise, as a passive solar system, the "CHUBS" can be directly irradiated by solar energy, thus storing the thermal energy for later use within the dwelling. The "CHUBS" also can be used to store heat in the dwelling to increase the thermal mass by phase change transition.

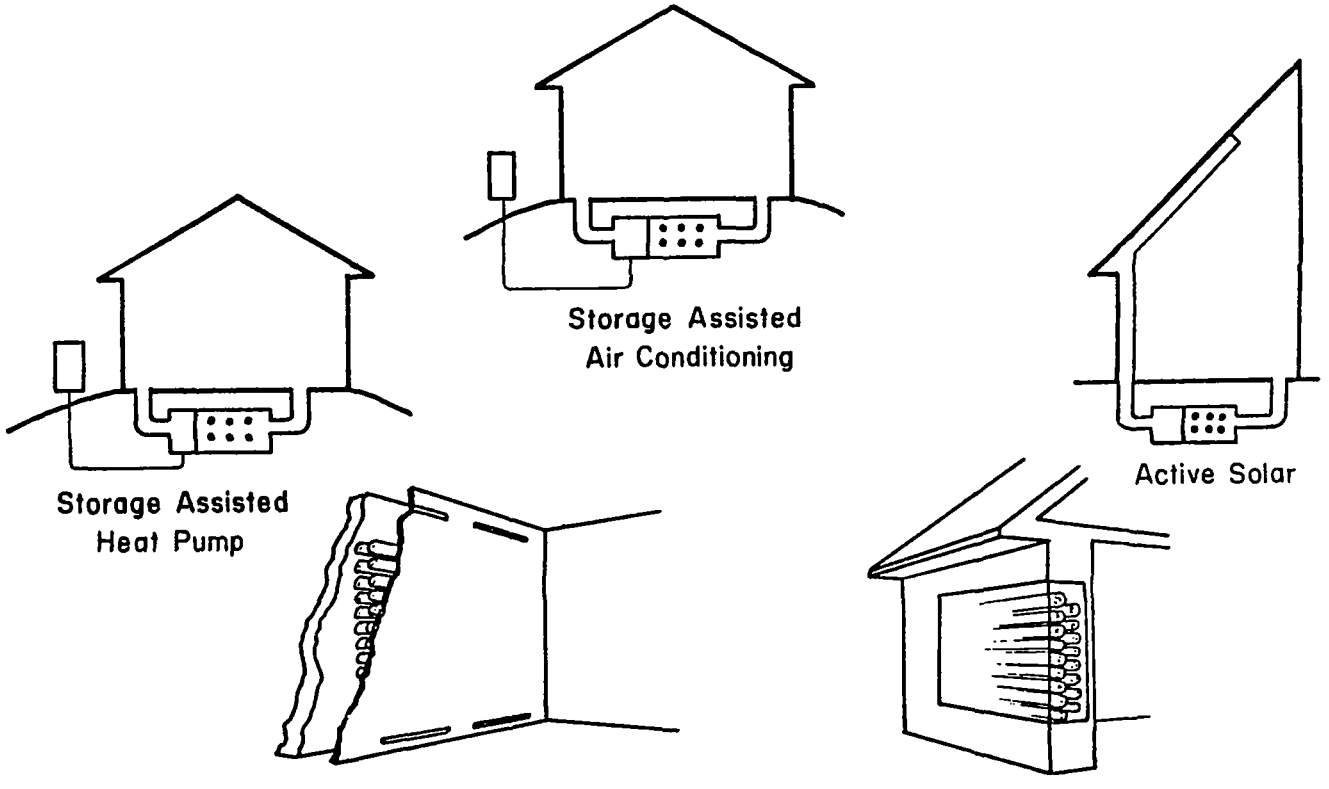
The application which is closest to commercialization integrates the thermal energy storage with a conventional air conditioner providing the capability of using off-peak electrical power for residential cooling. The daily house heat gain is removed into thermal storage. The heat is rejected at night by the air conditioner using off-peak (lower cost electricity), the heat being more efficiently rejected against the lower outside ambient temperature. The thermal energy storage capacity is thus renewed to absorb the next day's heat gain. The net result from the utility's point of view is that the air conditioning compressor's electrical demand is shifted from the daytime hours to nighttime hours where the utility load demand is reduced.

CHUB Qualification

The qualification of the "CHUB" thermal energy storage component by the University of Delaware, with the assistance of the Du Pont Company, was the objective of this contract from 1 September 1978 to 30 September 1979. Based on extensive laboratory verification of moisture vapor retention, a thin film laminate was specified having the characteristics required for successful containment of the Glauber's salt (sodium sulfate decahydrate) thermal energy storage materials over an operating life of 10-15 years. Significant test quantities of the qualified "CHUBS" were prepared at a



Chub Applications



prototype fabrication facility set up and operated at the University of Delaware in June 1979. The "CHUBS" produced at this facility met and exceeded the moisture vapor retention characteristics determined in earlier laboratory testing. The thin film plastic laminate (4 mils) is capable of retaining the thermal energy storage mixture so that extrapolated room temperature weight loss is only about 0.92% in ten years, corresponding to a theoretical efficiency reduction due to water loss of only 2.0% over this operating period. The packaging was shown to be capable of meeting fabrication quality assurance standards, as well as the package integrity tests required to ensure viability during field handling and use. The laminate specified has been shown to be successful as a thermal energy storage packaging material capable of being used in high-speed machinery from the food processing industry for the commercial packaging of the "CHUBS". With the availability of the "CHUBS" from the University of Delaware's prototype fabrication facility in June 1979, long-term performance testing of the packaged thermal energy storage materials was possible. This was initiated and extended through the duration of the contract to verify packaging integrity and also to obtain significant long-term performance data for the Glauber's salt behavior. Heretofore, this performance data analysis had been obscured because of the deficiencies of previously used commercial-type packaging. Laboratory results had given indication of performance but without the realistic field containment methods and a stabilization of the long-term moisture balance changes, the data were erroneous because they were taken on a constantly changing composition. Since the "CHUB" packages eliminate this problem, the results from the present tests should have significantly increased validity.

The daily cycle tests and the accelerated tests (six cycles per day) initiated with the availability of the qualified material in June 1979 have led to preliminary results verifying long-term performance behavior. The performance after 400 cycles was verified before the completion of the contract work period at the end of September. Air calorimeter tests indicated a total thermal energy storage capacity at the end of 405 cycles of 70-75 Btu's per pound which includes contributions for specific heat over the normal operating range of 30°F and the latent heat at the transition point.