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TITLE: COLLECTOR RESEARCH AND DEVELOPMENT

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MASTER

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COLLECTOR RESEARCH AND DEVELOPMENT*

LOS ALAMOS NATIONAL LABORATORY

DONALD A. NEEPER

W-7504-ENG-36

ABSTRACT

Current solar collector research of the Los Alamos National Laboratory is described. The document is divided into three sections dealing with the three aspects of the program: reliability and maintainability, optical materials, and evacuated tube collector testing.

I. RELIABILITY AND MAINTAINABILITY (John Avery)

OBJECTIVE

The objective of this work is to provide meaningful and useful solar reliability and maintainability information on corrosion of metallic components of solar collectors and the performance of various heattransfer fluids.

DESCRIPTION OF WORK

This task involves generation of both laboratory and field data regarding corrosion and fluids of interest to active solar applications. The real-time field data collected by Los Alamos will be used to validate the results of existing and continuing DOE-funded research and development projects. A subsequent report will supply needed information on fluid and hardware lifetimes.

The laboratory data generated by Olin Corporation under DOE Contract DE-AC04-81AL16222, consist of screening tests on more than 150 metal/fluid combinations: Cu, Al, steel, galvanic couples and solder joints, with various waters, glycols, and aqueous heat-transfer fluids.

The field data come from field sites specially instrumented to obtain data relevant to corrosion. Corrosion coupons and fluids will be withdrawn every 6 months and evaluated. Figures 1-3 show the collector array and corrosion coupons to be studied at the Los Alamos National Laboratory's newly constructed Support Facility.

FUTURE ACTIVITIES

Fluid and hardware lifetime data will be supplied to the private sector as the information becomes available.

MAJOR MILESTONE

State-of-the-art report on corrosion.

II. OPTICAL MATERIALS (Stanley Moore)

OBJECTIVE

The objectives of the optical materials investigation include operation of a high-altitude, materials exposure facility; investigation of chemical conversion coatings for passive or low-temperature selective surface applications; and determination of collector materials durability and reliability.

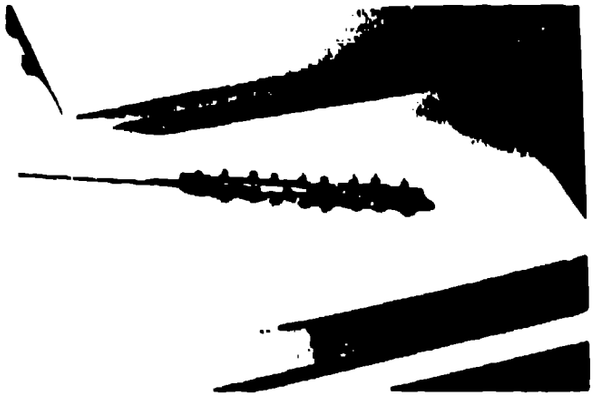

Fig. 1. Removable corrosion coupons

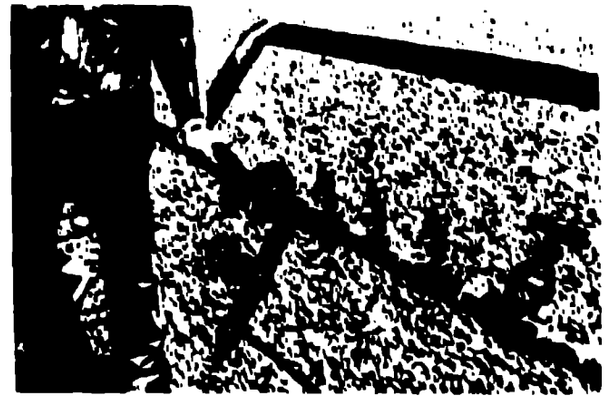

Fig. 2. Location of corrosion coupon rack

*Work performed under the auspices of the US Department of Energy, Office of Solar Applications for Buildings.

Fig. 3. Location of manifold in solar installation plumbing

DESCRIPTION OF WORK

A high-altitude exposure facility complements the environmental regional testing in desert control and industrial environments. Both developmental and commercially available glazings, reflectors, and absorber materials are being tested at this facility. Types and rates of degradation will be determined.

Chemical conversion coatings offer the promise of providing inexpensive selective absorbers for low-temperature and passive applications. A general study has been undertaken to determine prospective coatings followed by detailed optimization and environmental testing.

TECHNICAL ACCOMPLISHMENTS

- The high altitude exposure facility has been completed, instrumented, and is operational. The first round of Solar Energy Research Institute/Desert Sunshine Exposure Tests (SERI/DSET) commercially available materials is on test. Developmental materials are being installed.
- Chemical conversion solutions and substrate materials consisting of aluminum, zinc, cadmium, copper, stainless, galvalume and aluminized nylon have been procured. Screening samples of aluminum and copper have been prepared, and optical evaluation is under way.
- A 5-year stagnation test on black chrome selective absorber collectors has been completed. Optical evaluation has shown no degradation in either solar absorptance or emittance.
- A status report covering the progress of the DOE programs on painted coatings has been completed and is being published.
- Anti-reflectance-treated glass, etched by Honeywell/Nor-El1, Inc., is undergoing outdoor exposure testing. Neither the AFG Solatex nor the CR Heliotherm has shown any loss in transmittance after exposures of 10 months and 5 months, respectively.

FUTURE ACTIVITIES

Topical reports covering the detailed results of the black chrome and absorber paint durability evaluations will be published and made available for commercial evaluation and use.

PUBLICATIONS/REPORTS/REFERENCES

S. K. Reisfeld and D. A. Neeper, "Solar Energy Research at Los Alamos: April 1, 1980 - September 30, 1980, Los Alamos National Laboratory Report LA-8782-PR.

III. EVACUATED TUBE COLLECTOR TESTING (John Krall)

OBJECTIVE

The objective of this work is to test and evaluate the use of heat pipes configured in evacuated tube solar collectors.

DESCRIPTION OF WORK

Two evacuated tube collector modules were tested. One module employs heat pipe absorbers designed and built by Thermacore, Inc., under D Contract DE-AC04-77CS34099. The 5/16-in. steel heat pipes with the trimethylborate working flu replaces the hai-pin absorber of the standard General Electric evacuated tube collector. The heat pipes are brazed to the standard two-piece copper fin. The second module is a standard, 8-tube, parabolic cusp reflector, General Electric TC-100 collector.

The initial test objective was to duplicate and analyze apparent sporadic behavior of the heat pipe collector observed by General Electric. The sporadic behavior could not be duplicated, and we concluded that it resulted from the testing arrangement at the General Electric facility. The evacuated tube modules were tested side by side in parallel test loops using 100% glycol as the loop working fluid. Since the efficiency data were generated utilizing 100% glycol, the presented results should be used only for comparison and not for absolute efficiency data. Figures 4-6 show performance test data.

Both collector modules were also stagnated, and a brief study of oxidation of the copper absorber fin was conducted for comparison with observations of corrosion in collectors in the field. One collector was tested with the copper absorber fins removed to determine the worst case, i.e., the copper absorber fins had corrod completely away. Observed oxidation after two days of stagnation revealed that loose scale (Cu_2O or CuO) 1-mil thick had developed on a previously cleaned area on the copper fins and the general appearance of the majority of tubes was that of loose curled-up scale of a larger magnitude than that observed prior to the two-d stagnation. It is expected that because of the lower stagnation temperatures of the heat pipe collector, oxidation rates on the copper fins will be decreased.

Thermacore's latest copper heat pipes with water as the working fluid are currently being tested and evaluated, and the results will be compared to Thermacore's steel-trimethylborate heat pipes.

Additionally, Philips' evacuated tube heat pi collector is being tested and evaluated.

TECHNICAL ACCOMPLISHMENTS

- The GE-TC-100 evacuated tube collector configured with heat pipes (Fig. 4) was shown to have an efficiency comparable to that of the standard GE-TC-100 (Fig. 5) in the normal operating range.

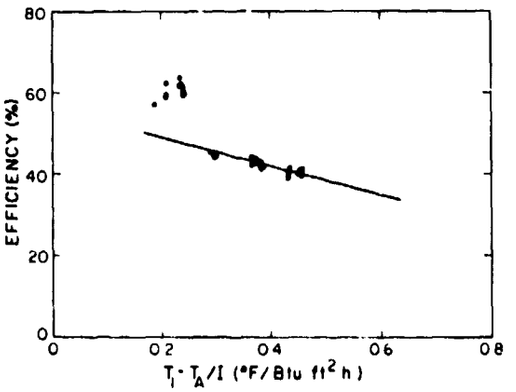

Fig. 4. GE-TC-100 evacuated tube collector configured with Thermacore heat pipes.

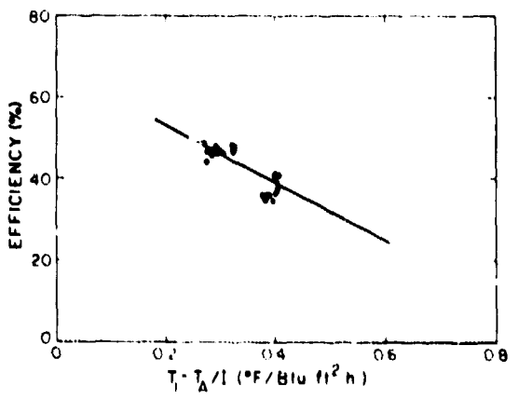

Fig. 5. Standard GE-TC-100 evacuated tube collector

- Stagnation temperatures of the GE-TC-100 evacuated tube collector configured with heat pipes are lower than stagnation temperatures of the standard GE-TC-100. Our tests under 300 Btu/ft^2 insolation at an ambient temperature near 80°F showed that the fin in the standard GE-TC-100 reached a temperature of 742°F. The heat pipe absorber fins remained considerably cooler. The range of temperatures on the heat pipe fins was 430-700°F.

- The removal of the heat conducting fins reduced the efficiency of the heat pipe, evacuated tube collector by 14% (Fig. 6).

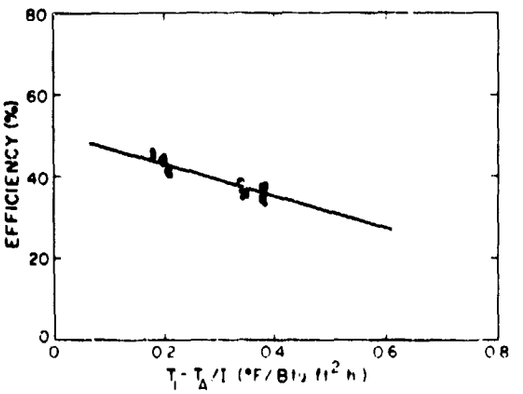

Fig. 6. GE-TC-100 evacuated tube collector with fins removed

FUTURE ACTIVITIES

Thermacore's new copper heat pipe with water as the working fluid will be evaluated and compared to the steel heat pipe with trimethylborate as the working fluid. The Phillips evacuated tube collector configured with copper heat pipes and isobutane as the working fluid will be tested and evaluated.

CONTRACT INFORMATION

START DATE October 1, 1980 END DATE Continuing CONTRACT VALUE $220k

MILESTONES

Item:	Due date:
1. Deliverables include progress reports and topical reports on materials investigations and exposure testing results.	As needed
2.	
3.	
4.	
5.	