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STANDARDIZED PERFORMANCE TESTS OF COLLECTORS OF SOLAR THERMAL ENERGY - A FLAT-PLATE COPPER COLLECTOR WITH PARALLEL MYLAR STRIPING

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16. Abstract

This preliminary data report gives basic test results of a flat-plate solar collector whose performance was determined in the NASA-Lewis solar simulator. The collector was tested over ranges of inlet temperatures, fluxes and one coolant flow rate. Collector efficiency is correlated in terms of inlet temperature and flux level.

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INTRODUCTION

An area that has been investigated by the NASA Lewis Research Center in its efforts to aid in the utilization of alternate energy sources is the use of solar energy for the heating and cooling of buildings. An important part of this effort was the evaluation of solar collectors which have the potential to be efficient, economical, and reliable.

This preliminary data report gives basic test results of a collector whose performance was determined in the NASA-Lewis solar simulator. In the interest of providing performance data on this collector to the technical community as quickly as possible, the basic test results reported herein are presented without evaluation. Detailed analyses and interpretation of these results may be presented in subsequent papers or reports by this Center. Some of the results contained in this report may be changes as warranted by reviews and evaluations, or by obtaining additional data on this collector.

Reference 1 describes the solar-simulator test facility, as well as the basic test procedure.

COLLECTOR DESCRIPTION

This collector (the SS-6) was made by Sunsav, Inc. of Lawrence, Massachusetts. It consists of a copper roll bond absorber plate with an

STAR Category 44

absorber area of 19.38 sq ft. Black paint is utilized as the absorber coating. Mylar strips running the width of the collector are installed to decrease convection and reradiation losses. These mylar strips are 4 inches deep and are 3/8 of an inch apart. The collector housing is aluminum and has a single glass cover. The insulation of the collector is composed of several inches of glass wool and polyurethane. A photograph of the collector on the test stand is shown in figure 1.

COLLECTOR TEST RESULTS

Basic test results are given in Table I. Since this collector was larger than the area of radiation provided by the solar simulator, it was necessary to use a "shield" approach as explained in Reference 1. This technique allows one to determine the efficiency of the entire collector even though only a portion of it is actually exposed to radiation. By using the analytical method outlined in Reference 1 for a collector tested with a "shield", the results given for the flow rate in Table I were used for a determination of the performance correlation given in Figure 2.

In addition to the basic test performed on the collector, a series of incident angle tests were run to help predict the effect the mylar strips might have on collector performance for daily and seasonal changes of sun incidence angle. Table II lists the collector efficiency, at various rotation and incidence angles, along with $K_{\alpha\tau}$ values. One analytical method for interpreting and using this data can be found in Reference 1.

REFERENCE

1. Simon, Frederick F.: Flat-Plate Solar-Collector Performance Evaluation with a Solar Simulator as a Basis for Collector Selection and Performance Prediction. NASA TM X-71793, 1975.

TABLE I. - BASIC EXPERIMENTAL DATA

[50/50 Water and ethylene glycol; incident angle = 0°; tilt angle = 57° above horizontal.]

Flow per radiated surface area, lb/hr ft^2	Flow, gal/min	Incident radiation flux, Btu/hr ft^2	Fluid outlet temperature, $^{\circ}F$	Fluid inlet temperature, $^{\circ}F$	Ambient temperature,	Efficiency
19.194	0.35785	182.03	92.368	83.761	83.761	0.74423
19.232	.35845	265.66	97.239	84.211	84.387	.77469
18.981	.35632	186.86	125.61	120.46	85.851	.43823
19.170	.35983	270.93	129.58	120.14	86.491	.55968
18.681	.35616	184.52	161.29	160.54	80.497	.64758E-01
18.763	.35758	274.03	164.96	159.86	80.827	.29982

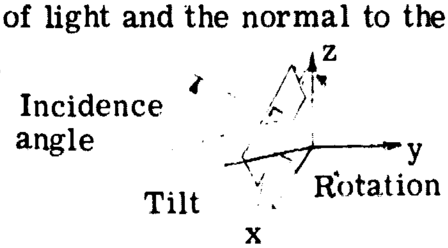
TABLE II. - INCIDENT ANGLE MODIFIER DATA

Tilt angle[a]	Rotation angle[b]	Incidence angle[c]	Efficiency	$K_{\alpha\tau}$
15°	0°	42.0	0.690	0.915
	30	7.7	.467	.619
	50	12.7	.447	.593
	70	17.2	.396	.525
	80	19.2	.379	.503
30°	0	27.0	0.701	0.930
	30	14.9	.592	.785
	50	24.4	.532	.706
	70	33.3	.470	.623
	80	37.5	.424	.562
45°	0	12.1	0.694	0.920
	30	21.1	.678	.899
	50	34.8	.743	.985
	70	47.9	.508	.674
	80	54.1	.435	.577
57°	0	0	0.754	1.0
	30	25	.713	.946
	50	41.4	.680	.902
	70	57.4	.603	.800
	80	61.9	.475	.630

[a] Tilt angle - the angle between the horizontal and the plane of the collector.

[b] Rotation angle - the angle that is measured in relation to the x-axis when the collector is rotated around the z-axis.

[c] Incidence angle - the angle that is measured between the beam of light and the normal to the plane of the collector.



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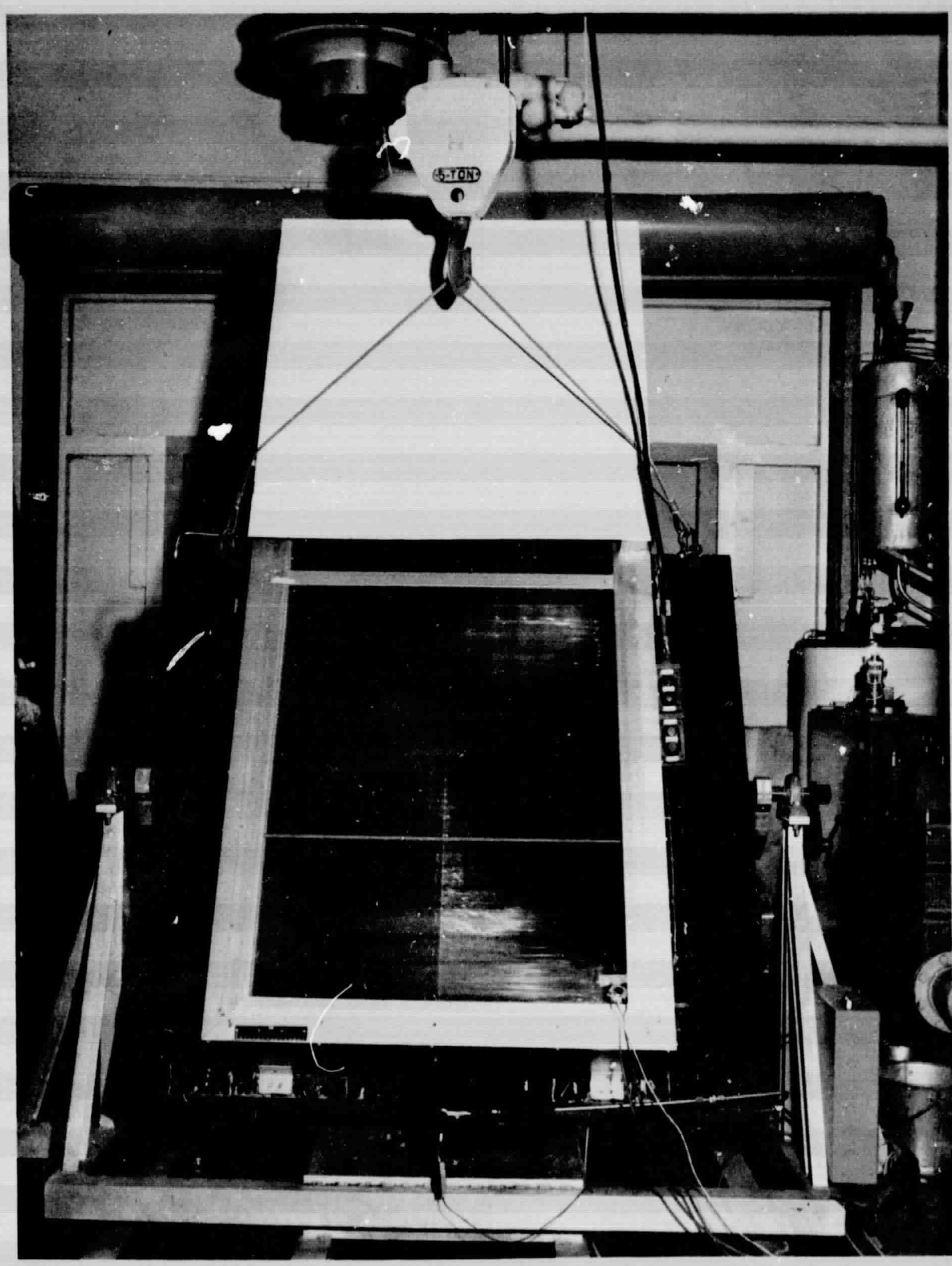

Figure 1. - Collector on Test Stand

COLLECTOR EFFICIENCY (η) AS A FUNCTION OF FLUID INLET TEMPERATURE (T_i) AND INCIDENT FLUX (q_i)

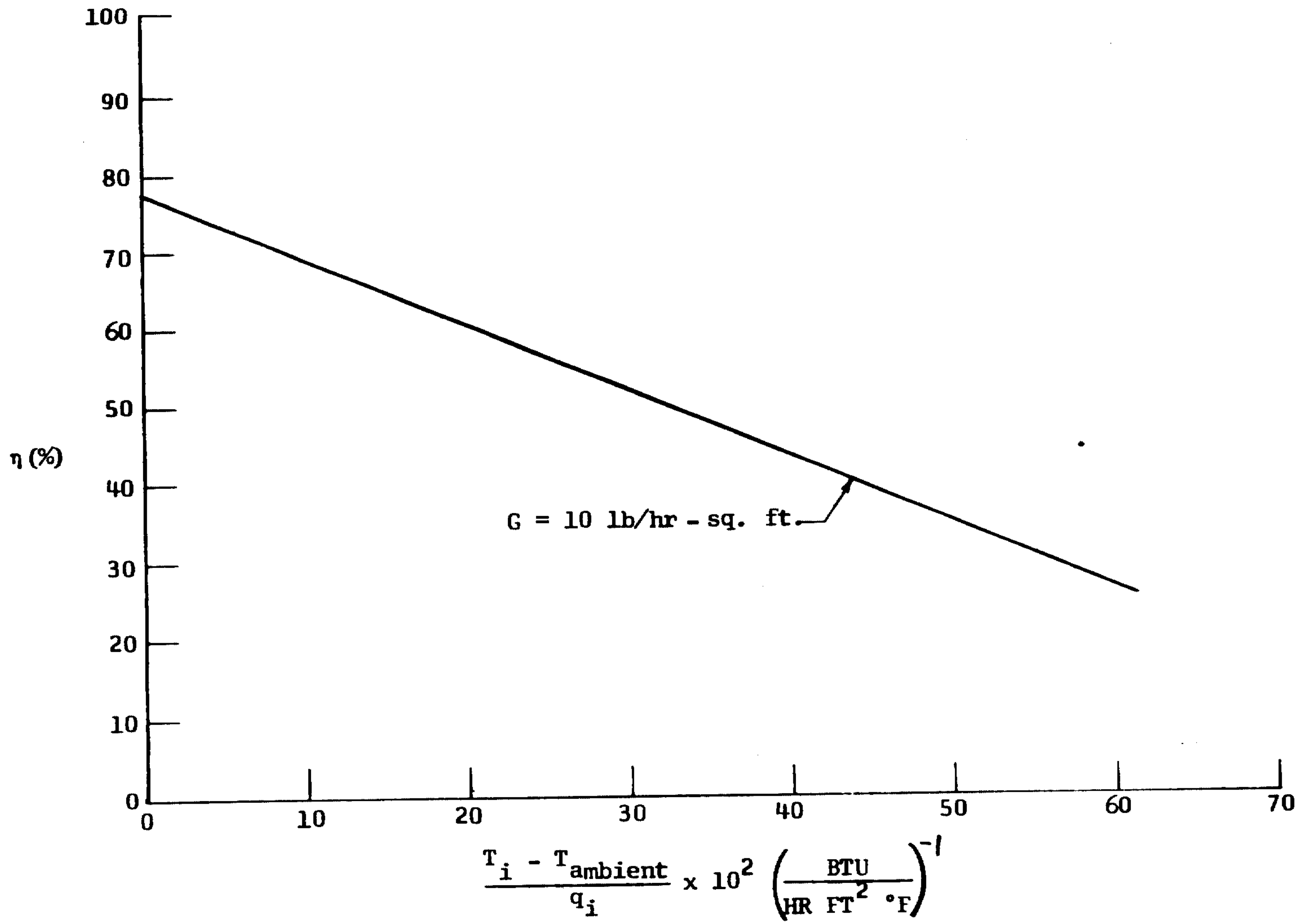

Figure 2.- Collector Performance Correlation