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PERFORMANCE TESTING AND CLASSIFICATION OF FLAT-PLATE SOLAR COLLECTORS

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PERFORMANCE TESTING AND CLASSIFICATION OF FLAT-PLATE COLLECTORS

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Summary

The objectives if this project are:

1.To study the ISO Standard concerning the performance characteristics of flat-plate solar collectors.

2.To identify the parameters affecting the thermal performance of flat-plate solar collectors.

3.To carry out experimental tests and investigate the thermal performance characteristics, the incidence angle modifier and the pressure drop, for different types of flat-plate collectors, using the methods described in the ISO Standard.

4.To classify the tested collectors according to their performance.

The tests were conducted at the Applied Energy Centre of the Ministry of Commerce, Industry & Tourism.

NOMENCLATURE

Symbol	Meaning	Units
A_A	Absorber area of collector	m^2
A_a	Aperture area of collector	m^2
A_G	Gross area of collector	m^2
c_f	Specific heat capacity of heat transfer fluid	J/kg K
F_R	Collector heat removal factor	
G	Global solar irradiance	W/m^2
K_θ	Incident angle modifier	
m	Mass flowrate of working fluid	kg/s
Q	Useful power extracted from collector	W
Ta	Ambient air temperature	^oC
Tout	Collector outlet temperature	^oC
Tin	Collector inlet temperature	^oC
Tm	Mean temperature of heat transfer fluid	^oC
U	Overall heat loss coefficient of collector	W/m^2
K		
α	Solar absorptance	
τ	Transmittance	

INTRODUCTION

One of the most essential components, unique to an active system, is the collector. Its function is to absorb the incoming solar radiation, convert it into heat at the absorbing surface, and transfer this heat to a working fluid (usually air or water) flowing trough the collector.

The solar collectors are classified into two main groups:

(i) Concentrating collectors, in which large areas of lenses or mirrors focus the sun-light onto a small absorber to collect heat and produce high temperatures.

(ii) Flat plate collectors, in which both the diffuse and direct beam solar radiation is absorbed. A flat-plate collector receives the solar energy and converts it into heat by absorbing the solar radiation in a black metal surface.

Flat-plate collectors have several advantages over other types of solar energy collectors:

(a) they absorb direct, diffuse and reflected components of solar radiation.

(b) they are fixed in tilt and orientation and thus there is no need of tracking the sun.

(c) they are easy to make and low in cost.

(d) they have comparatively low maintenance cost and long life.

(e) they operate at a comparatively high efficiency

Flat-plate collectors can also be classified into three groups according to their main applications as follows:

(a) Applications with a very small rise in temperature, such as in swimming pools where the collector needs no cover or insulation at the back or sides, and high flow rate is maintained to limit the temperature rise less than 2°C.

(b) Domestic heating and other applications where the maximum temperature required is not greater than 60°C.

(c) Applications such as process heating, which temperatures conciderably above 60°C are required.

A flat-plate collector consists of seven main components.

1. Absorber plate: The primary function of the absorber plate is to absorb as much as possible of the radiation reaching through the glazing. Also it must loose as little heat as possible, and transfer the retained heat to the working fluid. Absorbers are usually made of copper, aluminium or steel. Factors that determine the choise of absorber material are thermal conductivity, durability and ease of handling, availability and cost, and the energy required to produce

it. Also, in order to increase the fraction of available solar radiation absorbed by the plate ,a surface coating is usually given to the absorbed plate.

2. Tubes or fins:These are use2 2. Tubes or fins:These are used to direct the outlet.There are a number of tubes designs used in collector plates. A very serious problem in liquid type collectors is corrosion. In order to prevent corrosion is best to use copper pipes eventhough copper is not corrosion free, but is the most safe material to be used.

3. Glazing: The function of glazing is to admit as much radiation as possible and to reduce the upward loss of heat to the lowest attainable value. Also it keeps wind and natural condensation from robbing heat from the absorber plate. One or more transparent covers may be used on a collector. Materials used for glazing are glass or plastic.

4.Insulation: This reduces conduction and convection losses through the back and sides of the casing. The insulation material should be dimensionally and chemically stable at high temperatures, and resistant to weathering and dampness from condensation. Materials most widely used as insulation are various types of fiberglass and polyrethane.

5.Air space: Air space between the absorber plate and the glazing is needed in order to reduce the heat losses by conduction. Air space usually varies between 12 to 25mm.

6.Cover strip: This is needed for holding all the components in position and for making the whole assembly watertight.It should be of non corrosive materials.

7.Casing: It is used for supporting the rest of the components and keeping them free from dust, moisture, wind e.t.c.It is made of non corrosive materials, usually aluminium or zing.