Experimental Investigation of Outlet Water Temperature of Solar Flat Plate Collector & Comparison of efficiency of Single Glass Cover with Double Glass Cover

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***Abstract -** Solar energy is conventional energy source available at comparatively low cost and high capacity in these days. The objective of this project is to compare the efficiency of single and double glass cover solar flat plate collector on the basis of various mass flow rates. Project work is continuous in the field of cover material, observer plate material, double glass coating along with the changes in the design consideration. We obtain high temperature outlet water at low mass flow rate. We have found that the efficiency in case double glass cover flat plate collector is more than that of single glass cover flat plate collector.*

Key words: **Mass flow rate, Cover material, Observer plate material, Double glass, Conventional energy source.**

1. INTRODUCTION

Solar radiation is an alternative energy source for numerous industrial and domestic applications. One of the simplest and most direct applications of this energy is the conversion of solar radiation into heat. Hence the domestic sector can lesson its impact on the environment is by the installation of solar flat collector for heating water. Its thermal performance and efficiency which depends on its design parameters, thickness, type of insulation, number and type of glass covers, spacing between absorber and inner glass. Apart from these parameters its performance also depends on climatic and operational parameters. The objective of the study is to conceive a cheap and efficient flat plate solar water heater. The work focuses mainly on the increasing the performance and efficiency of the solar water heater. This is the most economical and large scale use of solar energy all over the world. This energy is very large, inexhaustible source of energy. The flat plate collector one of the main solar energy conversion devices is most widely used because it is simple in design, has no moving parts and requires a little maintenance.

Due to energy crisis worldwide of renewable energy sources particularly solar energy use in the environment depends upon type of application and one of the most common applications of solar energy at low temperatures is heating of water for useful purposes. Heating water for domestic purpose is a simple and effective way of utilizing solar energy.

1.1 Solar Collectors:

Solar collectors are the main component of active solar heating system. They absorb the sun`s energy, transform its radiation into heat, and then transfer that heat to a working fluid (usually water or air). A solar collector is a device for collecting solar radiation and transfer the energy to a fluid passing in contact with it. Utilization of solar energy requires solar collectors.

1.1.1 Flat Plate Collectors

Flat plate can collect and absorb both direct and diffuse solar radiation; they are consequently partially effective even on cloudy days when there is no direct radiation. Flat plate solar collectors may be divided into two main classifications best

On the type of heat transfer fluid used.

1.1.2 Liquid Flat-Plate Collectors

The basic parts that make up a conventional liquid flat plate collector are:

- The absorber plate,
- The tubes fixed to the absorber plate through which the liquid to be heated flows.
- The transparent covers and
- The insulated container.

The main advantage of a flat plate collector is that it utilizes both the beam and diffuse components of the solar radiation. In addition, because of its simple stationary design, it requires little maintenance. Its principal disadvantage is that because of the absence of optical concentration, from which heat is lost is large. As a result, the collection efficiency is generally low. In some designs, the tubes are bonded to the top or in- line and integral with the absorber plate. The metal most commonly used, both for the absorber plate and the tubes, is copper. The header pipes, which lead the water in and out of the collector and distribute it to the tubes, are made of the same metal as the tubes and are of slightly larger diameters (2 to 2.5 cm).

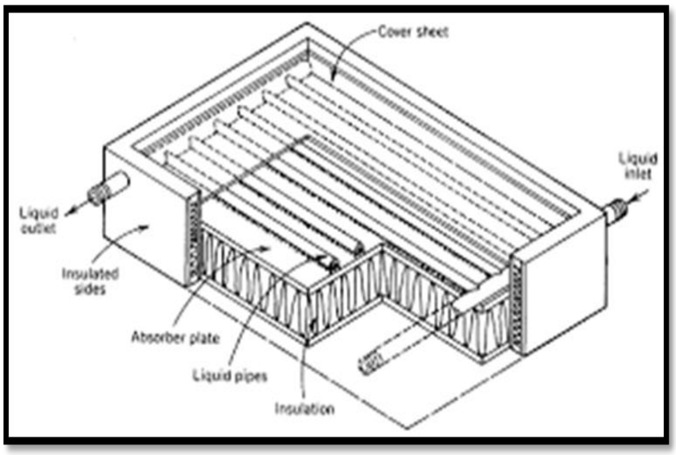

Fig -1: Liquid Solar Flat Plate Collector

1.2 Objectives

- To study and analysis elements of solar water heater.
- To study the principle of conversion of solar energy into heat energy.
- To understand and study the angle of inclination for maximum efficiency.
- To understand the co-relation between various parameter for finding the efficiency.
- To study the losses occurred in solar water heater.

2. METHODOLOGY AND EXPERIMENTAL SETUP

2.1 Test equipment

The equipment that is used for experiments and analysis of these is given below

2.1.1 Pyranometer

A pyranometer is a type of actinometer used for measurement solar irradiance on a planar surface and it is designed to measure the solar radiation flux density (w/m^2) from the hemisphere above within a wavelength range 0.3 um to 3 um. The name pyranometer stems from the Greek words pyr, meaning "fire", and ano, meaning "above sky".

2.1.2 Procedure

The pyranometer put on the collector and the sensor are set to the direction of the son which sense the solar radiation and display the digital meter. The unit of solar intensity w/m^2.

2.1.3 Thermometer

A thermometer is a device that measure temperature or a temperature gradient. A thermometer has two important elements (1) a temperature sensor in which some change occurs with change in temperature and (2) some means of converting this change into a numerical value (e.g. the visible scale that is marked on mercury in glass thermometer.

2.1.4 Procedure

The thermometer used to take riding inlet value temperature and also used to take reading of single glass and double glass temperature.

2.2 Experimental Setup

One of the probes is attached in the inlet and another in the outlet of the evacuated tube solar water heater. The insulating material used coconut coir to overcome a top, bottom, and side edges heat loss. One long flexible pipe are used to connect inlet valve to water flow in the collector and another side out let side 20L bucket are used to collect outlet hot water temperature are taken hourly interval basis in a day from 9am to 5pm. First of all we are taken a different mass flow rate and the same mass flow rate we measure single glass flat plate collector and double glass flat plate collector.

Fig -2: Experimental Setup

3 OBSERVATION & CALCULATION

Table: 3.1 Observations for Mass Flow Rate

S.N.	Volume of water bucket (L)	Time Taken To Fill A Bucket	Mass Flow Rate
1.	20	8:20	0.0396
2.	20	9:10	0.036
3.	20	10:20	0.033
4.	20	11:20	0.029

Table: 3.2 Reading for Single Glass

Date: 09/02/2018 Mass Flow Rate ($\dot{m}$) = 0.0396

S. N.	Time in hrs (T)	Solar Intensity in W/m² (I_S)	Inlet Temp. (T_I)	Outlet Temp. (T_O)	Heat Input (Q_{in})	Heat Output (Q_{out})	Efficiency (η)
1.	09:00 am	570	27°C	27°C	1170	725	61.95
2.	10:00 am	670	28°C	28°C	1315	859	65.29
3.	11:00 am	770	30°C	30°C	1516	1060	69.94
4.	12:00 noon	820	32°C	32°C	1627	1246	76.57
5.	01:00 pm	832	33°C	33°C	1899	1486	78.27
6.	02:00 pm	818	31°C	31°C	1923	1422	73.94
7.	03:00 pm	760	30°C	30°C	1716	1169	67.62
8.	04:00 pm	620	29°C	29°C	1581	1023	64.68
9.	05:00 pm	560	28°C	28°C	1448	877	60.58

Table- 3.3 Reading for Double Glass

Date: 15/02/2018 Mass Flow Rate ($\dot{m}$) = 0.0396

S. N.	Time in hrs (T)	Solar Intensity in W/m² (I_S)	Inlet Temp. (T_I)	Outlet Temp. (T_O)	Heat Input (Q_{in})	Heat Output (Q_{out})	Efficiency (η)
1.	09:00 am	660	28°C	33°C	1129	1671	67.56
2.	10:00 am	715	29°C	36°C	1160	1593	71.56
3.	11:00 am	795	31°C	40°C	1312	1772	74.05
4.	12:00 noon	842	33°C	42°C	1492	1876	79.51
5.	01:00 pm	925	34°C	43°C	1672	2061	81.10
6.	02:00 pm	830	32°C	41°C	1452	1850	78.49
7.	03:00 pm	750	30°C	38°C	1146	1571	72.94
8.	04:00 pm	710	28°C	35°C	1105	1582	69.86
9.	05:00 pm	630	27°C	32°C	919	1404	65.44

3.4 Sample Calculations

Efficiency (η) = Q_{out} / Q_{in}

Where,

$Q_{out} = \dot{m}_w * c_p * \Delta T$

$\dot{m}_w$ = mass flow rate of water

C_p = specific heat of water

ΔT = temperature difference

Q_{in} = area $\times I_s$ (solar intensity)

4. RESULTS AND DISCUSSION

4.1 Results

The performance of these both single glass solar flat plate collector and double glass solar flat plate collector was determined at Disha Institute of Management and Technology Raipur Chhattisgarh in India. From the experiment conducted it is observed that the outlet temperature of the fluid is a function of intensity of solar irradiation and mass flow rate. For all the two cases of flat plate collector, the maximum collector efficiency was obtained at 1:00 pm in all different mass flow rates.

4.2 Discussions on Results Achieved

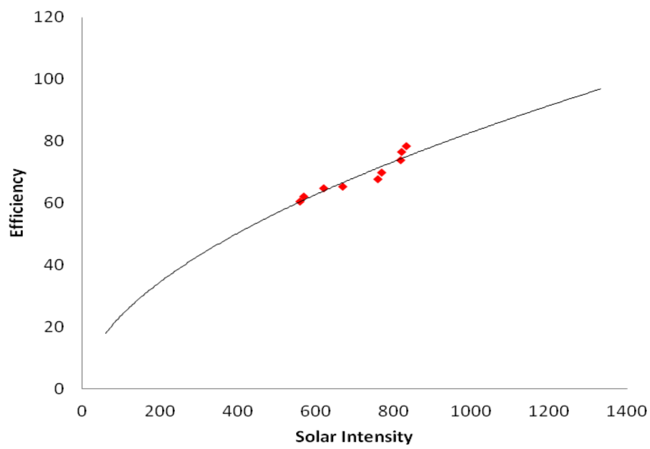

Chart -1: Efficiency vs. Solar Intensity for Single Glass

Chart 1 shows the variation of efficiency with respect to the solar intensity with mass flow rate 0.0396 for single glass cover. The efficiency increases with the increase in solar intensity.

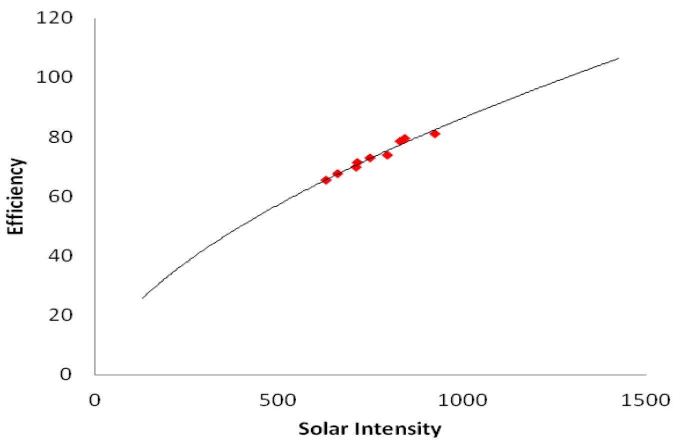

Chart -2: Efficiency VS Solar Intensity for Double Glass

Chart 1 shows the variation of efficiency with respect to the solar intensity with mass flow rate 0.0396 for double glass cover. The efficiency increases with the increase in solar intensity.

5. CONCLUSIONS

We obtain high temperature outlet water at low mass flow rate. We have found the efficiency in case double glass cover flat plate collector is more than that is single glass cover flat plate collector. The maximum efficiency is found that at a 1 pm in a day.

REFERENCES

1. P.P. Patil, Dr. D.S Deshmukh"Design consideration for flat plate solar water heater system '' IJSSB, volume 3, no.2 June 2015.

2. V. Awasthi and Jain k. k. and Dave R.K " Examination of thermal performance of double glazed flat plate solar collector " VSRD international journal of mechanical, civil , Automobile and production Engineering, India, vol-3, page 47-50.

3. Alok Kumar, " performance of solar flat plate by using semi-circular cross sectional tube'' IJERT volume 2, Issue 2, Feb-mar 2014.

4. M.S. Husain, A.K Pandey, Mohsin Ali Tunio, Jeyray Selvaray, "Thermal and economic analysis of low – cost modified flat plate solar water heater with parallel two-side serpentine flow" DOI 10, 1007/s 10973-015-4883-7.

5. Dhrupad Sharma, "optimization of glazing cover parameter of a solar flat plate collector" IJETT – volume 14 Number 2 – Aug 2014.

6. H.Y. Andoh, P. Ghaha" thermal performance study of a solar collector using a natural vegetable fiber , coconut coir , as heat insulation energy for sustainable development " 14(2010) 297 – 301.

7. Sandeep Kumar Dehariya, Dr. A.R. Jaurken " Efficiency Evaluation of heat exchanger pased domestic solar water heater " [Dehariya , 2(10): October , 2013]

8. Bhagyashree P. Dabhane, S.P Adhau " Experiment Analysis of flat plate collector solar water heater " volume 3, issue 24 , January 2014

9. M. Sridharan and N. Jayamalathi " performance comparison of differently configured solar water heater " ISSN 1450 – 216 ×Volume 91 No member , 2012 , P.P 23 – 31

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