TO EVALUTE THE PERFORMANCE OF LIQUID FLAT PLATE COLLECTOR BY COMPARING TWO DIFFERENT INSULATION MATERIALS AS GLASS WOOL AND FOAM

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ABSTRACT

Energy consumption is increasing very rapidly as the world is developing. Conventional sources are not able to fulfil the today's energy needs. Renewable energy sources eliminate the weaknesses of conventional sources. But because of less knowledge about these sources and high initial cost of the conversion systems we limit the use of these resources. Solar energy is one of the such renewable source which is in abundant in nature but it cannot be effectively utilized because of its intermittent nature. There is a need to trap this energy in some form to make it a reliable energy source.

In this present work, various studies and investigations are being done to develop the system and device that can effectively utilize the renewable energy resources for the purpose of industrial and domestic use. One such device is water flat plate collector which is used for heating water by using solar energy and hence investigations are being done to check out the performance characteristics of efficiently heating water using different selective insulating materials like glasswool and foam. It has been seen that on using glass wool as insulating material maximum collector efficiency is 44.4% and while using foam as insulating material maximum collector efficiency is 48.6%.Thus by using effective insulation and by varying thickness of insulation material we can increase the solar collector efficiency.

Keywords: Solar Collector Efficiency, Glass Wool, Foam

I. INTRODUCTION

Depletion of conventional energy resources and its adverse impact on environment have created renewed interest for the use of renewable energy resources. Hence developments of devices and instruments that can free us from use of conventional energy resources are of crucial importance. As a result, considerable research and development activities have taken place to identify reliable and economically feasible alternative clean energy sources. The solar energy is such a renewable energy resource, the direct incident energy in the form of sunlight can be converted to thermal energy and transferred to heating devices that are capable of trapping it for long hours. The purpose of solar water heater is to convert the solar radiation into heat to satisfy energy needs but with some limitations it is not being used on grid scale because of its poor efficiency and higher initial cost. So there is a requirement of advancement in the solar water heater using flat plate collector to overcome its limitations so that it can be used as a replacement of conventional heaters and power generation devices. Solar collector absorbs the incoming solar radiation, converting it into thermal energy at the absorbing surface, and transferring the energy to a fluid flowing through the collector.

Clarence Kemp et al. patented the old design of metal tanks exposed to the sun by adding a metal panel to the tank, in order to increase the efficiency of the solar tank. In the beginning of the 20th century, inventors designed improved systems, but still the heating and the storage unit were one, and both were exposed to the weather and the cold nights. **William Bailey et al.** began selling the Day and Night solar water heater, which provided an insulated indoor water storage tank, supplied by a separate solar collector located outside the house and facing south. The collector consisted of a coiled pipe inside a glass covered box which had to be mounted below the storage tank. This allowed the hot water to circulate from the collector to the storage tank by natural convection. **Otanicar et al.** proposed a direct absorption solar collector operated on nanofluids. They demonstrate efficiency improvement up to 5% by utilizing nanofluids as the absorption mechanism. **E. Natarajan and R. Sathish et al.** suggest the use of nanomaterials in the solar devices to increase the heat transfer and that can be useful in energy saving and compact designs. **Groenhout et al.** suggested a novel design of a double-sided absorber with low emissivity selective surface coupled with high reflectance stationary concentrators to reduce the radiative and conductive losses through the back of the collector. This particular design reduce the net heat loss to be 30– 70% lower than conventional systems.

II. EXPERIMENTAL SETUP

The set up comprises of the wooden frame of dimension 900mm* 1245mm. Two ports one as inlet and other at other end as outlet are made and the water is allowed to pass through the copper tubes that are installed below the absorber sheet and the glass cover. The aluminium sheet of 3 mm thickness is used as absorber sheet. The first experiment is carried out with glass wool as insulating material and other with the foam as insulating material. The thickness of insulating materials is same i.e 5 cm.
The dimensions of tubes are:

Inner Diameter of Tube	10 mm
Thickness of Tube	2 mm
Spacing between Tubes	100 mm

the function of tubes and channels is to circulate the water. The water flowing through these tubes takes away the heat from the absorber plate.

Figure 1. Liquid flat plate collector

Measuring devices and instruments

The different parameters are measured in this study. The instruments used are as follows:

1. Solar power meter
2. Temperature Sensor
3. Liquid mass flow rate Measurement

1. Solar power meter: Solar power meter is used to measure intensity of radiation falling on collector Surface in watt/m^2

2. Temperature Sensor: The Dial gauge type temperature sensor is used to measure the temperature of the inlet and outlet water from the Water flat plate collector. The range of the dial gauge type temperature sensor is from 0-250°C.

3. Liquid mass flow rate Measurement: The liquid flow rate is measured by conventional method in which we have recorded the time required to fill the beaker of known volume. By the help of this data, we have calculated discharge(volume/time) at the outlet of the water flat plate collector.

III.CALCULATION AND RESULT

Formulae used and nomenclature:

Collector efficiency is defined as the ratio of the heat transferred to the flowing fluid to the heat received from the incident radiation (I) falling on the surface of the collector.

$$\eta = \left(\frac{m * C_p * \Delta T}{I * A}\right)$$

where m_f = mass flow rate in kg/sec

C_p = specific heat at constant pressure in J/kg.k

$\Delta T = T_2 - T_1$ T_2 is the exit temperature

T_1 is the inlet temperature

I = Intensity of radiation falling on Collector Surface in watt/m^2

A = Area on which the radiation is falling in m^2

Table 1. Data obtained in experiment

WHEN GLASS WOOL IS USED AS INSULATION MATERIAL

THICKNESS OF GLASS WOOL=5 CM

Time	Outlet Temperature of water **T_2 (°C)**	Inlet Temperature of water **T_1 (°C)**	Water Flow Rate **M_f (kg/s)**	Solar Intensity **I (W/m^2)**	Temperature difference ΔT **(T_2-T_I) (°C)**	Efficiency **η (%)**
10:30 AM	31	24	0.005	615	7	21.2
11:30 AM	35	24	0.005	658	11	31.1
12:30 PM	40	24	0.005	733	16	40.7
1:30 PM	43	24	0.005	805	19	44.4
2:30 PM	41	24	0.005	742	17	42.7
3:30 PM	33	24	0.005	630	9	26.6
4:30 PM	30	24	0.005	605	6	18.5

Table 2. Data obtained in experiment

WHEN FOAM IS USED AS INSULATION MATERIAL

THICKNESS OF FOAM=5 CM

Time	Outlet Temperature of water **T_2 (°C)**	Inlet Temperature of water **T_1 (°C)**	Water Flow Rate **M_f (kg/s)**	Solar Intensity **I (W/m^2)**	Temperature difference ΔT **(T_2-T_I) (°C)**	Efficiency **η (%)**
10:30 AM	32	24	0.005	615	8	24.2
11:30 AM	37	24	0.005	658	13	36.8
12:30 PM	41	24	0.005	733	17	43.2
1:30 PM	45	24	0.005	805	21	48.6

2:30 PM	42	24	0.005	742	18	45.2
3:30 PM	35	24	0.005	630	11	32.5
4:30 PM	32	24	0.005	605	8	24.6

IV. GRAPH ANALYSIS

Comparison of efficiency of insulating material (glass wool and foam)

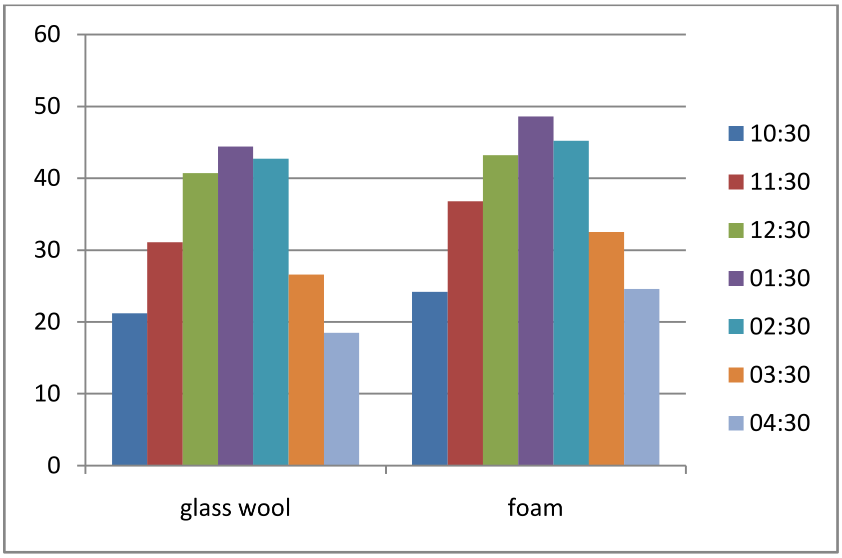

Table 3. Comparison between two different insulation materials

Type of Insulating material	Maximum efficiency (η)	Max Temperature difference ΔT (°C)	Thickness of material (cm)
Glass wool	44.4	19	5
Foam	48.6	21	5

V. CONCLUSION

Based on the review of the literature on solar collector, it has been found that solar collector was widely investigated both analytically and experimentally. A number of studies have been carried out in order to investigate the effect of various parameters on the performance of solar collector. Several promising advancement are taking place in the field of solar water heating system using flat plate collector. It is quite evident that by improvement in solar collector it can be used when conditions are not favourable. Optimization of operating parameters like orientation, fluid flow rate can also increase the efficiency. Thus we can conclude that by using different effective insulation materials and by varying the thickness of insulation materials we can increase the efficiency of Liquid flat plate collector.

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