Experimental Study and Analysis of Flat Plate Solar Water Heater with Different Flow Rates using of Circulating Pump

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Abstract

The Flat plate Solar Water Heaters are widely used mainly because of its simple working principle and low maintenance and functioning on renewable energy. Flat plate Solar Water Heater is popular due to their resilient design and low maintenance cost. This experiment represent the result of experimental investigation of the thermal performance of solar water heater flat plate collector by using of circulating pump which are cheep and easily available. A Solar Water Heater is a device which provides hot water for bathing, washing, cleaning, etc. using solar energy.

Keywords: Solar water heater, flat plate solar collector, circulating pump

I. INTRODUCTION

The solar energy are the most capable of the alternative energy sources. Due to increasing demand for energy and rising cost of fossil type fuels ex. gas or oil. Solar energy is considered an attractive source of renewable energy that can be used for water hearing in both homes and industry .In developed countries energy consumption in the building sector represents a major part of the total energy budget. Most of this amount is spend for hot water production and space heating.

II. WORKING OF A SOLAR WATER HEATER

The Sun's rays fall on the Collector Panel (a component of Solar Water Heater). A black absorbing surface inside the collector absorbs solar radiation and transfers the heat energy to water flowing through it. Heated water is collected in a tank which is insulated to prevent heat loss. Circulation of water from the tank through the collectors and back to the tank continues .

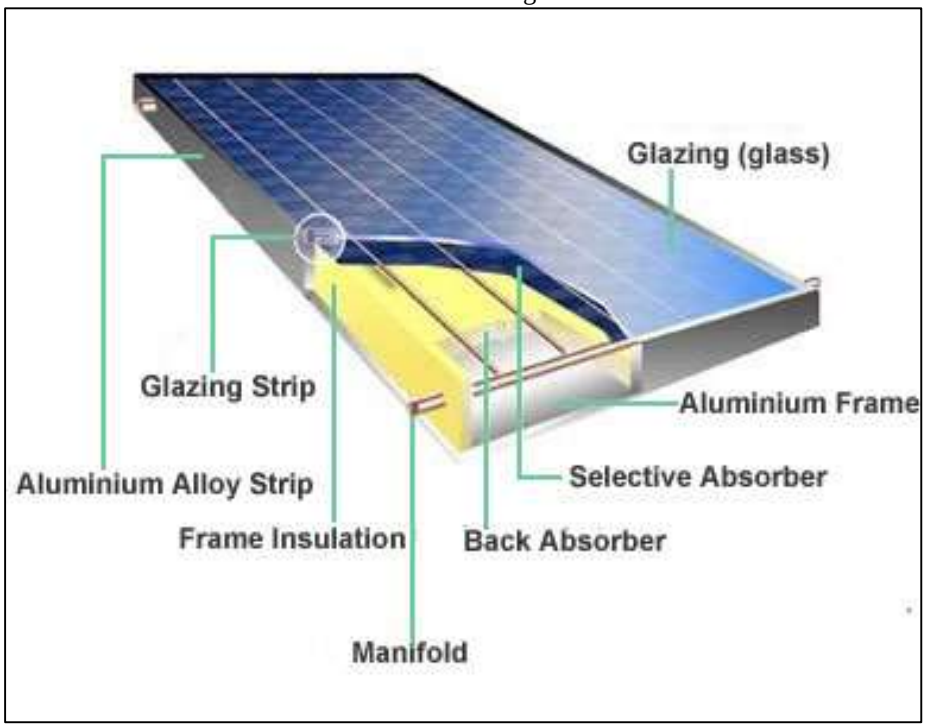

Fig. 1: Flat plate Solar Water Heater

A. Type of Solar Water Heater

Solar water heating systems can be classified in different ways:

1) The location of the collector - roof mount, ground mount, wall mount.
2) The location of the storage tank in relation to the collector
3) The requirement for a pump

B. Flat plate collectors are having the following components

1) Enclosure: A box or frame that holds all the components together.
2) Glazing: A transparent cover over the enclosure that allows the sun's rays to pass through to the absorber. Most glazing is glass, but some designs use clear plastic.3. Glazing Frame: Attaches the glazing to the enclosure. Glazing gaskets prevent leakage around the glazing frame and allow for contraction and expansion.
3) Insulation: Material between the absorber and the surfaces it touches that blocks heat loss by conduction thereby reducing the heat loss from the collector enclosure.
4) Absorber: A flat, usually metal surface inside the enclosure that, because of its physical properties, can absorb and transfer high levels of solar energy.
5) Flow Tubes: Highly conductive metal tubes across the absorber through which fluid flows, transferring heat from the absorber to the fluid.

III. EXPERIMENTAL SETUP

Fig. 2: Experimental setup

Fig. 3: Solar collector with pipe

Fig. 4: Control panel

Fig. 5: Circulating pump

IV. RESULTS AND DISCUSSION

A. September Month reading

Inlet water Temperature is 15 ^{o}C
Insulation thickness is 20 mm
Latitude = 23.25 at Bhopal, Madhya Pradesh
Latitude = 23° 15' 0"
Radiation intensity = 4.90 kWh/m^2/day at September 2016 , Bhopal, Madhya Pradesh

Table – 1
Time and temperature with water flow rate 5 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*22*
2	*11:00*	*23*
3	*12:00*	*32*
4	*13:00*	*35*
5	*14:00*	*34*
6	*15:00*	*28*
7	*16:00*	*26*
8	*17:00*	*24*

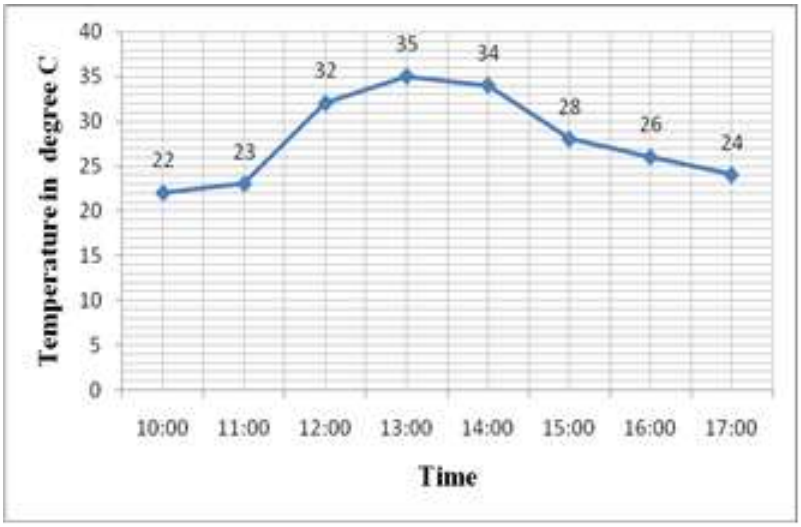

Fig. 6: Time and temperature with water flow rate 5 liters/ Minutes

Table – 2
Time and temperature with water flow rate 10 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*22*
2	*11:00*	*24*
3	*12:00*	*35*
4	*13:00*	*36*
5	*14:00*	*38*
6	*15:00*	*36*
7	*16:00*	*35*
8	*17:00*	*32*

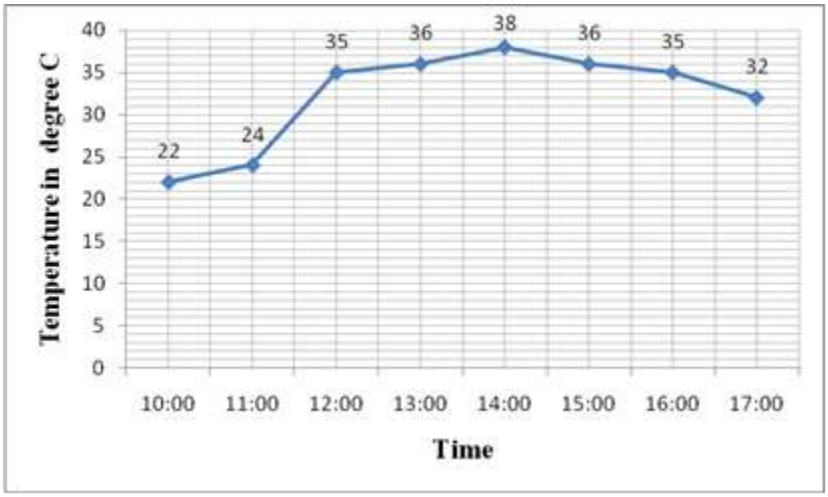

Fig. 7: Time and temperature with water flow rate 10 liters/ Minutes

Table – 3
Time and temperature with water flow rate 15 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*24*
2	*11:00*	*25*
3	*12:00*	*40*
4	*13:00*	*42*
5	*14:00*	*41*
6	*15:00*	*40*
7	*16:00*	*36*
8	*17:00*	*34*

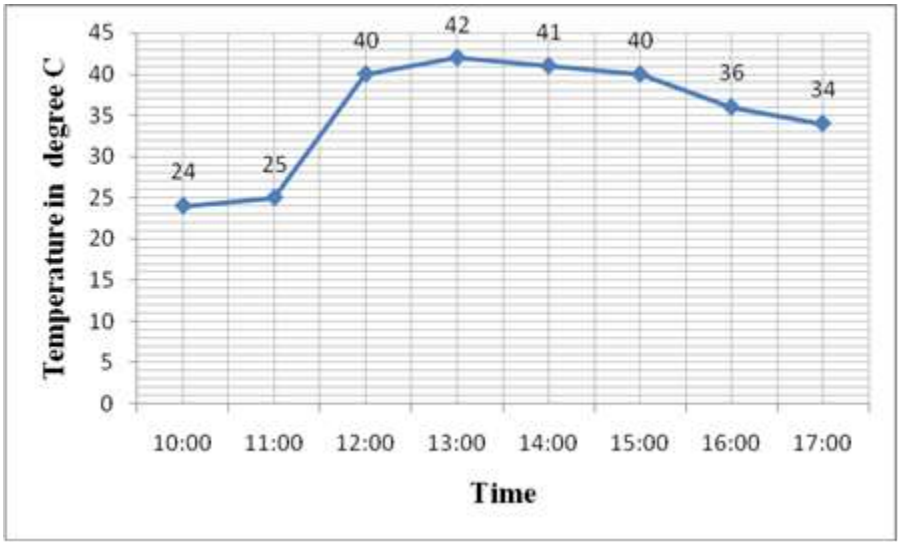

Fig. 8: Time and temperature with water flow rate 15 liters/ Minutes

Table – 4
Time and temperature with water flow rate 20 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*23*
2	*11:00*	*24*
3	*12:00*	*38*
4	*13:00*	*40*
5	*14:00*	*39*
6	*15:00*	*38*
7	*16:00*	*35*
8	*17:00*	*30*

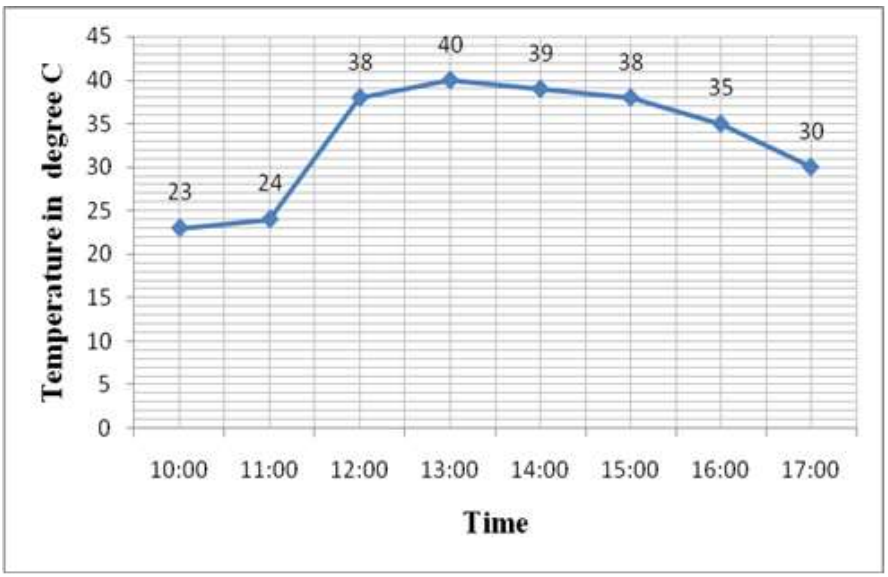

Fig. 9: Time and temperature with water flow rate 20 liters/ Minutes

October Month reading
Inlet water Temperature is 15 °C
Insulation thickness is 20 mm
Latitude = 23.25 at Bhopal, Madhya Pradesh
Latitude = 23° 15' 0"
Radiation intensity = 6.80 kWh/m^2/day at October 2016 , Bhopal, Madhya Pradesh

Table – 5
Time and temperature with water flow rate 5 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*24*
2	*11:00*	*26*
3	*12:00*	*35*
4	*13:00*	*40*
5	*14:00*	*37*
6	*15:00*	*32*
7	*16:00*	*30*
8	*17:00*	*26*

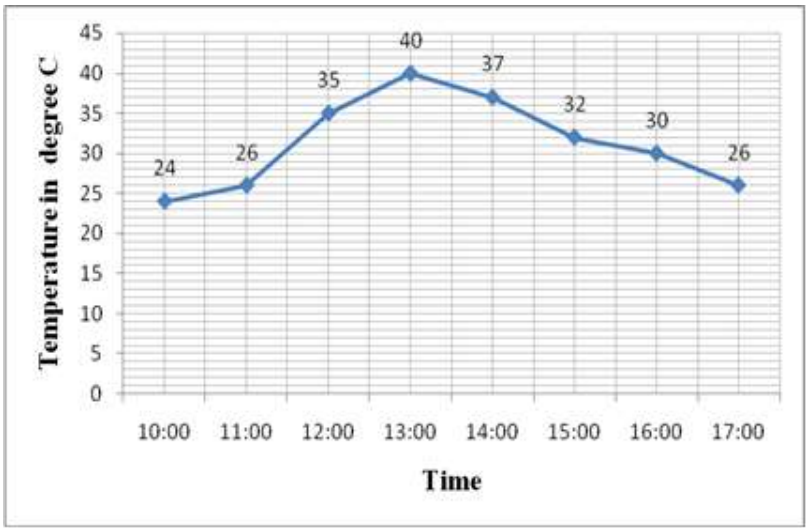

Fig. 10: Time and temperature with water flow rate 5 liters/ Minutes

Table – 6
Time and temperature with water flow rate 10 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*25*
2	*11:00*	*28*
3	*12:00*	*36*
4	*13:00*	*42*
5	*14:00*	*39*
6	*15:00*	*37*
7	*16:00*	*36*
8	*17:00*	*33*

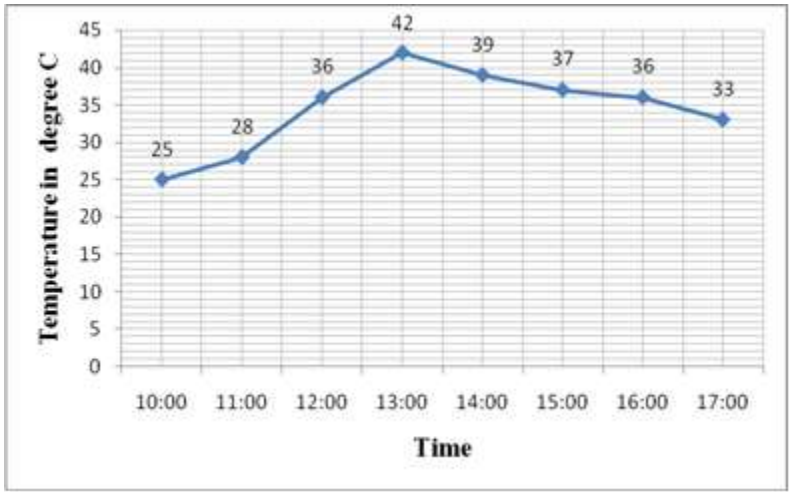

Fig. 11: Time and temperature with water flow rate 10 liters/ Minutes

Table – 7
Time and temperature with water flow rate 15 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*26*
2	*11:00*	*28*
3	*12:00*	*42*
4	*13:00*	*50*
5	*14:00*	*45*
6	*15:00*	*38*
7	*16:00*	*37*
8	*17:00*	*35*

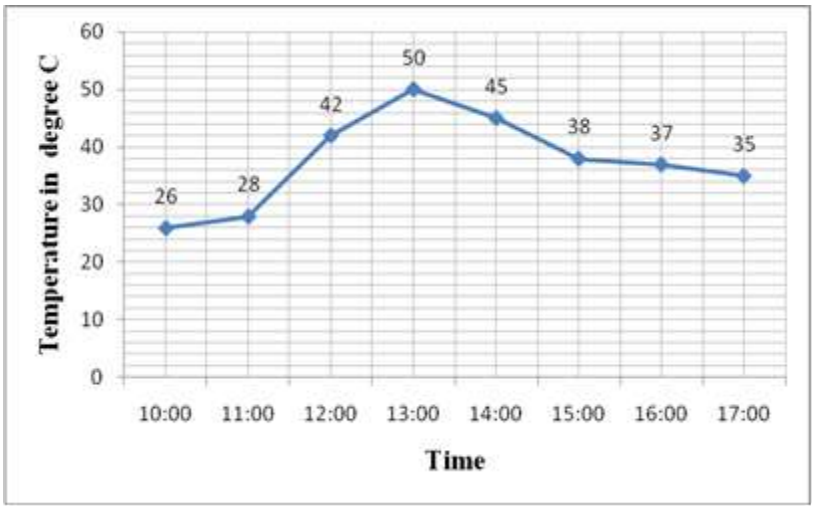

Fig. 12: Time and temperature with water flow rate 15 liters/ Minutes

Table – 8
Time and temperature with water flow rate 20 liters/ Minutes

Sr. No.	*Time*	*Temperature in degree C*
1	*10:00*	*28*
2	*11:00*	*30*
3	*12:00*	*39*
4	*13:00*	*42*
5	*14:00*	*41*
6	*15:00*	*39*
7	*16:00*	*36*
8	*17:00*	*28*

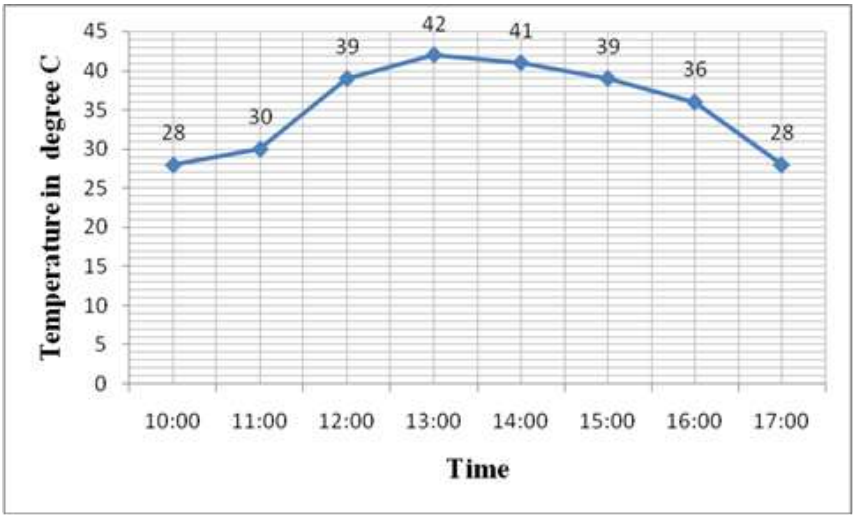

Fig. 13: Time and temperature with water flow rate 20 liters/ Minutes

V. CALCULATION

Incident angle θ= 45.3°
R_b = 1.40
Effective transmittance absorptance product = 0.811
$H_b = \frac{6.80 \text{ X} 1000}{24}$ W/m2 hr
=284W/ m2 hr
S = 284 X1.40X0.811 W/m2
= 3.22.4 W/m2
Useful gain $q_u = F_r [S - U_L (T_{fi} - T_a)]$ (F_r = 0.810) , (U_L =6.80)
= 0.810 [322.4 - 6.80 (50-15)]
= 68.364 Kcal/hr m2
Efficiency = $\frac{qu}{Hb\ Rb}$
$= \frac{68.364}{284 \text{ X} 1.40}$
= 0.17
= 17%

VI. CONCLUSION

The readings are taken on the day when the intensity of sunlight is high to get more efficiency and heat gain. We can see from the graphs that regarding the efficiency and heat gain from the morning to evening. The set up are made and the taking the reading. We are finding out the maximum water outlet temperature are 50 ° at time 13:00 , which are shown in Table .7. and Efficiency are 17%.

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