COMPARATIVE EXPERIMENTAL STUDY OF SIMPLE ABSORBER PLATE WITH ABSORBER PLATE HAVING CONCAVITIES

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Abstract

Solar water heater is one of the most widely used solar applications. Lot of study has been carried out on the enhancement of the thermal efficiency of solar water heater .In this experimental work the performance of conventional absorber plate is compared with the newly proposed absorber plate having concavities. The results shows that there is an improvement in the heat transfer rate. The heat transfer rate is increased by 5.12%. It shows that the increase in outlet temperature due to the provision of concavities which increase the diffusion area for radiation reducing the reflection losses.

Keywords: *Solar energy, Solar water heater, Absorber plate, Concavities etc…*

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1. INTRODUCTION

The development of the world is happening at the expense of energy consumption. Presently conventional sources are fulfilling the energy needs of the world. But the conventional energy sources like fossil fuels have two main limitations: firstly they are limited in quantity and secondly they produce environmental pollution. It makes the world think for alternative energy sources. Renewable energy sources eliminate the demerits of conventional sources. Less knowledge about these sources and high initial cost of the conversion systems limit the use of these resources. Out of the all renewable energy resources, solar energy is the most promising, abundantly available, clean, inexhaustible and universally available source of energy.[1]

Solar water heater is most widely used solar application. The function of solar water heater is to convert the solar radiation into heat to satisfy energy needs. Solar water heater systems consist of many parts. The flat plate collector is one of the important parts of solar water heater system where the absorber plate of the flat plate collector transfers solar energy to liquid flowing in the tubes.

A lot of research work has been done for the enhancement of the thermal efficiency of flat plate collector.

Ljiljana T. Kostic et al.[2] proposed an optimum position for the reflectors to improve the thermal efficiency of flat plate collector SWH. For that purpose they were conducted study on thermal collectors with and without flat plate solar radiation reflectors.

P. Rhushi Prasad et al.[3] placed two identical single cover flat plate collector with an angle at 28º to the horizontal towards south facing. One collector was fixed and other one tilted manually for every two hours with an angle of 30º for improving collector efficiency

N.K. Groenhout et al.[4] proposed the concept of advanced solar water heater. According to them, Flat plate collectors generally have high heat losses and low efficiency since only the upper side of the absorber plate is exposed to the sun

K. Sarath kumar et al. [5] manufactured the model on the concept of advanced solar water heater i.e. conventional solar water heater with concentric collector. They tested the model in two stages. In the first stage the solar water heater was tested without concentrator and in second stage with concentrator. They conducted experiments in two different stages. In first stage the experiment were conducted without parabolic concentrator. Then concentric collector is attached to it and experiment was conducted. The obtained results show the efficiency of advanced solar water heater is 15.3 percent higher than conventional flat plate water heater.

Manjunath M.S, K. et al. [6]carried out a CFD analysis for the two cases, in which absorber plate with dimples was compare with conventional absorber plate. Absorber plate temperature shows a increase of average surface temperature of about 5^0C for the dimple solar collector when compared to a flat plate solar collector. The average exit water temperature shows improvement of about 5.5^0C for a dimple solar collector when compared with a flat plate solar collector.

In this work, an experimental set up is manufactured as suggested by [6] to improve the thermal efficiency of the flat plate collector.

2. EXPERIMENTAL SETUP

Experiments were conducted on two absorber plates separately. In one plate, small cavities were produced while the other plate was kept simply smooth. Making concavities in the plate increases the surface area of the plate which is

supposed to improve the efficiency of the flat plate collector.

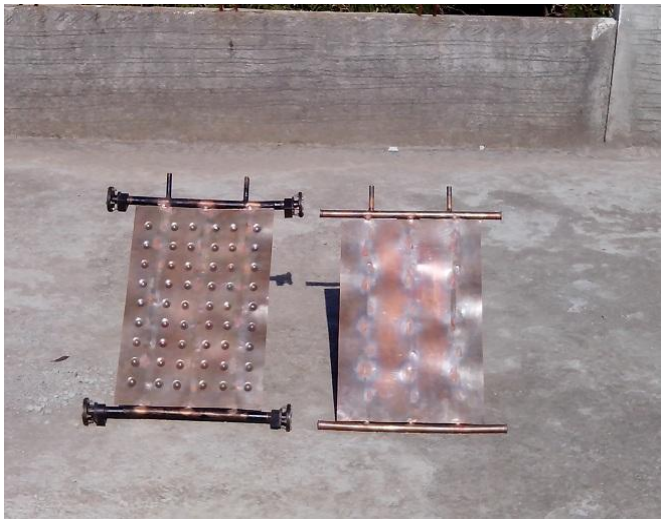

Fig1. Experimental Set Up for both Absorber Plates

Experiments were conducted on 17th and 18th of the march 2014 between 10 am to 4 pm on sunny day. For the given mass flow rate, rise in temperature of the water is recorded for both the plates. The ambient temperature and water inlet and outlet temperatures for the collector were measured with ordinary mercury thermometer.

3. RESULTS AND DISCUSSIONS

The results are given as

Table 1: Water Outlet temperature on 17th March, 2014

S. NO.	IST (Hrs)	Outlet Water Temperature(^{o}C)	
		Simple Flat Absorber Plate	Proposed Absorber Plate
1	10 AM	31	31
2	11 AM	47	47.5
3	12 PM	62	63
4	1 PM	65.4	67
5	2 PM	63	63.5
6	3 PM	60	61
7	4 PM	58	58

Table 2: Water Outlet temperature on 18th March, 2014

S. NO.	IST (Hrs)	Outlet Water Temperature(^{o}C)	
		Simple Flat Absorber Plate	Proposed Absorber Plate
1	10 AM	31	31
2	11 AM	47.2	47.5
3	12 PM	62.1	63.2
4	1 PM	65.4	66.8
5	2 PM	63.1	64
6	3 PM	61	61.6
7	4 PM	58	58.4

As seen in Fig.2 and Fig.3 and mentioned in Table 1 and Table 2, it is obvious that there is an increase in temperature of water in water tank of the proposed absorber plate as compared to simple absorber plate. The maximum temperature in simple absorber plate on 17 March is 65.5 ^{0}C at 1 PM at the same time proposed absorber plate has maximum temperature 67^{0}C. While on second day it is 65.4^{0}C and 66.8^{0}C respectively.

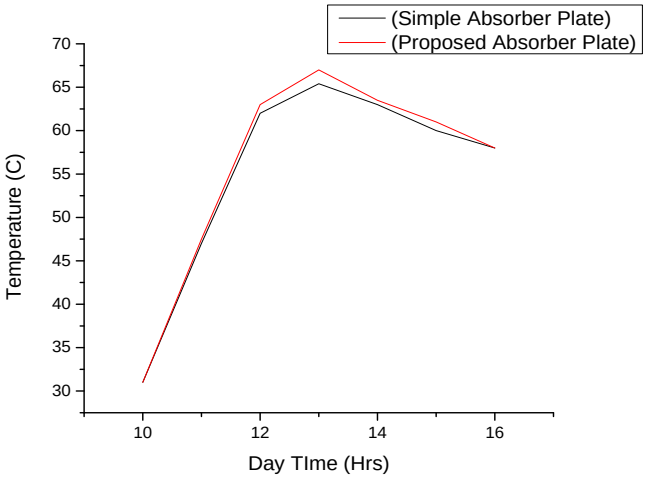

Fig. 2 Temperature versus Day Time on 17th March, 2014

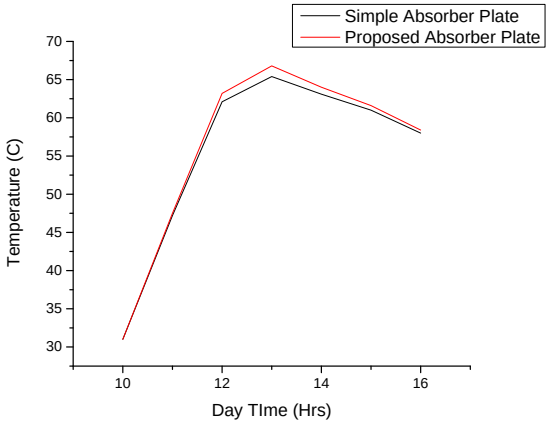

Fig. 3 Temperature versus Day Time on 18th March, 2014

Total heat absorbed in tank is calculated using following formula.

$$Q = m\, C_p\, (T_o - T_a)$$

Where
Q= Heat transferred in KJ
m=mass of water in kg
C_p=specific heat of water in KJ/kgK
T_o=Outlet water temperature ^{0}C
T_a=Ambient temperature ^{0}C

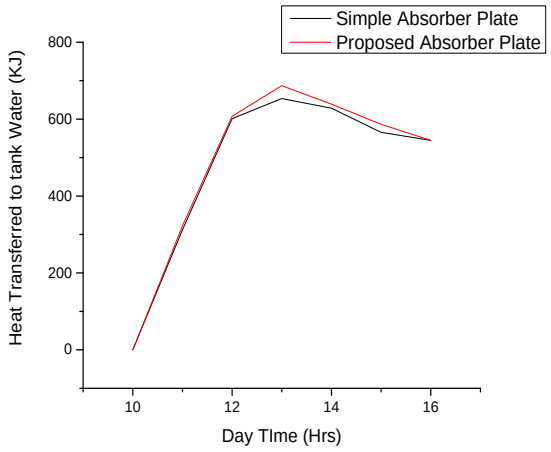

Fig. 4 Heat transfer to tank water Versus Day Time on 17th March, 2014

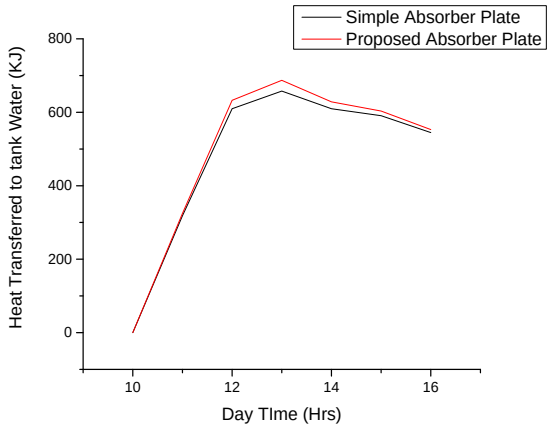

Fig. 5 Heat transfer to tank water Versus Day Time on 18th March, 2014

In the heat transfer rate plots (Fig.4 and Fig.5) described the same trends as observed in temperature plots.

It is observed that temperature achieved by the proposed absorber plate is greater by 0.3^0C to 1.6^0C as compared with simple absorber plate. The heat transfer rate is increased by 5.12%. The increase in temperature is due to provision of concavities which increase the diffusion area for radiation reducing the reflection losses.

4. CONCLUSIONS

This experimental work shows that the proposed absorber plate is more efficient than the simple absorber plate. However more experimentation is required to make findings further concrete using a large size of absorber plate as this work is carried on small size plate.

ACKNOWLEDGEMENTS

I would like to thanks the undergraduate students Kaushal Jain, Mahesh Girase, Ritesh Mahajan and Mahesh Mali who did make lot of efforts in erecting the experimental set up.

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