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Performance Evaluation of Square Emboss Absorber Solar Water Heaters

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Abstract

An effective solution for increasing global demand for energy is the utilization of renewable energy sources. Solar energy is taken as an alternative source of energy for numerous domestic and industrial applications. Solar energy is considered as one of the best alternative sources of energy since it is clean and sustainable for the environment. Extensive research on various aspects of solar water heating systems has been done in order to increase the overall efficiency of the system and optimize the design. The aim of present work is to analyze thermal performance of serpentine tube solar water heater with square embossed on the absorber plater using K type thermocouples.

Keywords: Solar Energy, Serpentine Tube, Solar Water Heater, Square emboss, K-type thermocouple.

1. Introduction

Solar water heating (SWH) is heating water with sunlight using a solar collector. The main function of a solar water heater is to expose water or heat transfer fluid to sunlight and then redistribute the heated liquid throughout the house for household use. The basic elements of one of them are a reservoir and a collector for storing solar heat. Different cost configurations are available to provide solutions for different climates and latitudes. SWH is widely used in residential areas applications and some industrial applications. The collector, facing the sun, heats the working medium, which will be put into the tank for further use. SWH is active (pumped) and passive. They use only water or both water and working fluid. They are heated either directly or by a mirror that focuses the light. They work alone or in combination with electric or gas stoves. Selvam S et al [1] focused on the performance factor of a unified solar water heating system in providing hot water in domestic and industrial applications. P.P.Patil et al [2] focused on the design of solar water heaters for domestic and industrial applications. Chii-Dong Ho et al [3] investigated and theoretically studied a double membrane and tube solar water heater with internal fins attached to the tube walls from the inside. L. Chilambarasan et al [ ] worked on solar panel collectors with helical internal slots to improve their conversion efficiency by reducing heat loss from the collector surface. Ganesh et al [5] conducted experimental studies on solar panel collectors by varying the geometry of the fin. Vikas Reddy Chittireddy et al [6] studied the flat solar collector with an air conditioner radiator as a heat sink for a domestic water boiler. Esdras nshimyumuremyi et al [7] analyzed the thermal efficiency and cost of a solar water boiler produced in Rwanda. K. Balaji et al [8] focused on the thermodynamic analysis of a solar water heater using an extended surface absorbing tube. S saravana et al [9] experimental study on flat solar water heaters with glass as absorber material to check the thermotechnical performance of differential absorber as absorptive, black painted transparent toughened glass sheet sandwich type (ABPCTG), absorptive tinted toughened glass sheet Absorptive

material was used sandwich type (ATTG) and absorbent tubular galvanized iron sheet (AGI). Tadvi Sachin et al [10] reviewed to understand the structure, layout, applications and size of solar thermal system. Sampath kumaretal [11] reported attempts to integrate a water heater through glass drained pipes into a swimming pool. Farahatetal [12] designed and developed two conventional solar water meters incorporated with flat solar water collectors and a thermal storage system. Mirmantoetal [13] presented a study to increase the productivity of single-slope solar computing by adding fins to the solar computing pool. Shah [14] designed a stepped basin instead of a flat basin to reduce the depth of the water table and increase the surface area. Singh [15] conducted an experimental study on a solar boiler connected to an external solar collector. Selimlietal [16] increased the productivity experimentally by connecting a solar mattress pond with a drained pipe of solar collectors. Dwivedi et al [17] carried out thermal efficiency and exergy analysis to calculate the thermal efficiency of a double slope solar array connected to a planar solar water collector. Mous et al.[18] experimented with a solar system to produce hot water and distilled water from brackish water. Hussain Al-Madani [19] experimented with a cylindrical photovoltaic water heater and the efficiency of the cylindrical photovoltaic water heater was calculated once. The highest efficiency cost at any point during the length of the experiment was determined to be 1.8%. S. Rajasekaran at el [20] focused on several fabrics such as steel, copper and aluminum used in water pipes as part of a photovoltaic water heater. Jignesh A. Patel at el [21] developed a spiral photovoltaic water heater to consider the overall thermal efficiency by improving the wave tube turbulence and evaluate the effect of a straight tube photovoltaic water heater. P.P.Patil and others [22] present a scheme of photovoltaic water heaters designed to obtain hot water for domestic and industrial use. Ho et al. [23] conducted an experimental and theoretical evaluation of a recycled flat solar water heater equipped with rectangular tubes. D Prakash et al. to [2] is aimed at the environmentally sustainable use of light energy with a new photovoltaic water heating system, and heat drift indoors is prevented by the use of sufficient roof insulation material. S. Sadhishkumar et al. to [25] began to investigate the possibility of using phase change materials (PCM) to purchase photovoltaic electricity and use this power to heat water at night for domestic use. Ankit S. Gujrathi et al. to [26] tried to use Ansys 15.0 Workbench software to model Parabolic Trough Collector and PTC is intended as awareness ratio 25. Arun K. Raj et. to [27] investigated the growth of a flat-plate photovoltaic water heater with and blocking fine. K. Vasudeva Karanth and others. to [28] analyzed the thermal performance penalties when large sizes and shapes are chosen for damper plate tubes. Mohammed Abdul Junaid et al [29] studied the form of photovoltage plate collector using CAD software to perform thermal evaluation March 11, 12, 13 and 1 and mass conservation. motion frequency at a constant level. V. Y. Chaudhary et al. to [30] addressed the use of photovoltaic intensity through a CFD evaluation involving an evacuated tube heat pipe that converts radiant power into useful heat. Hardik A. Parmar et al [31] focused on the overall thermal efficiency of serpentine photovoltaic water and additionally purchased a variety with a time-sensing efficiency fee. Besma Chekchek et al [32] built a photovoltaic water heater from plastic bottles and considered its thermal efficiency. Sivakumar et al. [33] investigated both the effect of the zigzag connection of fluke lifters and the choice of lifters. Kulkarni et al [3] investigated the effect of pipe preparations on conventional performance of SWH. Ramasamy et al [35] evoked SWHs due to rectangular and circular attenuations. They sought to refine the thermal switch by increasing the surface area while maintaining stress reduction and production speed. Sudhakar et al. [36] used four different photovoltaic telephone systems and different receivers to increase the efficiency of solar SWH. [37-53] Patel Anand et al. includes thermal performance studies of various type of solar collector devices which

includes solar water/air heater and solar cooker. The practical feasibility of solar heater are conceptualized using [54] Ruchi Shukla et al. [55] Patel et al. The thermal performance enhancement for solar heater is studied in [56] Hussain Al-Madani et al. Cylindrical Solar Water Heater [57] S. Vasanthaseelan et al. Different type of turbulators in solar ware heater [58] S. Sadhishkumar et al. historical solar water heating system work review paper. [59] Tengyue Wang et al. [60] Li et al. [61] Kime and Seo et al. [62] Pakdaman et al. documents thermal performance comparison between solar air heater, a conventional tube collector and transparent tube collector which is helpful to perform the in the current study of Performance Evaluation of Square Emboss Absorber Solar Water Heaters. [63-71] include articles about U-shaped heat exchangers in parabolic trough solar collector for air heating applications.

2. Experimental Set Up

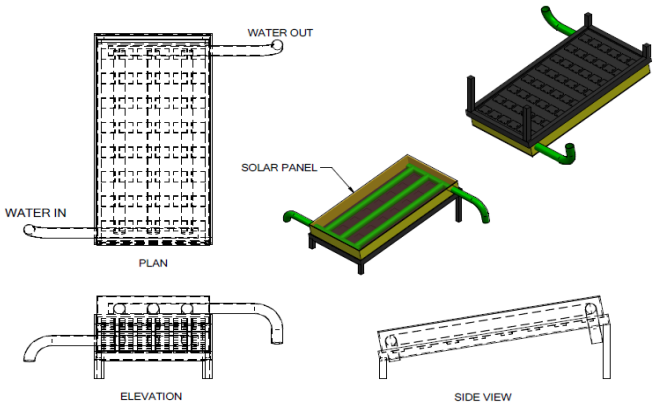

Fig 1 CAD Model of Square Shape Embossed Solar Water Heater

Figure 2 Square Shape Embossed Absorber Plate

Figure 3 Assembly of Solar Water Heater

In the present work using ½" copper pipes in serpentine shape about 1 m in length will be fabricated three in numbers with 0.5 m ½" copper pipes at upper and lower end in 1m three long pipes, and whole assembly will be placed in the wooden box of 1.1 m X 0.6 m X 0.05 m dimensions with 0.5 mm MS sheet as a absorber plate placed at the bottom of box and 2 mm thick transparent glass cover at top of the box. The 'K' type thermocouples are used to measure the temperature of water temperatures at inlet and outlet as well as body temperature too. The absorber plate consists of 50 mm X 50 mm square emboss shapes and 2 in each row and total seven columns are there. Fig 1 shows CAD model and Fig 2 and Fig 3 represent image of experimental set up.

3. Result and Discussion

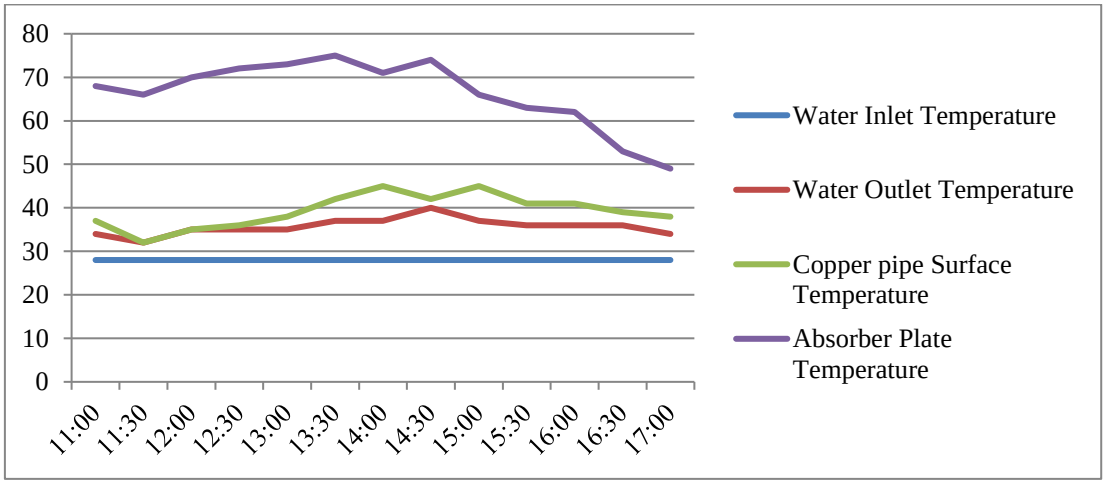

Fig 4 All Temperatures v/s Time

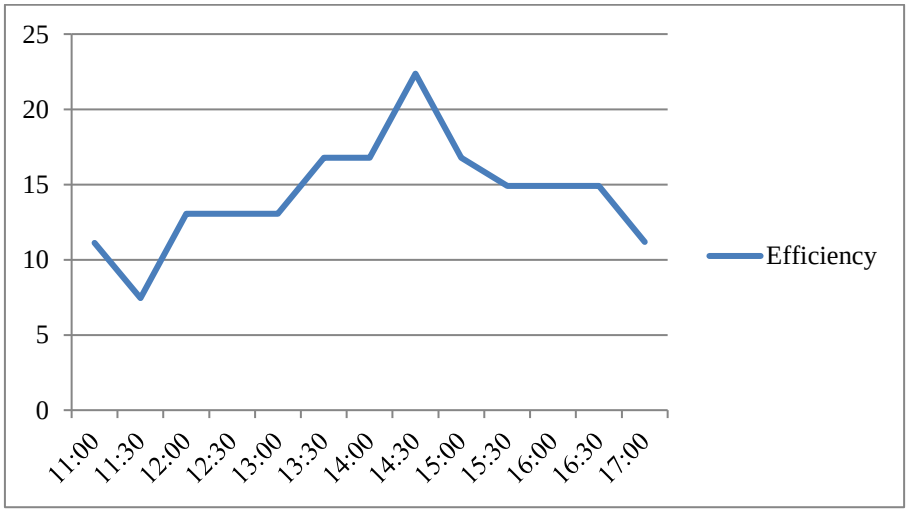

Fig 5 Efficiency v/s Time

From Fig 4 which indicates the various temperatures of solar water heater with respect to time and the Fig 5 observations are taken from mooring 11:00 a.m to 5:00 p.m in the evening and the interesting part is due to accumulation heat in the around 2:30 p.m maximum temperature is obtained. Here due serpentine tube shape and due emboss shape on absorber plate which enhances the rate of heat transfer and which leads to increase in the water outlet temperature.

4. Conclusion

The final outcome of this work is that the modification in pipe shapes and in absorber plate causes the improvement in the performance of the solar water heater.

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