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Comparative Thermal Analysis of Triangular and Circular Emboss Solar Water Heater

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***Abstract*: Solar energy is widely regarded as one of the most promising alternative sources of energy due to its environmentally friendly and sustainable nature. In order to enhance the overall efficiency and optimize the design of solar water heating systems, extensive research has been conducted on various aspects of the technology. The size of the system is contingent upon a number of factors, including the desired temperature, solar radiation, solar system arrangement, geographical conditions, and other relevant parameters. Therefore, it is imperative to design the solar water heating system with careful consideration of these parameters to ensure maximum benefit to the end user.**

***Keywords*: absorber plate, circular solar heater, emboss solar heater, solar energy thermal analysis, temperature, time.**

1. Introduction

Energy serves as the basis for all human activities. In the past, coal and wooden had been the most important sources of energy. However, with the increase of populace and demand, renewable energies have emerged as a recreation changer for development. The present-day strength useful resource disaster necessitates the improvement of emergent applied sciences and the demonstration of their readiness for use. India is lucky to possess an abundance of photo voltaic power at no cost. The photo voltaic radiation that reaches the earth's floor can be quite simply harnessed for the advantage of human society. One of the most famous gadgets for synthesizing photo voltaic power is the photo voltaic water heater. Solar strength is the most potential choice power source. With the growing demand for strength and the rising fee of fossil fuels such as coal and gas, photo voltaic electricity is an pleasing supply of power that can be utilized for water heating in each residential and industrial settings. Solar water heating structures are the least expensive and smoothest source of energy available. When sunlight hits the collector of a photovoltaic water heater, the black absorber (absorber) inside the collector absorbs the photovoltaic radiation and transfers thermal force to the water passing through it. Hot water accumulates in the tank which is insulated to prevent heat loss and the circulation of water from the tank through the collector and back to the tank continues at regular intervals. Sanjay Kumar Sharma and colleagues [1] studied experiments on flat V receivers in the hot climatic conditions of Rajasthan. Ismail N.R. et al [2] studied the work of improving the overall performance of photovoltaic water heaters. Krthik Munisamy and colleagues [3] studied the performance of a photovoltaic water heater on a unique tube system. P. Shivkumar and colleagues [4] found that on photovoltaic water heaters, the efficiency increases when increasing the number of risers and it lies in the zigzag arrangement of risers. Jayesh V. Bute and colleagues [5] focused on experimental research on flat-plate photovoltaic collectors. Bhowmik and colleagues [6] used a reflector capable of adjusting its role according to the role of the sun. Sivakumar et al. [7] explored the impact of the zigzag alignment of existing collection risers as well as the diversity of risers. The thermal conduction effect of the absorption plate of the SWH thermal tank was studied by Hossain et al. [8] and found that the incoming hot water was about 300oC higher than the temperature inside the room. Kulkarni et al [9] studied the effect of tube preparation on the basic performance of SWH. Ramasamy et al [10] were fascinated by SWH with rectangular and circular absorber fins. Some evaluations of the number of types of air-fed heat pumps (ASHPs) are introduced by Wang et al. [11]. Rukman et al. [12] tested the durability and exergy of several types of water-based photovoltaic structures operating under a variety of conditions. Sudhakar et al. [13] used four types of photovoltaic mobile networks and several receiver geometries to improve the photovoltaic SWH focusing efficiency. Saxena et al. [14] performed photovoltaic thermal manipulation by modifying parameters that affect the temperature and overall performance of the photovoltaic panel. Varol et al [15] performed CFD evaluation of in-plant convection thermal switches inside inclined wave PV collectors and flat-plate PV collectors. Akpinar et al [16] performed an experimental evaluation on a novel flat-plate photovoltaic air heater equipped with various boundaries to create turbulence in the fluid flow. Wang and associates. [17] performed numerical simulations on a photoelectric transmissive air collector and observed that the collector has a significant advantage in the preheating region of the air flow and further demonstrated that the CFD device has advantages specifically in the field of photovoltaic air collector research. Selmi et al. [18] performed a validated CFD model for a flat-plate photovoltaic water heater. Ho et al. [19] performed an experimental and theoretical evaluation of a recycled flat-plate photovoltaic water heater equipped with rectangular ducts. Kumar et al [20] found that the use of twisted tape inserted inside water pipes increased efficiency by 18-70% with

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a stress reduction of 87-132%, unlike conventional manifolds. Dwivedi et al [21] performed thermal performance and exergy analysis to calculate the thermal performance of a double-sloped solar panel connected to a planar solar water collector. Mous et al [22] tested a solar system producing hot and distilled water from brackish water. Hussain Al-Madani [23] tested a cylindrical photovoltaic water heater. And the performance of the cylindrical photovoltaic water heater is only calculated once. The highest cost effectiveness at any time during the trial was determined to be 1.8%. S. Rajasekaran at al [24] focuses on several fabrics such as steel, copper and aluminum used in water pipes as part of photovoltaic water heaters. Jignesh A. Patel at al [25] developed a spiral photovoltaic water heater to achieve overall thermal efficiency by improving corrugated tube turbulence and evaluated the efficiency of photovoltaic water heater straight tube. P.P. Patil et al [26] presented a photovoltaic water heater system designed to obtain hot water for domestic and industrial use. Ho et al. [27] conducted an experimental and theoretical evaluation of a recycled flat-plate solar water heater equipped with rectangular tubes. D Prakash et al. at [28] aimed at ecologically sustainable use of light energy with a new photovoltaic water heating system and to avoid heat drift in the house by using sufficient insulation on the roof. S. Sadhishkumar et al. and [29] started investigating the possibility of using phase change materials (PCMs) to purchase photovoltaic electricity and use this energy to heat water at night for domestic purposes. Ankit S. Gujrathi et al. at [30] attempted to use Ansys 15.0 Workbench software to model the Parabolic Trough Collector and PTC for the purpose of serving as cognitive reporting 25. Arun K. Raj et. in [31] studied the development of a flat-plate photovoltaic water heater with and fine particle containment. The studies from [32-47] Patel Anand et al. for solar air and water heater; [48, 49, 50, 51] Anand Patel et al. for heat exchanger involves various geometrical configuration of solar absorber plate by performing thermal analysis or study of materials in this device to improve heat transfer enhancement.

2. Experimental Set up

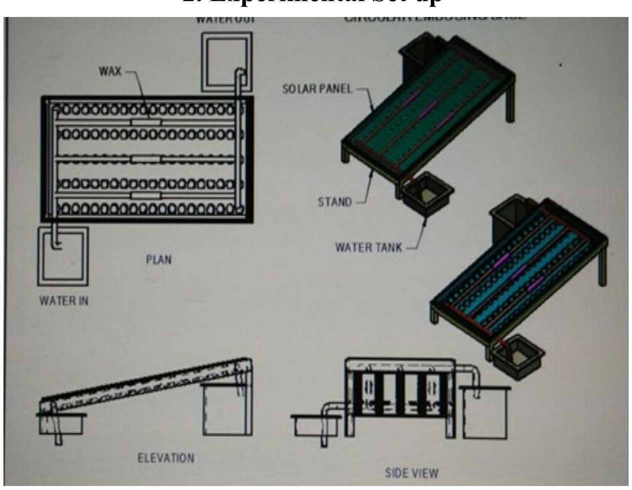

Fig. 1. Circular emboss solar water heater

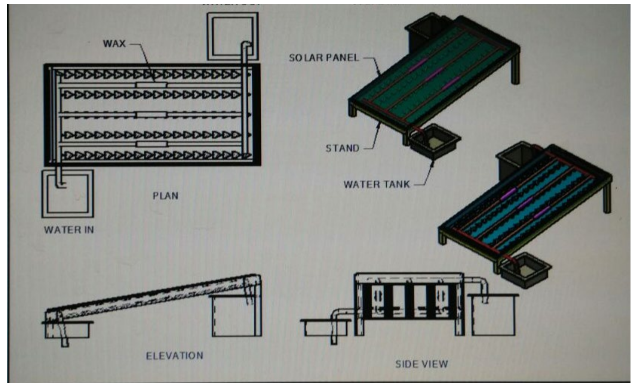

Fig. 2. Triangular emboss solar water heater

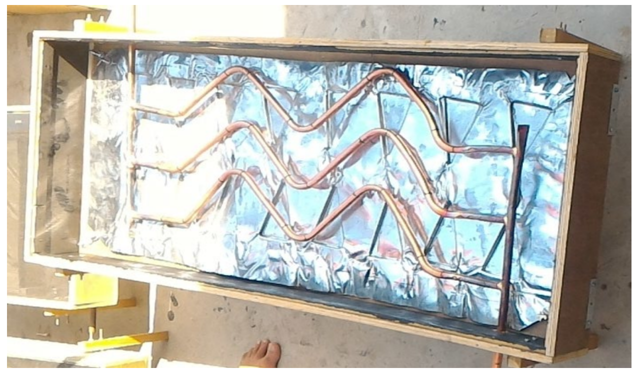

Fig. 3. Triangular emboss solar water assembly

Fig. 4. Circular emboss absorber plate

There are two experimental set ups are fabricated with same dimension only embossed shapes are different in case of both experimental set up. Both set up consist of 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 with circular and triangular emboss shapes on each absorber plate in case of both set up respectively; 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 and Fig. 2 show CAD model and Fig. 3 and Fig. 4 represent image of experimental set up.

3. Results and Discussion

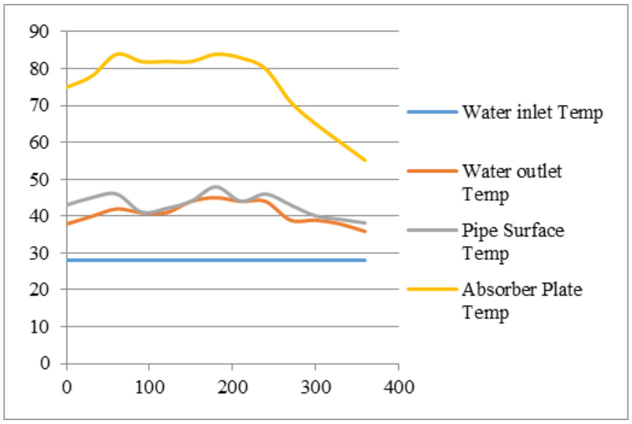

Fig. 5. Temperature variation in circular SWH with time

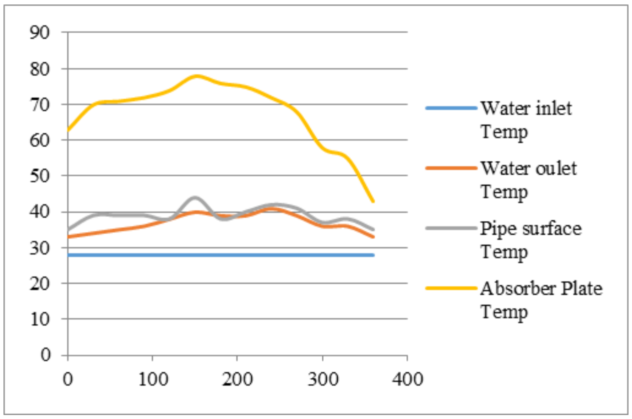

Fig. 6. Temperature variation in triangular SWH with time

Fig. 5 and Fig. 6 show the temperature variation at various locations in case of Circular and Triangular emboss solar water heater, respectively. From Fig 3 and Fig 4 it is observed that all temperature values are high in case of circular emboss solar water heater it may be because of the circular shape which provides better shape factor in comparison of triangular shape which also reflects that the geometrical shape plays an important role though the cross-section areas are same but surface areas are different.

4. Conclusion

The interesting outcome of the present work is that the emboss shapes on absorber plate of solar water heater affect the thermal performance of solar water heater.

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