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Experimental Investigation of Oval Tube Solar Water Heater with Fin Cover Absorber Plate

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ABSTRACT:

Solar energy is one of the simplest and easiest to use forms of renewable energy. Solar water heaters use solar energy from the sun to generate heat, which can then be used to heat water for bathing, space heating, industrial processes, or even cooking with solar. Solar energy is readily available in nature, less polluting, invaluable and therefore accepted as one of the most efficient non-conventional energy sources. The efficient use of solar energy is hindered by the intermittent nature of this energy source, limiting its use and success in household and industrial applications, especially in heating of water. The objective of this work was to manufacture an oval tubular solar water heater fin cover absorber plate and evaluate its thermal performance using variable water flow.

Keywords: Fin Cover Absorber Plate, Oval Tube Solar Water Heater, Solar Energy, Variable Water Flow.

INTRODUCTION

Solar energy is responsible for all the light and most of the heat we experience on Earth. A lot of free energy flows. Heat from the sun can be used to heat water by absorption and conduction in solar panels. It can be thickened with kitchen mirrors and used for rooms that need heating and have well-placed windows. Photons (light) from the sun can even be converted into electricity using photovoltaic cells. When it comes to renewable energy sources, the sun is by far the largest and most accessible here on earth.Solar radiation is an alternative source of energy for many industrial and domestic applications. One of the simplest and most direct applications of this energy is the conversion of solar radiation into heat. Thus, the household sector can reduce its environmental impact by installing flat solar water heaters. Conventional flat circulation solar water heaters are the most economical and extensive use of solar energy in the world. The thermal parameters and the thermal efficiency are depending on its design parameters, thickness, type of insulation, number and type of glasses, and the distance between the absorber and the inner pane.

Hashim et al.[1] concentrated on major scenarios for solar thermal applications in Iraq by using the Solar water heating (SWH) for flat plate collector. Ogueke et al. [2] reviewed various types of solar water heater models and compared the efficiencies. Zhanga et al.[3] focused on Comparative study on annual performance between loop thermosiphon SWHS and conventional SWHSTsung-Ching Chen et al.[4] investigated the collector efficiency of double pass sheet-and-tube solar water heaters with attaching internal fins on tube wall and external recycle. Chittireddy et al. [5] Studied flat plate solar collector with an AC radiator as a heat absorber for a domestic Water heater with presence of high-density corrugated fins attached to the tubes. Kalogirou [6] surveyed various types of solar thermal collectors and applications. Al-Madani [7] evaluated the thermal performance was evaluated extensively throughout the months of March and April. Sivakumar et al. [8] carried out Experimented on the elliptical heat pipe solar collector which was designed, fabricated and tested for different mass flow rates and Lc/Le ratio. Mazarron et al. [9] checked feasibility of SWH with evacuated tube collector at different operational temperature. Ogie et al. [10] analyzed the design and construction of SWH where the water gets heated and flows into a storage tank through the thermosiphon principle. Rhushi Prasad et al.[11] compared the performance fixed flat plate water heater with that of the heater with tracking by conducting experiments.

Herrero Martin et al. [12] developed an experimental side by side solar collector test under the requirement of EN12975-2. Parent et al [13] analyzed the performance of the shell and tube HX external to the storage tank, in which fluid flow was induced by natural convection. Smith et al.[14] studied on helical tape is inserted in the tube with a view to generate swirl flow. Shahidul Islam Khan et al [15] collected data of SWH performance over entire year for capacity of 100 lt and 200 lt. Zohreh Rahimi-Ahar et al [16] reviewed flat plate and concentrate-type solar collectors, integrated collector–storage systems, and solar water heaters combined with photovoltaic–thermal modules, solar-assisted heat pump solar water heaters, and solar water heaters using, phase change materials are studied based on their thermal performance, cost, energy, and exergy efficiencies. T Yamaguchi et al. [17] focused onthe policy measures implemented for the contribution of SWHs confirms reducing the 300–500 kg of CO_2 emission per year from the residential sector. Siampour et al.[18] studied Energy policies in some countries are aimed to provide sustainable and secure energy. A novel ICS vessel design based on a pyramid shape was presented by Abdel-Rehin [19]. Davis et al. [20] developed a symmetric cusp reflector ICSSWH system designed particularly to suit Colorado's cold weather conditions, and found that the collector efficiency can reach as high has72%. Nagy [21] designed an inverted ICSSWH system which consisted of as lender glass lined tank enclosed in insulation with a double glazed aperture facing downward to collect the reflected solar radiation from the parabolic reflector.

Soteris A. Kalogirou [22] presented a study on different types of solar collectors and their applications. Samara Sadrin et al [23] focused on a method of replacing solar water heating systems. P. Rhushi Prasad et al. [24] studied the experimental analysis of the flat plate collector and compared the performance with the tracking receiver. Wattana Ratismith et al [25] described a passive collector design in which the outlet temperature is increased by reducing heat loss. Krisztina Uzuneanu et al. [26] described the optimal tilt angle for low-concentration solar collectors. R. Herrero et al. [27] Concentrated enhancement technique for flat plate liquid solar collectors. Mustafa AKTAS et al [28] obtained an experimental analysis of the optimal fin size, which can be used in solar system heat exchangers, was performed. K. Sivakumar et al. [29] designed a flat elliptical heat-pipe solar collector and tested it with a collector tilt angle of 11° from the horizontal. Kalogirou [30] labored on comparison of thermal overall performance of the photo voltaic water heater. Madani et al. [31] targeted on lookup titled heating options for residential structures in China: modern-day reputation and future outlook. Souliotis et al. [32] carried out lookup on the photo voltaic water heating for social housing: power evaluation and existence cycle assessment. Fani et al [33] targeted on photo voltaic assisted CCHP system, energetic, economic, and environmental analysis, case study: academic workplace buildings. Altoé et al. [34] labored on lookup of titled an evaluation of the monetary viability and greenhouse gasoline emissions savings ensuing from the use of solar water heaters in a standard Brazilian dwelling.

Hossain et al. [35] furnished lookup titled thermal and financial evaluation of less expensive modified flat-plate photo voltaic water heater with parallel two-side serpentine flow. Şerban et al. [36] focused on lookup titled monetary and environmental evaluation of investing in photo voltaic water heating systems. Bouhal et al. [37] studied on lookup titled graph and thermal overall performance optimization of a pressured collective solar warm water manufacturing gadget in Morocco for strength saving in residential buildings. Ayadi et al [38] got outcomes from lookup titled contrast of photo voltaic thermal and photo voltaic electric powered house heating and cooling structures for structures in exceptional climatic regions.[39-42] Anand Patel et al. [43] HD Chaudhary et al. [44-49] Patel Anand et al. includes studies about thermal performance enhancement by variation of solar collector geometry in Solar Cooker and Solar Heater. Solar Energy are utilized in various application such as [50, 51] Anand Patel et al. for heat exchanger [52, 53] Nikul Patel et al. for biofuels.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 in Experimental Investigation of Oval Tube Solar Water Heater with Fin Cover Absorber Plate.

EXPERIMENTAL SET UP

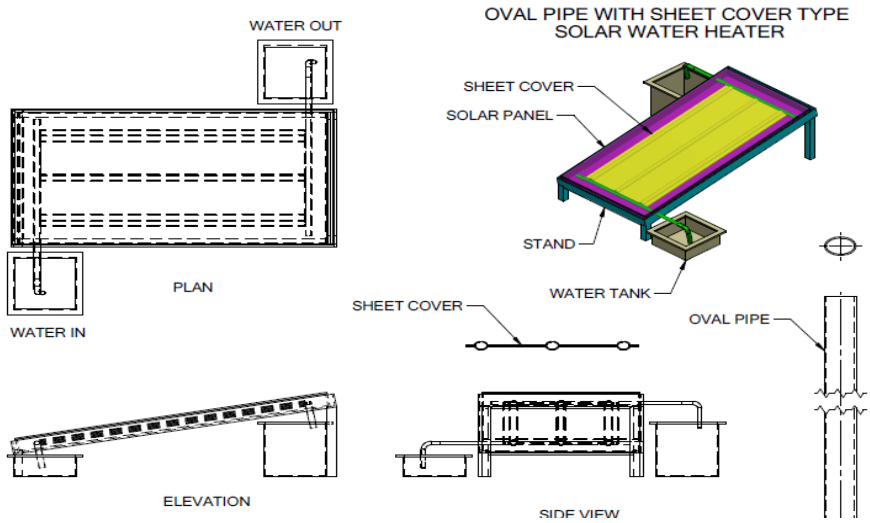

Fig 1 CAD Model of Solar Water Heater

Plate 1 Solar Water Heater Assembly

Plate 2 Assembly of Solar Water Heater with Cover Plate

Plate 3 Circular and Oval Pipe

In the present work solar water heater having overall dimensions of 1m X 0.5 m X 0.05 m box made of wooden sheet and in straight tube solar water heater set up and the shape of copper pipes are oval as shown in Plate3 and pipe assembly is covered with 0.2 mm thick cover plate from top and bottom to enhance the surface area as shown in Plate 2. The coversheets and pipe assembly painted with black color to increase the heat absorbing capacity and this whole assembly place in wood box with mention dimensions and covers with 2 mm transparent glass sheet. To measure the water flow 1 lt measuring flask and stop watch is used and water is supplied through 20 lt tank with tape to vary flow of water in experimental set up. Fig 1 indicates CAD model shaped solar water heater.

RESULT AND DISCUSSION

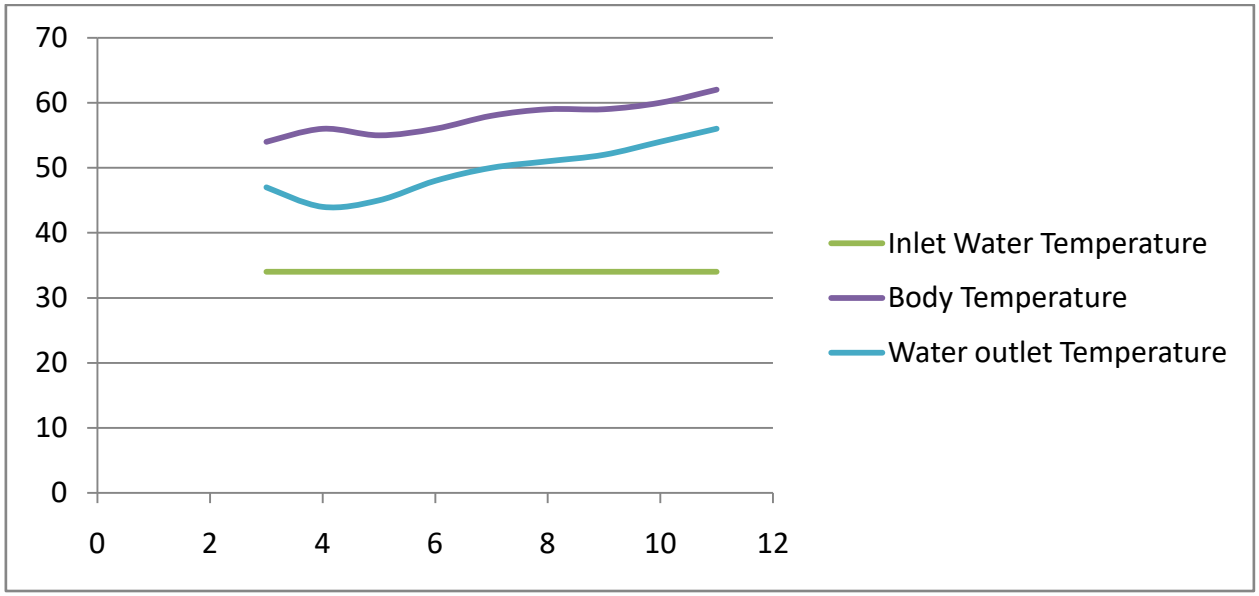

Fig 2 Temperature Variation with respect Time

Table 1 Result Table

Time required to fill 1000 ml tank	Mass Flow Rate Kg/s	Qo kW	Qi kW	η
292	0.003	0.107	0.681	15.69

292	0.003	0.119	0.681	17.43
292	0.003	0.142	0.681	20.92
292	0.003	0.166	0.681	24.40
292	0.003	0.178	0.681	26.15
292	0.003	0.189	0.681	27.81
292	0.003	0.212	0.681	31.20
292	0.003	0.223	0.681	32.84
292	0.003	0.272	0.681	40.04

The present work indicates that the water outlet temperature is quit better which is again reflected by thermal efficiency of solar water heater. In the existing work due to cover plate at the top and bottom of pipe assembly and due to oval shape of pipe the overall surface area increases and so water out let temperature rises at faster rate and so better thermal performance can be obtained.

CONCLUSION

The conclusion drawn from the present work is by increasing surface area better thermal performance can be obtained.

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