Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 07, July-2023

Experimental Evaluation of Twisted Tube Solar Water Heater

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Abstract: **Alternative energy sources are new option in the world to overcome energy crisis and pollution related issues. Solar energy, wind energy and biomass are three major sources and out of these three energy sources, solar energy is the easiest source to extract useful energy because wind energy can be useful, particularly in coastal areas where there is high wind velocity and energy extraction bio mass needs either chemical conversion or thermo chemical conversion process. Solar energy has wide applications in solar heating, particular in water heating and air heating. The objective of present work is to design a new concept of solar water heater with twisted tubes and to evaluate its thermal performance using K type thermocouples.**

Keywords—Twisted Tube Solar Water Heater, Alternative Energy, K type thermocoupl.

I. INTRODUCTION

Energy is the main driver of economic growth and essential to the survival of modern economies. Future economic growth will depend heavily on the long-term availability of energy from affordable, accessible and environmentally friendly technologies. A solar water heater or home solar water heater is a cheap and affordable way to bring hot water to your home. They use solar radiation or sunlight as fuel to heat water. This method of hot water heating is cheaper because you don't have to pay for heat from the sun. Solar water heaters are also called “solar thermal systems”. This device is used for energy addiction as most of our energy is generated by burning fossil fuels, causing many environmental problems. Harnessing solar energy requires a simple device to capture the heat of the sun. Solar hot water systems use this free energy to heat water. The boiled water can be used for various purposes such as bathing, cleaning, and washing. Installing a solar water heater will give you unlimited clean energy and lower your electricity bill.Chittireddy et al. [1] flat solar collector with AC cooler tested as a heat sink for a water heater with high density corrugated fins attached to the tubes. Kalogirou [2] studied the different types of solar collectors and their applications. Al-Madani [3] estimated that the thermal performance was comprehensively assessed in the months of March and April. Shivakumar et al.[4] performed experiments with an elliptical heat pipe solar collector designed, manufactured and tested for different mass flow rates and Lc/Le ratios. Mazron et al. [5] tested the feasibility of water heating with evacuated tube collectors at different operating temperatures. Ogie et al. [6] analyzed the design and construction of the HUW, in which water heats up and flows through the tank like a cooler.Rhushi Prasad et al. [7] compared the performance of a fixed plate water heater to a lag water heater by conducting experiments. Herrero Martin et al. [8] has developed an experimental test of side-by-side solar panels according to the requirements of the EN12975-2 standard. Parent et al. [9] studied the operation of HX liners and hoses outside of a storage tank where fluid flow was induced by natural convection.Smith et al. [10] tested a coiled ribbon inserted into a tube to create a swirling flow. Shahidul Islam Khan et al. [11] collected year-round data on SWH performance for 100 liter and 200 liter capacities. Zohreh Rahimi-Ahar et al. [12] Flat-plate and concentrating solar collectors, integrated collection and storage systems, and solar water heaters combined with photovoltaic thermal modules, solar water heaters with solar-assisted solar heat pump, and solar water heaters with phase change materials are tested for their thermal efficiency, cost, energy efficiency, and exergy. Hussain Al-Madani [13] experimented with a cylindrical solar water heater and the efficiency of a cylindrical solar water heater was calculated.It was found that the maximum efficiency value during the experimental period was 41.8%. S. Rajasekaran focused in el[14] on the effects of different materials such as steel, copper and aluminum used for water pipes as part of a solar water heater. Jinesh APatel of El [15] developed a spiral solar water heater to evaluate thermal performance by increasing turbulence in the flow and comparing the results to a simple tubular solar water heater. PP Patil et al. [16] deal with the design of solar water heaters for domestic and industrial water heating applications.Hardik A. Parmar et al. [17] focused on the thermal efficiency of the solar water coil and also determined the variability of the efficiency values over time. Besma Chekchek et al. [18] built a solar water heater from plastic bottles and evaluated its thermal efficiency. Shivakumar et al. [19] studied the effect of the zigzag arrangement of existing distribution risers and the number of risers. Kulkarni et al. [20] studied the influence of piping on the overall performance of SWH. Ramasamy et al. [21] studied SWHs with rectangular and circular absorber fins. They attempted to improve heat transfer by increasing surface area while maintaining pressure relief and muzzle velocity. Sudhakar et al. [22] used four types of solar cell

International Journal of Engineering Research & Technology (IJERT)
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arrays and different forms of receivers to increase the efficiency of the SWH concentrator PV package. Mangesh, A. Pachkawade et al. [23] made a solar water heater from unconventional materials such as plastic side pipes, HDPE pipes, old glass wool, thermocol, plastic barrels, etc. and thermal performance rated.Prakash Kumar Sen et al. [24] focused on customer satisfaction with solar water heaters. From this study, it can be concluded that solar water heaters are the best due to the lack of electricity switching and environmental safety. JP Kesari et al. [25] discussed various methods to increase the efficiency of solar water heaters. Somasekhar T et al. [26] used Al2O3-H2O nanoparticles in a solar water heater to improve its thermal performance compared to a CuO nanofluid.H.I.Abu-Mulaweh [27] discussed the design and development of an experimental setup for a solar water heating system. A standardized test procedure is required to compare the effectiveness of different sensor types and to be able to design and select suitable devices. Sushil Tiwari et al. [28] reviewed various methods proposed by different researchers to increase the efficiency of a solar water heater.Ho et al. [29] performed an experimental and theoretical analysis of a recyclable flat solar water heater equipped with rectangular channels. D. Prakasz et al. Aluminum. [30] focused on the efficient use of solar energy by a new solar water heating system, where the heat flow in the internal structure is interrupted by appropriate ceiling insulation material.S. Sadishkumar et. al. [31] initiated a study on the possibility of using phase change materials (PCM) to store solar energy and use this energy at night to heat water for domestic needs. Ankit S Gujrathi et al. [32] attempted to use Ansys 15.0 Workbench software to model the parabolic trough collector and the PTC was designed for a concentration factor of 25. [33-36] Patel Anand et al. [37] HD Chaudhary et al. [38-46] Patel Anand et al. documents studies of various configuration of solar collector in solar air/water heater and solar cooker. Few other applications where solar energy utilized, and thermal performance enhancement was studies in [47-48] Patel Anand et. al for-Heat Exchanger. [49-53] heat transfer performance of solar water with twist tape inserts are evaluated using CFD. [54-63] includes research studies of combination of twisted tabe within evacuated tubes of the solar water heater to enhance thermal performance of the system.

II. EXPERIMENTAL SET UP

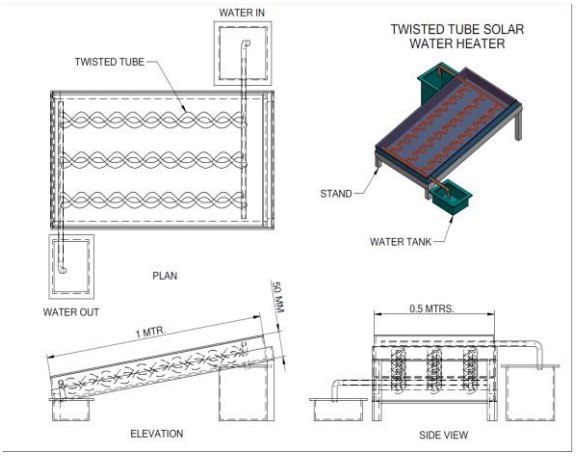

Fig 1 CAD Model of Experimental Set up

Plate 1 Twisted Tube

Plate 2 Twisted Tubes with sand

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Plate 3 Twisted Tubes with Fixture

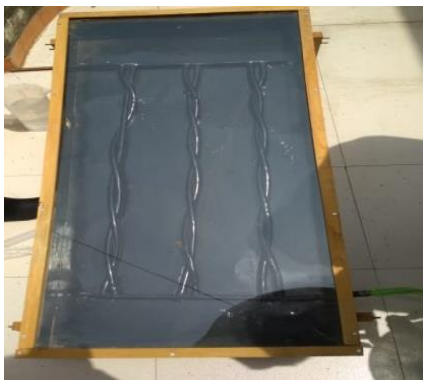

Plate 4 Twisted Tubes Experimental Set Up

In the present work using ½" copper pipes about 1 m length will be fabricated in pair and total 6 in numbers and fabricated with 0.5 m ½" diameter copper pipes at upper and lower ends after pipes are twisted for water entry and outlet, and whole assembly will be placed in the wooden box having dimensions of 1.1 m X 0.6m X 0.05 m and covered with 0.5 mm MS sheet at bottom as a absorber plate and 3 mm thick transparent glass cover at top To Twist the both pipes simultaneously pipes are filled with sand and using specially design fixture is used to twist pipes. The 'K' type thermocouples are used to measure the temperature of water temperatures at inlet and outlet as well as body temperature too.

$$Q_{out} = mc_p \Delta T$$

$$Q_{in} = IA$$

$$\eta = \frac{Q_{out}}{Q_{in}} X\ 100$$

Q_{out} = Heat gain by water, Q_{in} = Heat incident upon solar water heater

I = Intensity of solar radiation, A= surface Area, m = mass flow of water

C_p= Specific Heat of water, ΔT = water outlet (T_2)-water inlet Temperature (T_1)

III. RESULTS AND DISCUSSION

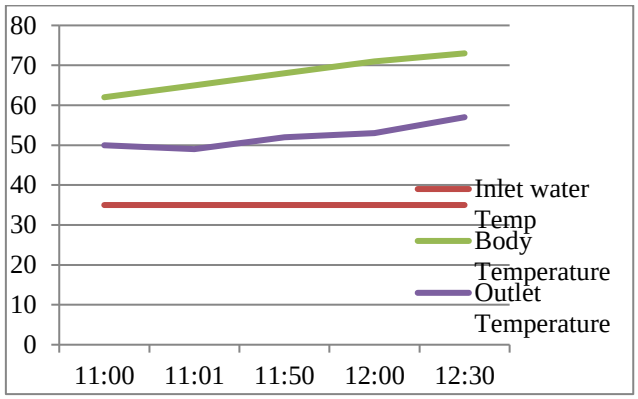

Fig 2 Variation in Temperature

Time required to fill 1000 ml tank second	Mass Flow Rate Kg/s	**Qout kW**	**Qin kW**	**η**
470	0.002	0.134	0.612	21.89
470	0.002	0.125	0.612	20.43
470	0.002	0.152	0.612	24.80
470	0.002	0.161	0.612	26.26
470	0.002	0.197	0.612	32.10

Table 1 Result Table

Figure 2 shows temperature variation of water inlet, water outlet and body with respect to time while Table 1 shows results of experimental work. Here due to twisted pipe and flow of water is divided in two pipes and as there is turbulence in the flow water flow rate is low and which enhances the temperature of water also water is divided in two pipes less quantity of water heater with more quantity of heat.

IV. CONCLUSION

The best outcome the present work is that to enhance the thermal performance of solar water heater is that to create turbulence in the flow plays important role in improvement in thermal performance.

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