

### EFFECT OF INSERTED STRIP DIRECTION ON THERMAL PERFORMANCE ON EVACUATED SOLAR WATER HEATER

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#### ABSTRACT

The solar energy is becoming excellent energy source in 21<sup>st</sup> century mainly due to two reasons are: availability in ample amount and pollution free energy. The solar energy can be utilized for water heating, drying of agriculture products and for power generation purpose also. The hot water having various domestic as well as industrial applications and in case of domestic application of hot water almost 15-20 % energy is utilized. The objective of present research

work is to fabricate two experimental set up of evacuated tube solar water heater (ETC) and by using augmentation method like twisted tape insertion with same pitch and different direction to evaluate thermal performance of ETC.

**KEYWORDS:** Evacuated Tube Solar Water Heater, Inserted Strip, Flow rate, Temperature, Twisted tape.

#### INTRODUCTION

Indeed, though the Sun is an important source of energy and sun is the most common type of energy entered by the Earth, the intensity of sun at the Earth's face is rather low. Because of the huge radial spread of light from the away Sun, this is the primary cause. Solar radiation is absorbed or scattered by Earth's atmosphere and shadows, performing in just a negligible quantum of fresh loss. Only around 45 of the sun's energy is visible light, with the rest being infrared, ultraviolet, and other types of electromagnetic radiation in trace quantities. This is the most common way to use solar energy. Generally, this includes a collection device that's

constantly exposed to sun radiation. This might be either absorbing or concentrating. In the first script, a dark face is exposed to the sun and absorbs radiation. The energy absorbed is also transmitted to a fluid in contact with the absorber. Solar radiation is a clean energy source that can be used in a number of marketable and domestic operations. The transfer of sun energy to heat is among the most straightforward and easiest operations. As a consequence, by erecting a solar flat force for heating water, the domestic sector reduces environmental impacts.

O.P Shukla et al.<sup>[1]</sup> used CFD to evaluate the performance of a solar water heater employing a flat typed plate collector and the evacuated tubes with the fin tubes. Jichun Yanget. Al.<sup>[2]</sup> tested the influence of glass tube inserting in evacuated tube solar water heater, which causes water to be forcefully circulated in all glasses evacuated solar collector tubes, hence improving solar collector performance. Murtuzavasanwala et. Al.<sup>[3]</sup> conducted a review of previous research and various strategies for improving the thermal efficiency of evacuating solar water heaters. Experiments were carried out by Jain Pankaj K at.el.<sup>[4]</sup> in the case of an evacuated tube solar hot water utilising phase change material. A.A. Satam.<sup>[5]</sup> discussed in detailed about the construction features of evacuated tube solar water heater including its constructional and design features. Tushar Choudhary et al.<sup>[6]</sup> investigated if an evacuating U tube solar water heating system is among the most effective techniques of solar thermal power collection when mass flow variation is taken into account utilizing tape angle movement. CFD analysis of a moisture evacuated tube collector of solar was performed by Zaw Min Thant et al.<sup>[7]</sup> G.L.Morrison et al.<sup>[8]</sup> discussed about numerical study for thermal performance carried out on single long evacuated solar tube collector. I.George et al.<sup>[9]</sup> carried out optimization of evacuated tube solar water heater using response surface method (RSM). A. I. Sato.<sup>[10]</sup> employed computational fluid dynamics to do a numerical investigation of evacuated solar tube water (CFD). The effects of tube combustion at 15° and 30° with horizontal of an evacuated tube solar water heater were explored by Arpan Das et al.<sup>[11]</sup> Deshmukh K B et al,<sup>[12]</sup> reviewed about various methods in case of solar water heater including the limitation of research. Flat plated solar water heaters and evacuated tube solar water heaters were compared by P. Vijayakumar et al.<sup>[13]</sup> Selvakumar P et al.<sup>[14]</sup> detailed experimental analysis carried out on corrugated plate solar water heater under practical conditions along with mathematical validation. K Ashok Reddy.<sup>[15]</sup> critically reviewed the research work carried out by various researchers for the thermally performance improvement of evacuated solar water heater. Hitendra et al.<sup>[16,17,18]</sup> focused on thermal performance of

evacuated tube solar water heater with twisted tape insertion. P.P.Patil et al.<sup>[19]</sup> focused on design consideration of the solar water heaters to obtain hot water for the domestic and industrial applications. Chii-Dong Ho et al.<sup>[20]</sup> investigated and theoretically studied on the double pass sheet and tube solar water heater with attaching internal fins on tube walls internally. L. Chilambarasan et al.<sup>[21]</sup> worked on helical internal grooved solar flat plate collectors to enhance their conversion efficiency by reducing heat loss from the collector surface. Mr. Ganesh et al.<sup>[22]</sup> conducted experimental investigations on solar flat plate collectors by changing the geometry of the fin. Vikas Reddy Chittireddy et al.<sup>[23]</sup> studied flat plate solar collector with an air conditioning radiator as a heat absorber for a domestic Water heater. K.Balaji et al.<sup>[24]</sup> focused on thermodynamics analysis of a solar flat plate water heater using an extended surface absorber tube. He studied the effect of with and without extended surface by using a data acquisition system. S saravanan et al.<sup>[25]</sup> experimental investigation on the flat plate solar water heater with glass as an absorber material to check the thermal performance of difference absorbent such as absorber black painted clear toughened glass plate sandwich type. Hardik A. Parmar et al.<sup>[26]</sup> zeroed down on its thermal performance and derived its time-dependent efficiency value change. Besma Chekchek et al.<sup>[27]</sup> built a solar water heater out of recycled soda bottles and tested its efficiency. The number and configuration of riser tubes emanating from the current collector were investigated by Sivakumar et al.<sup>[28]</sup> Kulkarni et al.<sup>[29]</sup> looked into how different tube configurations affected the overall SWH performance. The absorber fin of both rectangular and circular SWHS piqued the curiosity of Ramasamy et al.<sup>[30]</sup> To improve heat transfer, they increased the surface area, but kept the pressure drop and the outlet speed constant. To improve the efficiency  $\eta$  of troughs concentrating photovoltaic SWH, Sudhakar et al.<sup>[31]</sup> used four different solar cell array types and different shaped receivers. The thermal performance of a spiral tube solar water heater, which comprises of a copper tube and a flat plate collector, was compared to that of a conventional straight tube solar water heater by Jignesh A. Patel et al.<sup>[32]</sup> The,<sup>[33-48]</sup> Patel Anand et al. for Solar Air and Water Heater.<sup>[49,50]</sup> Patel Anand for Solar Cooker,<sup>[51,52]</sup> for Heat Exchange studies include thermal performance analysis to increase heat transfer by varying the dimensions of solar collector or adding different materials to it which is similar to the current study in this article.

### Experimental Set Up



Figure 1: Full Length Evacuated Tube with Coupler. Figure 2: Twisted Tape Insertions in Evacuated Tube.



Figure 3: Right Hand and Left Hand Twisted Tape.

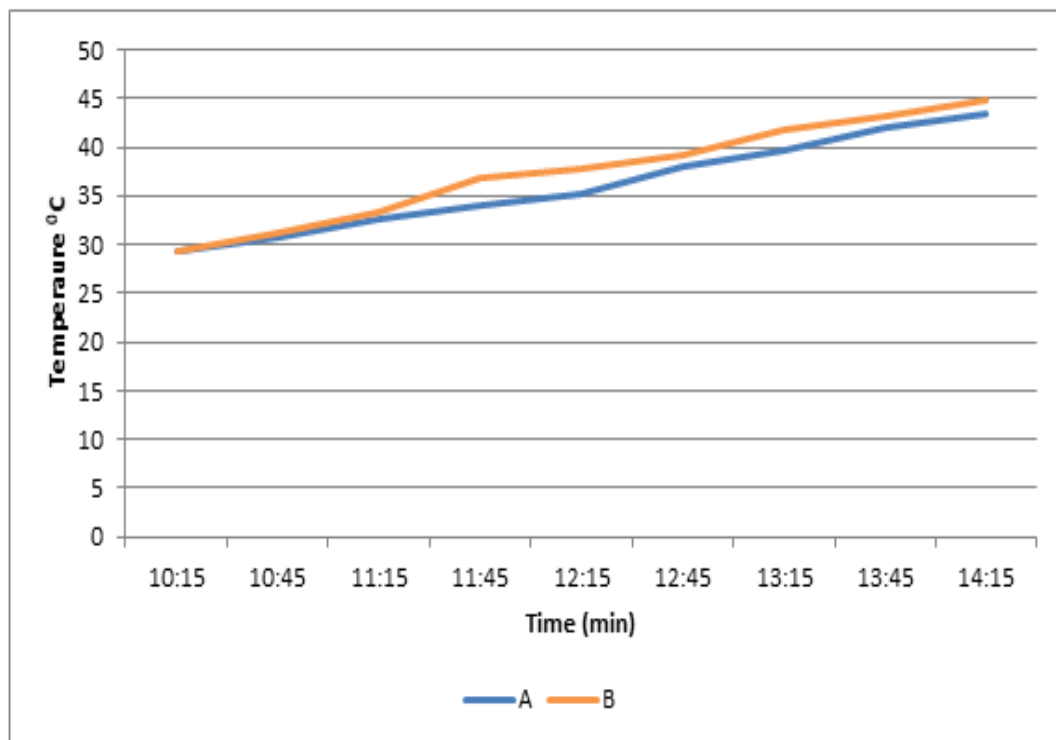


Figure 4: Complete Experimental Set up.

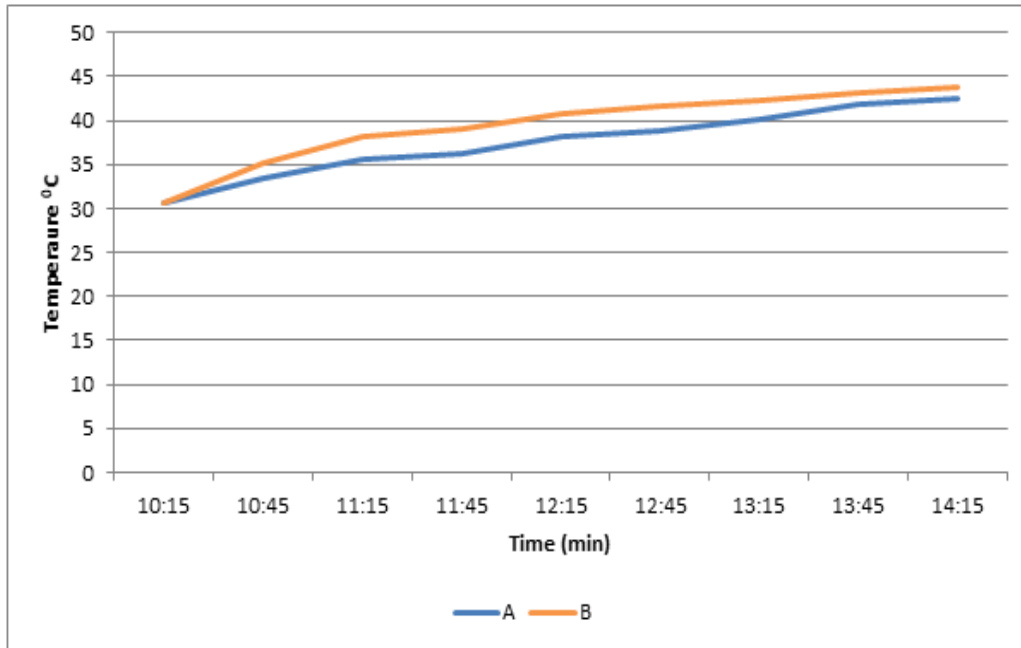
In the experimental work principally there are 2 evacuated type tubes solar water heaters set up each having three evacuated glass tubes of 1 m length and with diameter of 40 mm as outer diameter of tube and diameter of 20 mm as inner tube. No black coating is used to show strip insertion inside the evacuated tube and this is the reason why there is slightly low temperature compare to temperature obtained by other researchers. In the present experimental set up to insert the tape inside the tubes and connect those tubes with water tank coupler or reducers are used in both experimental set up.

## RESULT AND DISCUSSION

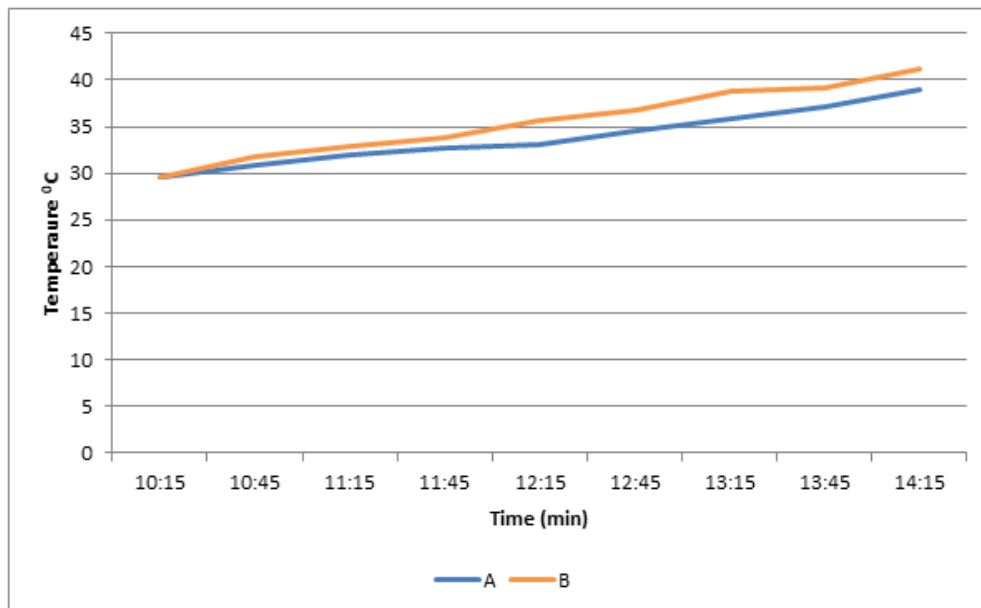
In the present experimentation the observations are taken at interval of 30 min using K type thermocouples placed at inlet and outlet of water tank for slow medium and fast flow rate of water in case of both experimental models. The water flow rate is measured using conventional method of measuring flak and stop watch with flow adjustment using tape connected with storage tank.



**Figure 5: Temperature Variation for Low Flow Rate A: Right Hand Twisted Tape in Evacuated Tube B: Left Hand Twisted Tape in Evacuated Tube.**



**Figure 6: Temperature Variation for Medium Flow Rate.**



**Figure 7: Temperature Variation for High Flow Rate.**

From observations it is clear that flow rate is the influencing factor and at high flow rate the gain in temperature is low due to less retention time for water. Most interesting observation in the present work is as the direction of flow of water is from left to right and so in case of left twisted tape inserted in the more increment in water temperature which may due to opposite direction of rotation of flow which may cause more holding period of water inside the tube and more solar radiation is absorbed by water.

## CONCLUSION

The conclusion of this work is that not only due to insertion of twisted tape the thermal performance is improved but due to direction of twisted tape insertions is equally important in comparison of direction water entry.

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