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Effect of various embossing shapes on the absorber plate, on the thermal performance of the solar water heater

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Abstract: The sun is the source of all energies available on the earth. The major advantage of the solar energy when compared to other alternative energies is that it is available in ample amount throughout the year and the best application of it is for heating and energy generation purpose. The objective of present work is to develop such solar water heater in which the absorber plate with various embossed shapes which are likely circular, triangular and rectangular(square). Also in addition to this the cavity, that is developed will be filled with various heat absorbing materials like Sand ,Salt and powdered form of glass. The thermal performance of this solar water heater will be evaluated with the help of "K" type thermocouple with appropriate location. The effect of various embossing shape on the performance of solar water with and without using black-sand to enhance the performance of solar water heater.

Keywords: Solar water heater , embossed plates

1. Introduction.

Solar energy is beaming light and heat from the Sun is developed using a wide range of technologies likely solar heating, photovoltaic, solar thermal energy, solar framework and artificial photosynthesis. It is one of the most mandatory source of non-conventional energy and it' s technologies are vastly classified as passive solar or active solar which depends on the way they capture and parcel solar energy or it's conversion into solar power. Active solar channels include the use of photovoltaic systems, full-boided solar power and solar water heating to develop energy. Passive solar techniques comprises of initiating a building to the Sun, selecting materials with responsive thermal mass or light dissipating properties, and designing spaces in which air circulates naturally.

1.1 Basic Flat plate solar water heater

SWH systems are generally very simple as they are usually using only sunlight to heat water. The working fluid is brought into contact with a dark surface exposed to sunlight which in turn causes the temperature of the fluid to raise. This fluid might be water, that is being heated directly, is also known a direct system, or it may be a heat transfer fluid such as a glycol/water mixture that is passed through some form of heat exchanger called an indirect system.

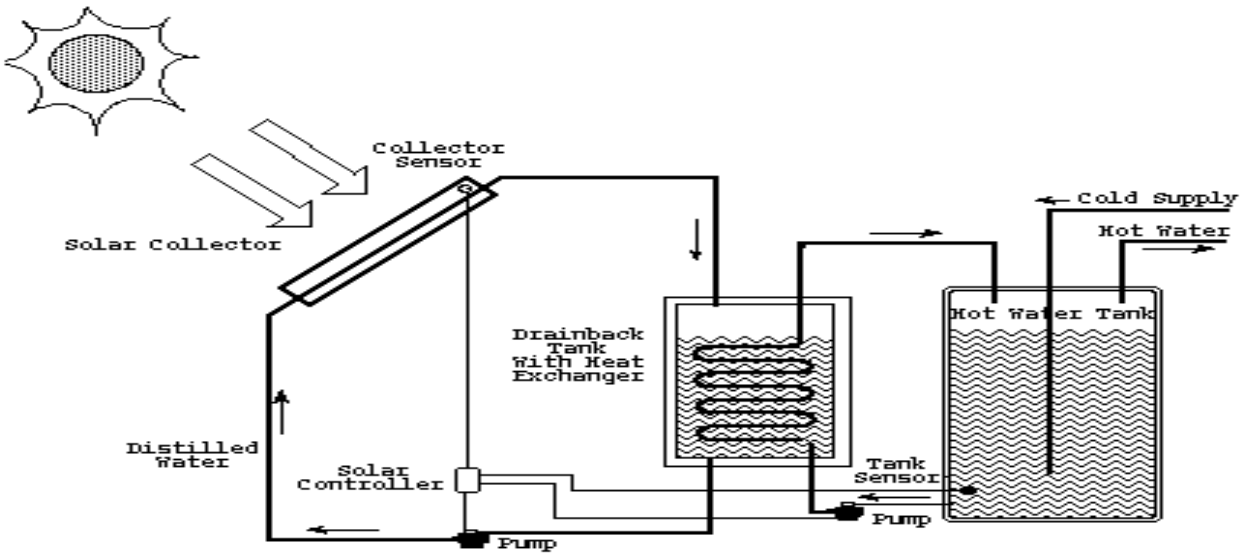


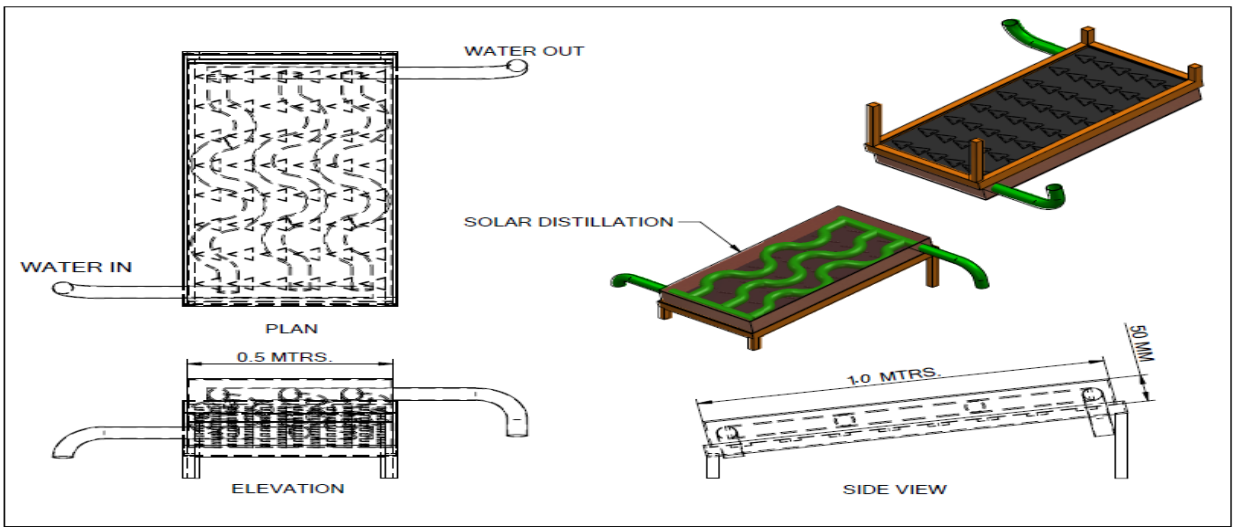
Fig 1 Simple solar water heater with flat plate collector.

1.2 Problem definition and Solution

The experiment is being carried out to develop such solar water heater in which the absorber plate having various embossed shapes which are likely circular, triangular and square. Also in addition to this the cavity that is developed will be filled with various heat absorbing materials like Sand , Salt and powdered form of glass. The thermal performance of this solar water heater will be evaluated with the help of "K" type thermocouple with appropriate location.

II. DESCRIPTION OF SYSTEM

In traditional Solar water heater systems the normal flat plates were used for collecting the Solar radiation and using that to heat the water by the conduction and convection. So we came on the decision of making the modification in the absorber plate by creating embossed shapes on the surface of absorber plate and fill up the cavity with some heat holding material like sand. The embossed shapes were square triangular and circular. The dimensions of the whole arrangement was same , only the embossed plates were being replaced in order to check which shape provides more efficiency and which one has more heat holding capacity.



This is the main model of the current experiment and only the absorber plates were made with different shapes just like this triangular one. The serpentine shapes copper pipes were used in order make the flow passage, Serpentine shape was given in order to provide more turbulence so that the fluid passing through can absorb more of heat through conduction and convection phenomena of heat transfer.

2.1 Working principle

The solar water heater is kept at angle of 28^o inclination in order to attain the full effect of solar radiation and the water flow through the pipe is by the effect of thermosyphon which occurs due to the density difference. Due to serpentine shaped pipes the turbulence is created and the flow inside the pipe gets mostly all the heat.

2.2 Mechanical parts

A. Wooden box:
The wooden box houses the whole system which includes the piping system along the glass and the solar collector.

B. Tank
The water connection to flow inside the solar water heater is made from the main tank with the help various nozzle and joints system

III. TEST RESULT

3.1Theoretical calculation

- The intensity of solar radiation is given as follows

  $I = [1+ 0.033 \cos (360 \times n / 365)]I_{sc}$

- Efficiency of the SWH is

  $$\eta = \frac{\text{Qout}}{\text{Qin}} = \frac{m\text{Cp}\Delta\text{T}}{I * A}$$

  where;

  m= 1000ml / time

  C= 4.187 KJ/Kg k (assumed constant)

Type of plate	**Average T_{in} ^oC**	**Average T_{out} ^oC**	**Mass flow rate (kg/sec)**	**Intensity of solar radiation (Kw)**	**Average Efficiency(%)**
Flat plate	**28**	**38.23**	$3.17x10^{-3}$	**1.3652**	**19.91**
Circular without sand	**28**	**40.84**	$2.73x10^{-3}$	1.3560	21.6
Circular with sand	**28**	**41.15**	$2.85x10^{-3}$	1.3622	**23.03**
Square Without sand	**28**	**35.69**	$3.03x10^{-3}$	**1.3606**	**14.33**
Square With sand	**28**	**39.84**	$2.94x10^{-3}$	**1.3608**	**29.56**
Triangular without sand	**28**	**36.84**	$3.17x10^{-3}$	**1.3615**	**16.06**
Triangular with sand	**28**	**36.76**	$3.22x10^{-3}$	**1.3622**	**17.38**

3.2 Results of Comparison of flat and circular plates

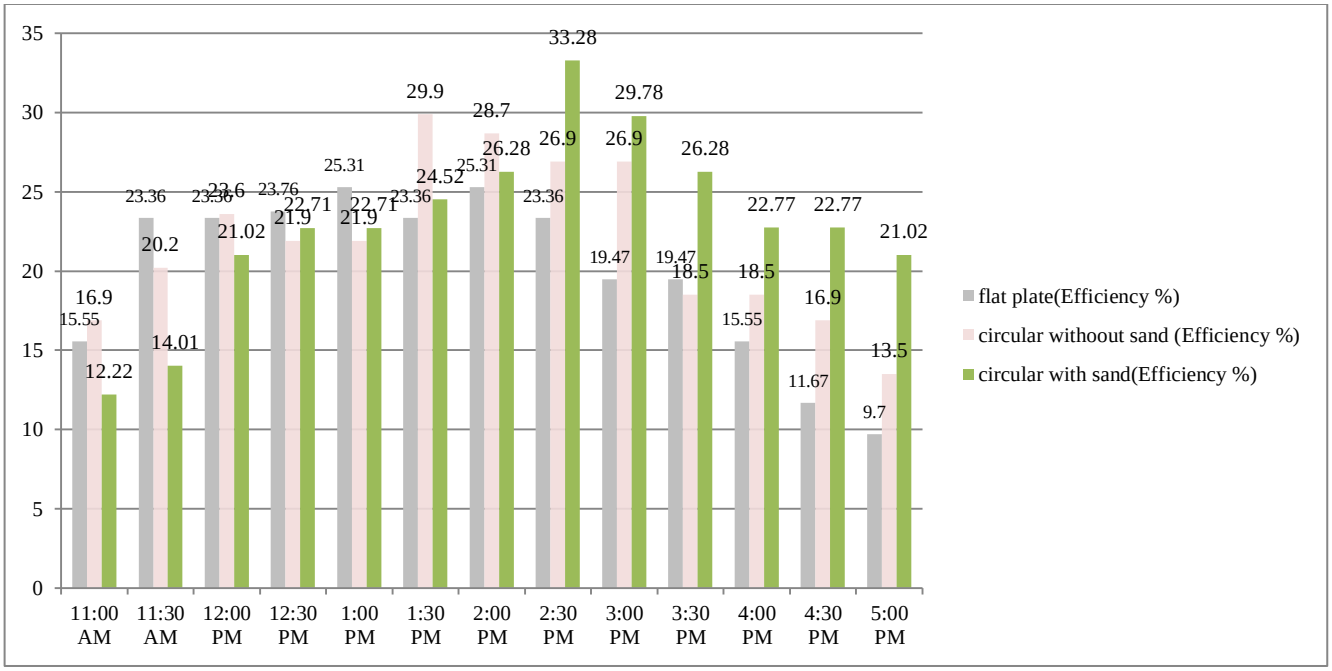


Fig 3.1 Comparison of flat and circular plates

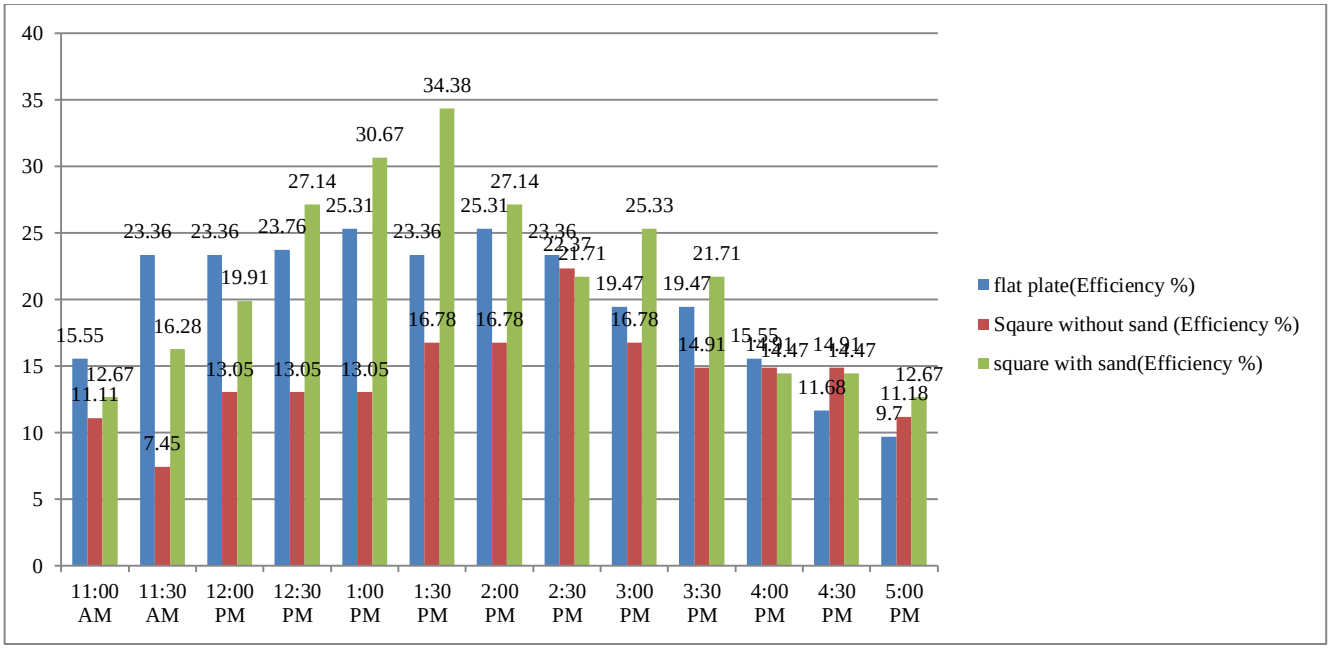
3.1.1 Conclusion

From this bar chart we can see that the efficiency of circular with sand is higher after 2:30pm in comparison to the other two cases which are flat plate and circular without sand.

The overall efficiency of circular plate with sand is 23.028% which higher in comparison to that of circular without sand which is 21.6% and also higher from flat plate which is 19.91%.

Hence from this chart we can that circular sand is having more effect in the overall efficiency of the solar water heater.

3.2 Comparison of square embossed plate and flat plate



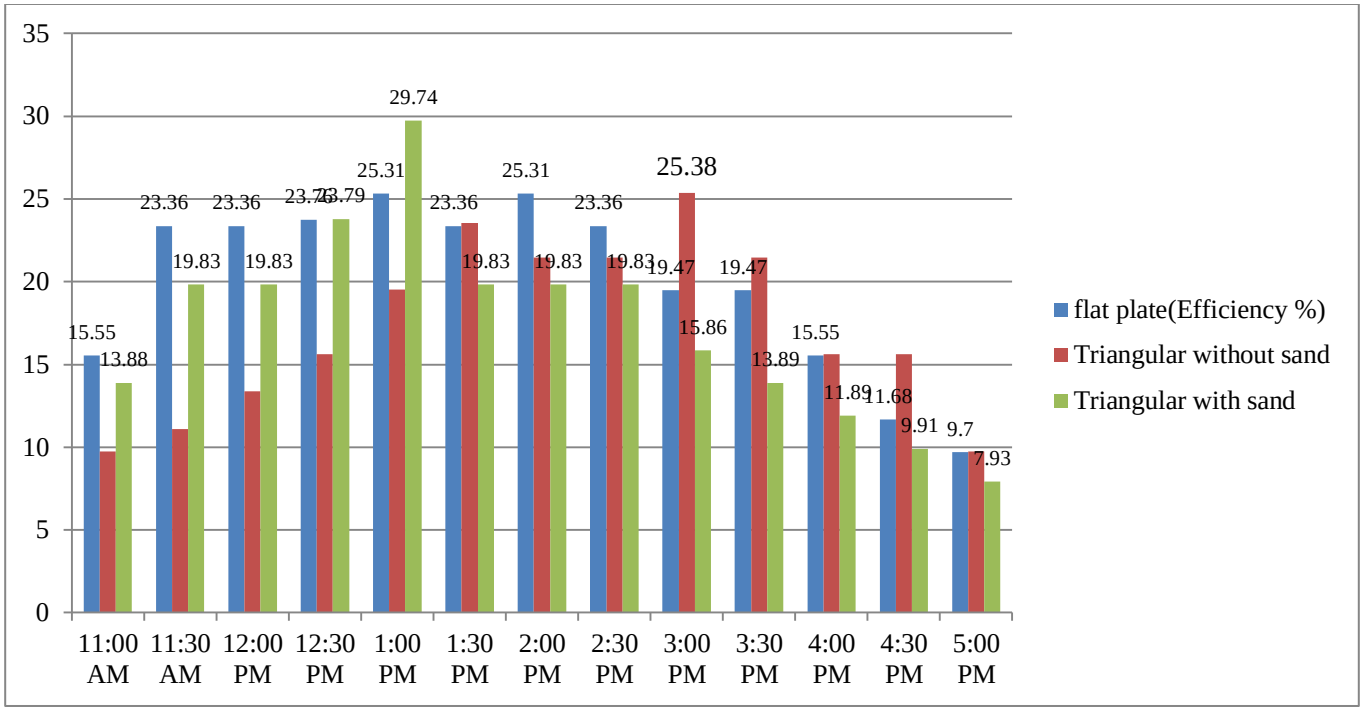
3.2.1 Conclusion

From this bar chart we can see that the efficiency of square with sand is higher after 1:30pm in comparison to the other two cases which are flat plate and square without sand.

The overall efficiency of square plate with sand is 21.56% which higher in comparison to that of square without sand which is 14.33% and also higher from flat plate which is 19.91%.

Hence from this chart we can that square with sand is having more effect in the overall efficiency of the solar water heater.

3.4 Comparison of flat and triangular plates



3.4.1 Conclusion

From this bar chart we can see that the efficiency of square with sand is higher after 1:00pm in comparison to the other two cases which are flat plate and square without sand.

The overall efficiency of triangular plate with sand is 17.36% which higher in comparison to that of triangular without sand which is 16.06% and also higher from flat plate which is 19.91%.

Hence from this chart we can that sand's effect in the overall efficiency is low in the triangular embossed shape in comparison to that flat plate SWH.

3.5 Conclusion

Hence from the above charts we can say that the circular embossed shaped plates with sand is having better efficiency in comparison to other plates. The sand had an impact in the overall efficiency also in some the days periods because its having an heat holing capacity more and due to which the overall results are successful.

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