Experimental Investigation of Solar Water Heater through Zig-Zag Tube ArrangementWithNaturalConvection.

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Abstract: Solar energy is easily available in nature, pollute less, priceless and therefore it is accepted as one of the most capable unconventional energy sources. The effective use of solar energy is held up by the intermittent nature of its availability, limiting its use and success in domestic and industrial applications especially in water heating. This topic is about to investigation and optimization of solar water heating system by varying zig-zag tube arrangement with natural convection. By using zig-zag tube arrangement in the solar water heating system the efficiency will slightly increase.

The aim of the research work is to improve the performance of solar water heater by changing the tubes geometry and material of tube..

Keyword : Solar Radiation Intensity, Tube Geometry, Tube Material, Type of Flat Plate Collector used.

I. INTRODUCTION

Now-a-days, 80% of energy is produced by the fossil fuels, and this massive exploitation is leading to the exhaustion of these resources and imposes a real threat to the environment, mainly through global warming and acidification of water cycle. The distribution of fossil fuels around the world is uneven. Middle East countries possess more than half of the known oil reserves. This fact leads to economical instabilities around the world, which affect the whole geopolitical system. The impact it has on the environment as well as on humans cannot be disputed.Solar water heating system is a natural solar thermal system. In Solar Water Heating System, incident solar radiation is converted into heat, which is transmitted to a transport medium(water). Solar water heating is often viable for substitution of electricity and fossil fuels used for water heating purpose. Flat plate collector is an expansion of the basic idea of solar energy collector in an oven like a box. The riser tubes are connected to the header tube and is placed inside the box under absorber plate. The water enters from the bottom side of the plate and gets heated into the collector area and the hot water is given out. Flat plate collector was first implemented in 1920 in Florida, and in 1953 first sample was made.

Sanjay Kumar Sharma: studied investigated on the experiments on V-Through Flat Plate Collector in Hot Climatic Conditions of Rajasthan. In this they have presented one case study related to this work at Jaipur. They have been observed that the V-grooved reflector will improved the performance of solar flat collector.

Ismail.N.R.: investigated the research work on the performance improvement the solar water heater. In this the zigzag grooves and three layers glass were used in the absorber plate for analyzing the performance of solar flat collector The results shows that the performance of flat plate shows enhance in overall conditions.

KrthikMunisamy :Stuided the Performance of solar water heating system on different tube arrangement.Incresing the thermal efficiency of different tube arrangement. In both summer and winter season high percentage of collected heat in zigzag tube arrangement.The water enters from the bottom side of the plate and gets heated into the collector area and the hot water is given out. The solar energy is the most capable of the unconventional energy sources. Due to increasing demand for energy and increasing the cost of fossil type fuels (i.e., gas or oil) solar energy is considered an attractive source of renewable energy that can be usedfor solar water heating in both industry and homes.The thermal performance of the solar collector was determined by obtaining values of instantaneous efficiency for different combination of Incident radiation, ambient temperature, and inlet fluid temperature.

Y.R.Shivarkar : Presented the work Review on recent devopment for performance aenhancement of solar Water heater.This research mainly focuses on the recent development in the field of solar water heater (SWH). The used of different techniques incorporated for improve the performance of solar water heater is mainly discussed in the research.The performance of these solar system is depends on the collector. The collector absorbs maximum amount heatfrom sun and this energy is used for heating the water. Now a day's many compact design of solar water heater isavailable. The thermal performance improvement techniques like used of grooved or rough surface absorber iswidely used in solar water heater.

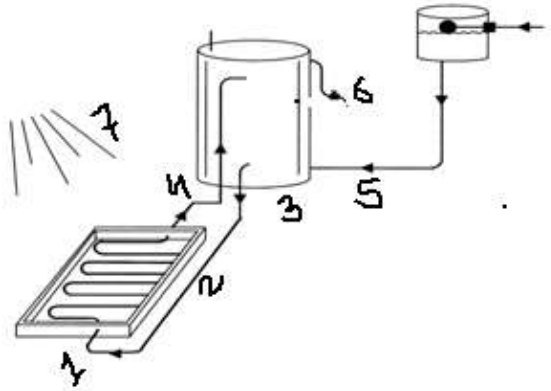
P.Shivkumar : In this research study The performance shows

that the efficiency is increase when increasing thenumber of riser tubes and its in the zig-zag arrangement (Z- Configuration) of the riser tube. Now-a-days this system produces higher efficiency than the existing conventional flat plate collector.The amount of heat delivered by solar system is 7 kW/m2 in a day. Solar collectors are commonly used for active conversion of solar energy into heat.Solar water heating system is a natural solar thermal technology. In solar water heating systems, incident solar radiation is converted into heat and transmitted to a transfer medium such as water. Solar water heating is often viable for replacement of electricity and fossil fuels used for water heating. Flat plate collector is an extension of the basic idea of solar energy collector in an oven like box; here riser tubes are connected with the header tube and is placed inside the box under absorber plate.

Jayesh V. Bute Experimental investigation of a solar Flat plate collector This study investigates the heat transfer process as well as the thermal behaviour of a flat plate collector evaluating different configurations of Tubes. This study investigates the heat transfer process as well as the thermal behaviour of a flat plate collector evaluating different configurations of Tubes. The main objective of this research is to evaluate the performance of solar flat plate collector with tube arrangement, through experimentation, theoretical formulation and its computational analysis of heat transfer.

2. EXPERIMENTAL SETUP

Solar water heater is an appliance which is used to produce hot water and steam for domestic and industrial purpose of utilizing the solar energy. Solar energy is the energy which is coming from the sun in the form of solar radiations in inestimable amount, when these solar radiations falls on absorbing surface, then they get converted into the heat, which is used for heating the water. The schematic diagram of fluid flow pattern is shown in Figure.1 Dimensions of tubes in flat collector are reduced but area of collector remains the same.The tube diameter is 9.52 mm and thickness of tube is 1mm.



1-Solar Collector , 2- Cold Water Flow , 3- Storage tank,4- Hot water Flow, 5- Cold water inlet, 6- Hot water tap, 7- solar radiation.

Figure.1 :Parts of the solar water heater.

2.1 Parts of the solar water heater

The solar water heater consists of the following parts, see the figure;

1. The solar **collector,** in which water is heated by solar radiation.
2. An insulated **storage tank**, in which the heated water from the collector is stored. The storage tank must be put higher than the top of the collector.
3. An insulated pipe connecting the lower part of the collector and the upper part of the storage tank.
4. An insulated pipe connecting the lower part of the storage tank and the bottom of the collector.
5. A **cold water inlet** connecting an existing water supply system to the storage tank. Usually the cold water inlet runs via a buffer tank with a floating gauge.
6. An insulated **hot water outlet** running from the storage tank to the tap.

2.2 Construction of the solar collectors

A solar collector consists of 4 parts:

1. The absorber

This is a dull-black painted metal body on which the zigzag pipe containing the water is fixed. The black coating absorbs almost all the solar radiation that falls on it. The collected radiation is transformed into heat and simultaneously heats the water inside. Temperatures of 100 ºC or more can be reached.

2. The casing or collector box

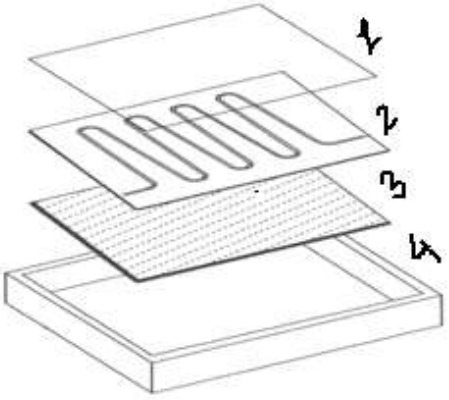
The absorber is put into a box made of wood with a depth of 10 to 15 cm. The absorber is adjusted about half way the total depth so that there is sufficient space underneath as well as above the absorber.

3. The insulation layer

The space underneath the absorber is filled with insulation material that retains the heat of the absorber. Usually the insulation layer should be about 5 cm thick.

4. The cover sheet

To retain the heat in the collector, the box is covered by glass. Thickness of the glass-sheet must be at least 4 to 5 mm. The glass-sheet allows sunshine to pass through without absorbing too much solar radiation. Also, it prevents the cooling of air by wind.



1-Glass sheet ,2- Absorber ,3- insulation ,4- Casing Or Collector box.

Figure.2 :The collector consists of a cover sheet, absorber,

insulation and casing.

2.3 Working principle of the solar hot water system

When solar radiation heats the collector, the water inside will be heated as well. The heated water starts rising through the connection on top of the collector to the insulated storage tank. Heated water entering the storage tank displaces cooler water that is in turn forced via the connection to the bottom of the collector. In this way a circulation comes into being. We call it natural circulation or thermo-syphon principle. The cold water -entering the collector- will be heated again by solar radiation. Because the water temperature inside the collector becomes much higher than inside the storage tank, the natural circulation continues as long as

the sun heats the collector. Consequently, the water inside the storage tank will get hotter and hotter. Depending on the amount of solar radiation and insulation, the system can produce water temperatures between 40 and 70 degrees Celsius.Reduce the thermal losses for providing the insulation.The wooden material uses the reducing the losses of heat.The inner casing temp.can be measured by the digital thermometer.The solar intensity is incerses 9:00am to 1:00 pm.The maximum solar intensity observed in time 1:00pm.The inlet water temp.at 9:00 am is 35^0c and solar intensity is 542 w/m^2 and outlet temp.is 41^0c.The maximum temp.recorded at time 1:00 pm.After 1:00 pm decresing the solar intensity and water outlet temp. also.

RESULTS AND DISCUSSIONS

The Natural circulation solar water heater was tested in the month of March, 2018 at intervals of one hour between 9.00 am and 5.00 pm. The incident solar radiation intensity wasmeasured using pyranometer. The water inlet and outlet temperatures for the collector as well as ambient air were measured by thermometer . The mass flow rate of the system was measured by rotometer. The collector efficiency of the system was calculated using efficiency Eq. The solar intensity is increasing from 9.00 am to 1:00 pm, reaching a maximum value . The inlet temp.of water at 9.00 am is 35.7^{o}c and outlet temp. is41.8^{0}c. The maximum temp.will be obtained at 1:00 pm is 62^0c. The temp.decreases after 1.00pm till 5.00 pm in the same manner The graph shows the variation of fluid outlet temp.with respect to time.And variation of solar intensity with respect ti time.

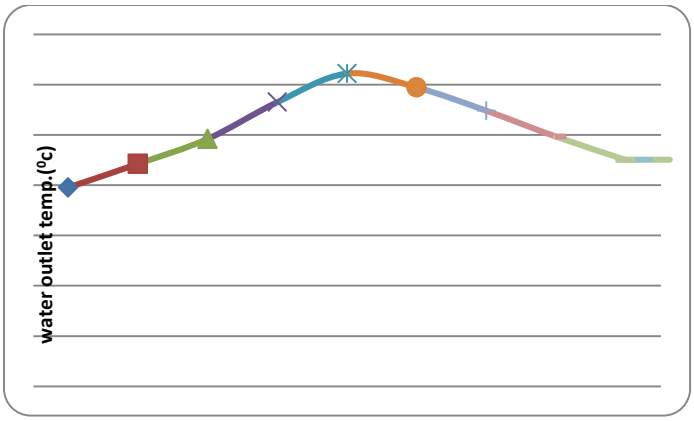


Figure 3: The curve for Hourly variation of fluid outlet temperature

Figure-3. The outlet temperatures at 9.00 hour is 41^0cfor zig-zag tube arrangement . The maximum outlet temperatures were recorded at 1.00 pm. The outlet temperature reduced after 1.00pm
until 5:00 pm. Above graph shows the total increasing temp.with respect to time.

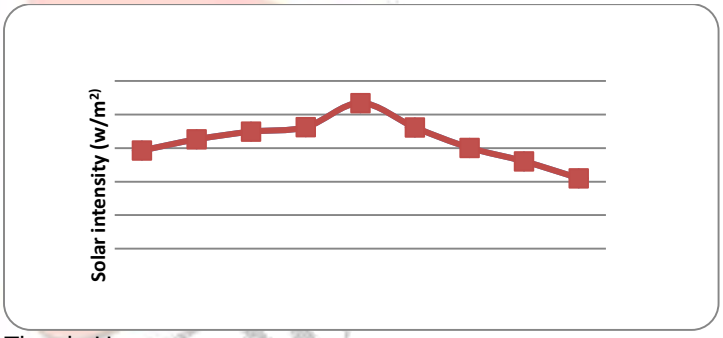


Figure4 :The curve for solar intensity against time.

The hourly variation of the solar intensity, collector efficiency and collector water outlet temperatures are shown in Figurers. The solar intensity is increasing from 9.00 am to 1.00pm , reaching a maximum value of 918 W/m_2 at 1.00 in Figure.

CONCLUSION

This study was to understand that the efficiency varies with zig-zag types of tube arrangement in the solar water heating system. The result records that the collector outlet temperature is the function of solar irradiance and time.
The maximum collector efficiency is at 1.00 pm is observed at zig-zag solar water heater. If area increase, Heat transfer also increases, so the collector tube which having large absorbed area provide high thermal Efficiency. The maximum efficiency was observed at the time 1.00 Pm.is 62^0c.

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