Thermal Performance of Solar Water Heater Using Porous Medium and Agitator

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***Abstract*- Energy application from sun to heat water is well known. Solar water heater is device which is used for heating the water for domestic and industrial purposes by utilizing the solar energy. In this review paper effect of porous material on the performance of solar water heater have been carried out. porous medium i .e metal foam, geometry of absorber plate and collector, other various things that have been investigate for performance improvement of the solar collector. Agitator is used in solar collector. The basic function of agitator in the riser tube is to increasing heat transfer; packing of collector surface with pebbles and metal chips is for longer heat absorption and enhanced heat capture respectively. It has been found that the efficiency of the solar collector with porous medium is more among all other combinations. An ASHRAE standard is used to examine the effects of metal chips on the solar collector performance at different flow rates.**

***Index Terms*- Flat plate solar collector, Porous media, Thermal performance, Pressure drop.**

INTRODUCTION

Heat transfer phenomena are applied in many industrial devices such as heat exchanges in petroleum engineering, filtration, geomechanics, and solar energy. In this paper using a solar energy for hot water generation is one of the engineering major interest areas that are concerned with sustainable energy.

Flat plate collector using porous medium and agitator is the most innovative method to improve thermal performance of solar water heater at the cost of low. The easiest and the most effective ways to utilize solar energy are to convert it into thermal energy for heating applications by using solar collectors. In solar water heater, solar collectors are a main part of solar heating system, which absorb the solar radiation and transfer it to moving fluid. We know that, there are three types of collectors and many forms of storage units. The three types of collectors are flat-plate collectors, focusing collectors, and passive collectors from these three types of collector Flat plate collector are used in this project. Flat Plate Solar Collector (FPSC) is the oldest and the most widespread one. These kinds of collectors essentially have low efficiency and have been used for Several decades without any significant attempts for improving their performance and changing their design.

Improvement of the solar flat plate collector thermal performance can lead to decreasing of its size and fabrication cost. The working fluid and the collector plate are two major components of a FPSC. [1]

In this work, using nanofluids as a working fluid is an effective method which can improve the collector thermal operation.

In order to continue and extend previous studies,this paper present Heat transfer in porous media has been used for heat transfer enhancement in solar water heater because of its considerable advantages of high solid thermal conductivity and large specific area. Porous medium i.e. metal foam can improve the collector thermal performance due to their significant effect on the base fluid thermal conductivity and also their possible effect on the thermal boundary layer. There are a great attempt to investigate the effect of different sorts of nanoparticles on the thermal performance of FPSC.

LITERATURE REVIEW

1] H.Javaniyan, jouybari, S.Saedodin [1] conducted studies on Experimental investigation of thermal performance and entropy generation of a flat solar collector filled with porous media. In their studies, thermal performance of flat plat collector fully filled with porous channel has been performed based on ASHARE standard. Using porous channel enhances the optical efficiency and reduces the heat losses in lower values of Reynolds number due to improving the potential of solar energy absorption by working

fluid. Nusselt number has a greater value in porous channel collector and its value enhances relatively up to 82% using porous media.

S. Saedodin, S.A.H. Zamzamianb, M. Eshagh Nimvaric, S.Wongwisesd,e, H.Javaniyan Jouybari[2]conducted studies on Experimental and numerical analysis of Performance evaluation of a flat-plate solar collector filled with porous metal foam. In these studies, the effect metal foam of fully filled porous channel flat plate solar collector have been investigated experimentally and numerically. these papers gives the information about the thickness of porous channel has been optimized based on absorber wall and insulated wall, The nusslet number improves relatively up to 82% with using porous material .porous material improves the absorbed energy parameter up to maximum 18.5%.Sorour, [3] has designed and fabricated three models for FPSC in which the working fluids obtains the thermal energy from a transparent cover and flow perpendicular to a porous absorber. Lansing and Clark [4] in their studies an analytical solution to determine the temperature distribution. It is used in solar air collector they improve performance of collector by 102%.Al-Nimr and alkam, improve thermal performance of tubeless FPSC by placing porous medium layers at the boundary side of the collector and also the effect of porous are used at boundary wall of tubular FPSC. Leinstreuer and chaing[5]have numerically solved coupled fluid and heat transfer porous medium FPSC and compared its thermal performance with that of a tubular collector. Mbaye and Bilgen,[6]a numerical study of natural convection in porous wall solar system. They investigate effect of different geometrical factors. H.P. Garg et al. [7] reported that the storage potential of built-in-storage type solar water heater with transparent insulation is higher than that of a system with moveable insulation. R.P. Sharma [8] proposed that Agitator in the raiser tubes enhanced heat transfer while Pebbles and stainless steel chips enhanced the retention period of heat. The internal dimensions of the collector were 1.2m x 0.6m x 0.18m. Agitator using curling copper wire inside the raiser tubes in the form of a helix was used to increase the heat transfer coefficient. Pebbles and stainless steel chips were used to cover the absorber surface to enhance heat transfer and retention of the transparent insulation more than offsets its better insulating property during the sunshine hours. Raj Thundil Karuppa R et al. [9] tested with the absorber made of 2 sheets of GI (1 mm) with integrated canals, painted in a silica based black paint solar water heater and small pump for forced circulation. It can be concluded there is little difference between the output temperatures while using copper and GI different collectors. Efficiency of the flat plate collector for copper is 24.17% and GI is 20.19%. Alberto García, et al. [10] investigated the heat transfer augmentation in the flat plate solar water collector using wire inserts experiment were performed with different mass flow rate values. It was concluded that wire-coils can be inserted in the riser tubes of flat plate solar water collectors for improving its heat transfer rate and thermal efficiency. By inserting wire-coils the collector efficiency was increase by 14 -31%, counted on mass flow rate. Volker Weitbrecht et al., [11] performed, the results of an experimental study conducted in a water solar flat plate collector with laminar flow conditions to

METHOD AND MATERIALS

Researches present the idea to utilise different porous material on a flat plate collector[1-5].we utilize one of this porous material i.e. pebbles stones on flat plate collector and agitator in riser tube for enhanced heat transfer rate of flow. Aschematics principle is shown in the fig.1.

A Solar water collector using pebbles stones is modified.water tube risers which is made up of copper are sorrounded by porous media,so that copper tube heated with help of pebbles stones.

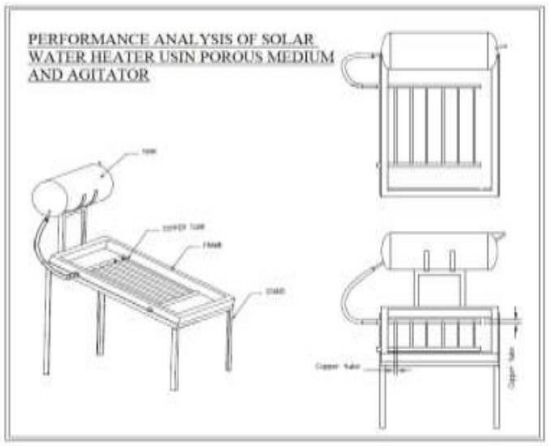

Fig.1 A schematics view of solar flat plat collector using porous media and agitator

Fabrication

A copper tube is chosen for water flow because it is easy to heated and to devlop a surpentine flow.The distance between two adjacent tubes from centre to centre is 60mm.Fig.(1).

First of all iron box as shown in figure.3 was made for collector it is the most important part.

Figure 3.Iron box used in the study

Iron box insulated with glass wool.Solar radiation falling on the absorber plate was heating the copper plate and some of heat was transferred to water flowing thriugh tubes.

The copper tubes were joined by welding. Copper rod was used for welding the rods. The arrangement of copper tubes as a carrier of fluid is shown in fig.

Figure.4.Copper tube structure of Flat Plat Collector

Double glazing was used as to protect the loss of heat.The thickness of inner glass was kept 3mm and outer glass 5mm.Double glazing because of more heat is lost by single glazing.Double glazing results more absorption of heat at the inner side.Glass is effective in reducing rediated heat loss because it is opaque to the longer wavelength infrared radiation and re-emitted by the hot absorber plate.The collector with freame as shown in figure.5.In this way collector was fabricated.

A tank was used in solar water heating system called hot water storage tank to store hot water.After completing the fabrication of collector and tanks assembly of different components was done and was fitted to circulate the water towards the collector.

Figure.5.Collector with frame

EXPERIMENTAL SET UP

The set up installed at the roof of GCOEA college building at amravati,india which has geographical location is (26013'17'N78010'41"E) and elevation is 196m.The collector is installed at optimum angle for amravati(230)for summer climatic condition facing south.It was made sure that the system is free from shadows Further collector connected to 5 liter with inlet and outlet supply from 300 lite supply tank with gravity flow. The system installation is shown in fig.6.Adata logger is use to record the temperature of inlet,outlet of water, surface temperature of plate and ambient air temperature. The value of various temperature recorded by data logger at every 33 sec.

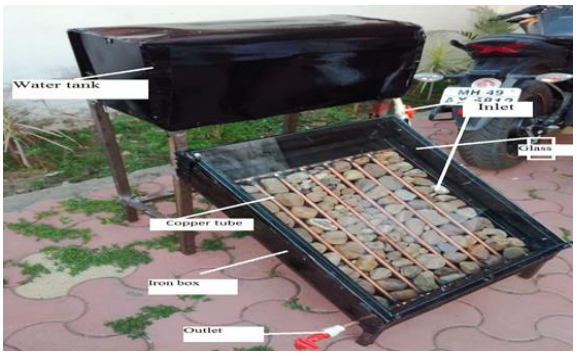

Figure6. Experimental set up of solar collector using porous material and agitator

RESULTS AND DISCUSSION

Experiments were conducted in the summer seasons of Indian climatic conditions and in the premises of GOVT COLLEGE OF ENGG AMRAVATI. Observations taken for a particular day are used in the study. Fig.6.1 shows the variation of solar intensity with respect to time of the day. Fig. 6.2 shows the variation of WATER temperature at the

outlet of the heater. Maximum 10 % variation is obtained between the theoretical and experimental values.

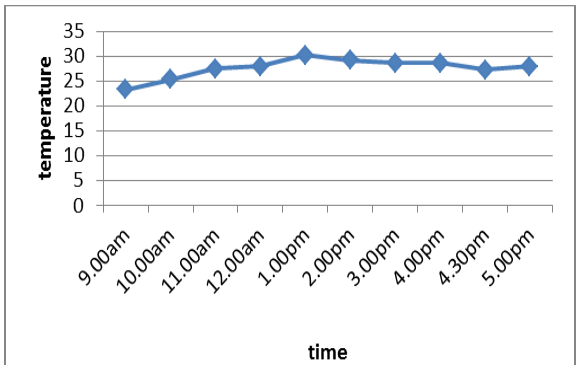

Figure :6.1. solar water heater

Agitator in the riser tube:On by using Agitator in the riser tube of solar water heater there is a gradual increase of temperature but however there is a decrease in temperature after certain time. graph are tabulated below,

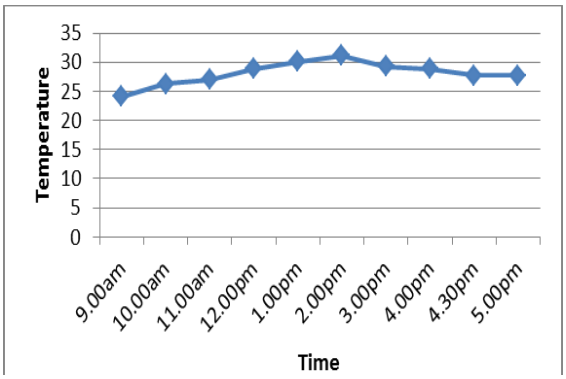

Figure :6.2. temp Vs time with agitator

Case 3: Agitator and porous medium in collector On by using Agitator and porous medium in the collector temperature rise as well as temperature is being maintained constant Graph are tabulated below

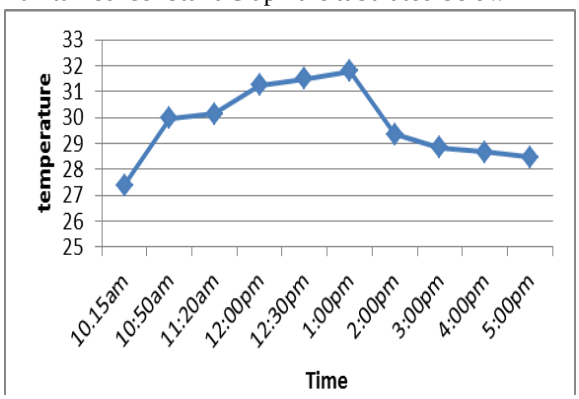

Figure 6.3. temp Vs time with porous medium

Case 4: Agitator, porous medium and transparent cover in collector. On by using Agitator, porous medium and transparent cover in the collector high temperature is being achieved and as well as temperature is being with stand for longer time. graph are tabulated below.

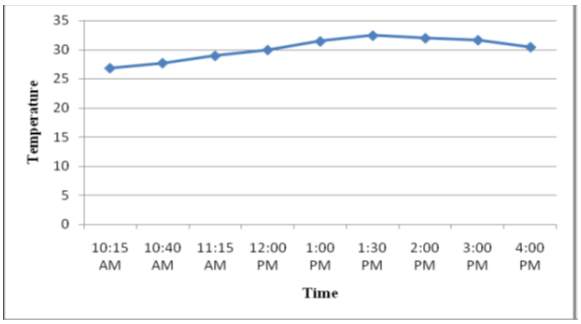

Figure 6.4. temp Vs time with agitator, porous medium

CONCLUSION AND FUTURE WORK

The following conclusions are observed by the present study for low cost flat plat collector: In this project study of effects of porous metal foam on the thermal performance and pressure drop of a fully porous channel FPSC. In this study solar energy was used to heat water through sun energy. Collector absorbs the heat from sun and rises the temperature of collector. Solar flat plate collector has low efficiency because of convention heat transfer loss so that in this project this factor is considered and prevention of this loss is done by porous medium and agitator in riser tube. If there will be more solar radiation than more will be temperature of water. Different readings have been taken and noted. Following parameters have been measured:

Following are the maximum temperature attained by solar water heater:

1. Ordinary solar water heater ----------35
2. Solar water heater with agitator----------36.15
3. Solar water heater with porous medium--------47.5
4. Solar water heater with agitator and porous medium---50.01

Here porous medium used is pebble stone as it had high heat energy absorbing properties, so it has highest temperature in comparison with agitator and ordinary solar water heater.

FUTURE WORK

Further research will involve testing to measure problems associated with colletor filled with porous materials.The work involves testing various assembly

methods, such as making the design cheaper by taking out the SFPC.

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