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Design, Fabrication and Testing of Evacuated Heat Pipe Solar Collector Using Nano Fluid

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ABSTRACT

The solar energy is the most capable of the alternative energy sources. The sun emits the vast amount of energy on earth every day. But we are unable the use it to its full extent. The conventional solar water heater suffers from heat losses due to radiation and convection. Such losses increase rapidly as the temperature of the working fluid increases. Evacuated tube solar collector, which uses the circular heat pipes with CuO-H2O Nano fluid has better thermal performance than conventional heat pipe evacuated tube solar collector tube. The effects of the angle of inclination and the variation in percentage of nano particles in the collector were also studied. The solar energy is the most promising energy source for the future.

Keywords- Nano fluid, heat pipe, glass tube, solar energy, solar radiation

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I. INTRODUCTION

Evacuated tube solar collectors are designed in such a way that heat loss to the environment is reduced. Solar heater is a device which is used for heating the water, for producing the steam for domestic and industrial purposes by utilizing the solar energy Solar energy is the energy which is coming from sun in the form of solar radiations in infinite amount, when these solar radiations falls on absorbing surface, then they gets converted into the heat, this heat is used for heating the water.

This type of thermal collector suffers from heat losses due to radiation and convection. Such losses increase rapidly as the temperature of the working fluid increases The demand for energy is increasing at staggering rate. The population is increasing and there is also increase in the demand of energy. The conventional sources of fuel are unable to provide the solution for this increasing demand. The pollution has become a major problem. The conventional energy sources produce the pollution and also they are costly. The conventional sources will be exhausted over the span of few years. It has become the need to find the new sources of clean energy. Solar energy fits all the norms as it is infinite and produces no pollution. The solar energy has vast potential to fulfil our needs. The sun almost gives us 3.8*10^26 Joules of energy per second. But we are unable to use it to its full potential. So it has become the necessity of the time that we must focus our attention towards the solar energy. Solar water heating systems are the cheapest and most easily affordable clean energy available to homeowners that may provide most of hot water required for a family. Solar heater utilizes the solar energy to produce the hot water and steam for our use. This type of thermal collector suffers from heat losses due to radiation and convection. Such losses increase rapidly as the temperature of the working fluid increases. In this process we have varied the percentage of nano particles in the working fluid to get better results regarding efficiency of the system.

Types of Nanofluids:

There are several types of the Nanofluids Important among them are as follows-

- Metallic Oxides (Al2O3,CuO)
- Nitride Ceramics(AIN,SiN)
- Carbide Ceramics(SiC,TiC)
- Metals(Cu,Ag,Au)
- Semiconductors(TiO2,Sic)

Objective:-

The solar energy is available in the vast amount. The solar energy gives the vast amount t of energy but we are unable to utilise it to its full extent. The conventional solar heater suffers from the losses in the radiation and convection. The objectives of this project are

- To increase the heat transfer rate.

- To increase the overall efficiency of the solar water heating system.
- To reduce the time required for heating the water.

II. LITERATURE REVIEW

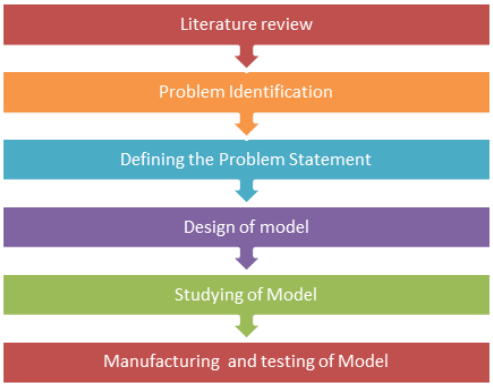
Vishwajeet Khalipe, Padmakar Deshmukh,[1] Authors focus on studying the effect on heat transfer rate and efficiency of evacuated tube collector using Nano fluid and studying the effect of orientation of evacuated tube collector on its performance. The effects were compared with the conventional heat pipe collectors using water as working fluid. It was found that the thermal performance of solar collector with heat pipe containing Nano fluid is better than that of conventional heat pipe collector.

Ahmed Kadhim Hussein, Lioua Kolsi, Sanatana Kata, Brundaban Sahoo,[2] Author have studied the heat pipe collector. They have studied various nanofluids used in the heat pipe collector.The relation between the size and volume fraction of the nanoparticle and efficiency of the heat pipe collector were studied.It was found that the efficiency of the heat pipe collector was directly affected by the properties of nanofliuds used. It is also suggested tthat more economical and non-toxic nanofluids must be found out. The mixture of various nanoparticles must be used to improve efficiency further

N. H. Mujawar, S. M. Shaikh,[3] In their study they used the CuO nanoparticles as material for making nanofluids. The nanofluid was preapared by using water Ethylene glycol mixture as conducting material. The mixture was prepared in the ratio 70:30. The CuO Nanoparticles were added in this mixture. The effects of fluids on the heat carrying capacity on the heat pipe collectors was observed. It was found that the heat carrying capacity of the CuO Nano fluid increas. es as the temperature increases. Also the viscosity of the fluid increases with increase in the temperature. Hence it has good thermo physical properties at increased temperature. There was also greater increase in efficiency of the heat pipe collector with small amount of increase in the amount of nanoparticles .

Khullar Etal [4). In their study, the aluminium based nano particles were suspended in Therminal VP-1 base fluid with 0.05% volume concentration. The results were compared with the conventional concentric parabolic solar collector which reveals that increase in 5-10% of thermal efficiency was observed. Currently, Titan C.Paul,et.al summarized their experimental investigation on next generation solar collectors (CSP) using NEILS (Nanoparticle Enhanced Ionic Liquids) as working fluids their results revealed that thermal conductivity was enhanced around 5% depending on the base fluid and ionic concentration. The heat capacity of nanofluid using Al2O3 nano particles was enhanced by 23% and 26% for nanofluids using silica nano particles and similarly 20% enhancement in convective heat transfer capacity was also observed.

III. METHODOLOGY



IV. HEAT PIPE

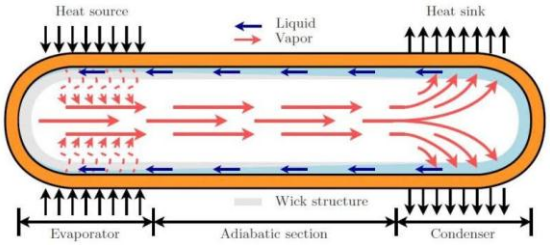


Fig.1 Heat Pipe

A Heat pipe is a sealed copper to that is under vacuum, and can transfer heat rapidly away from the source. It has very high effective thermal conductivity. Heat pipe is device which can transfer heat from one place to another by the help of vaporization and condensation of a liquid.

V. HEAT PIPE SOLAR COLLECTOR (HPC)

The heat pipe or some times called the evacuated tube solar collector (ETC) consists of a heat pipe maintained inside a glass enclosure . This type of collector are invented in order to solve the problems which are appeared in the conventional flat-plate solar collectors. Since , the latter collectors efficiency are connected significantly with the weather conditions. In other words , their performance decreases dramatically in the cold, cloudy and windy days [27]. In addition to the severe weather conditions, both the condensation and moisture cause early failure of internal pipe materials and reduces the collector performance. Also, the limited quantity of heat transferred by the classical base fluid Moreover, the forced circulation system due to the pump and its extracted power, extra space required for the natural circulation system due to the position limitations required , the night cooling due to the reverse flow of cooled water, freezing of the water on cold nights, pipe corrosion due to the use of water can be considered as an additional problems.

VI. NANOFLUIDS

In the present work, nanofluids are prepared by two step method. Copper oxide (CuO) nanopowder are purchased from Sisco Laboratory, Mumbai. The average particle size (APS) of CuO nanopowder is 40nm. Both these nanopowder were mixed in calculated proportion in 500ml of distilled water. We added 32gm of CuO (1% by volume) in 500ml of

distilled water. Then the nanofluid was stirred well for proper mixing of nanopowder. The prepared nanofluid was then delivered to Golden Star Technical Services Pvt. Ltd., Pune, the manufacturers of heat pipe, for charging the heat pipe with Nanofluid.

Fig.2- CuO Nanopowder

Advantage:

- The HPC is very suitable for very cold regions.
- It can be operated effectively at the high temperatures and low incidence angles.
- The efficiency of HPC is high in comparison with the other conventional collectors.
- The size of the heater was reduced effectively by using heat pipe technology. Also the cost and space requirements are also reduced.
- The vacuum envelope of HPC reduces both the convection and conduction losses, so it can be operate effectively at the high temperatures.

Applications:-

- Thermal Power Plant.
- Boilers.
- Home electric gizzard system
- Heat Exchanger.
- Refrigeration and Air Conditioning System.
- Sugar Industry.

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VII. CONCLUSION

This paper provides an integrated approach to manufacturing, designing of Sola . In comparison between CuO Nano fluid and water when used as working fluid, CuO Nano fluid shows better heat transfer characteristics as compared to water.The heat pipe shows a higher thermal resistance during startup, but eventually reduces with increase in heat input. CuO shows lesser thermal resistance than the water during initial startup.In condenser section, pipe wall temperatures increase towards the end where the coolant outlet pipe was located. The increase was due to the gain of heat by coolant water flowing from inlet to outlet section of condenser.The thermal performance of solar collector with heat pipe containing nanofluid is better than that of conventional heat pipe collector. There is 10-15% rise in instantaneous collector efficiency due to nanofluid as a working fluid. Nanoparticles must be dispersed uniformly in the base fluid to enhance the solar-weighted absorption and increase the efficiency of the solar collector. 5-Volume fraction of nanoparticles must be chosen accurately to enhance the performance of nanofluid collectorIt is recommended to use carbon nanohorns (CNHs) as a nanoparticles to improve the optical properties of the HPC. This is due to their large surface area and large number of cavities. Further efforts must be directed towards various significant challenges in the field of nanotechnology and its application in the solar collector such as : Brownian motion of particles , particle migration,changing thermophysical properties with temperature , tendency of nanoparticles to agglomeration , changing nanofluid properties by using additives and the stability of nanofluids. The results of the reviewed papers indicated that the overall performance of HPC is a function of nanofluid properties and the other properties of system heat loss coefficient of solar collector, and obtains the amount of more heat energy.

VIII. ACKNOWLEDGMENT

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