

WWJMRD 2017; 3(2): 32-36
www.wwjmr.com
Impact Factor MJIF: 4.25
e-ISSN: 2454-6615

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Comparison of evacuated tube and flat plate solar collector – A review

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Abstract

Solar energy is an enormous and mostly untapped resource. Solar energy remains used mainly in small direct-use application such as water heating. Solar energy is used as direct light and heat from sun that is yoked with a scale of ever-needed innovative technology such as solar water heating, Solar Air heating, Photosynthesis, etc. It is a universal energy used by most of peoples. It is renewable and ecofriendly energy. Solar energy is trapped by solar collector. A collector of solar collects heat by gripping process. Solar collector is describing as a device deliberate to attract incident solar radiation, transference the energy to fluid transient in contact with it usually liquid or air. Heat pipes are primary heat receiving device in solar collector. Heat pipe heat exchanger is a device which is used to transmit the heat from one side to another place using an evaporation-condensation cycle. In solar collector, three types of solar collectors are being used. The names of heat pipes are evacuated tube, flat plate solar collector and focused solar collector. The performance of heat pipes is determined by working fluid. But now day's Nano fluids are used in heat pipe. In otherwise Nanofluid describes the fluid requiring Nano particles is called Nano fluid. Nano fluid plays an important task in water heater, power generation.

Keywords: Solar Energy, Heat Pipe, Nano fluids

1. Introduction

In the world, plenty of energy sources are available. But some sources are eco-friendly and non-polluting the environment. At the way, solar energy is a prudish used energy. Because coal, gasoline and fossil fuels are creating a many disadvantages to atmosphere. Nuclear reaction obtains in sun and radiation emitted from sun. It is called as solar energy. In earth, solar collectors are mainly used to capture the solar energy. These are flat- plate solar collector, evacuated and focused solar collectors. Inside of solar collectors having long vertical heat pipes that are placed in proper distance. At first, Heat pipes were developed by NASA for Space applications. Later on, still now, it will have been using for many applications like solar water heating solar cooling systems. Heat pipe having three types of sections. Evaporation section, adiabatic section, condensation section. When a working fluid entering evaporation section, fluid is evaporated. Then evaporated fluid flow through adiabatic section. In adiabatic section, heat does not transfer to environment. So, heat transfer value is zero. At last evaporated fluid come into condensation section. In condensation section evaporated fluid condensed to fluid.

1.1 Flat Plate Solar Collector

Flat plate collectors consist a flat-plate absorber which is colored as dark, a transparent cover, working fluid and baking which is insulated. A flat-plate absorber which is colored as dark that has a thin absorber sheet which has been backed by a fluid tubing coil.

This heat energy then transferred to the liquid (water) that will have been circulating through pipes which is fitted with the absorber plate in which is absorbing the heat. The absorbing plate is made up of aluminum or copper, because these types of metals are very good heat conductor which transfers large amount of heat by conduction. Mainly copper is used for absorber plate and it is more expensive, but less corrosive than aluminum.

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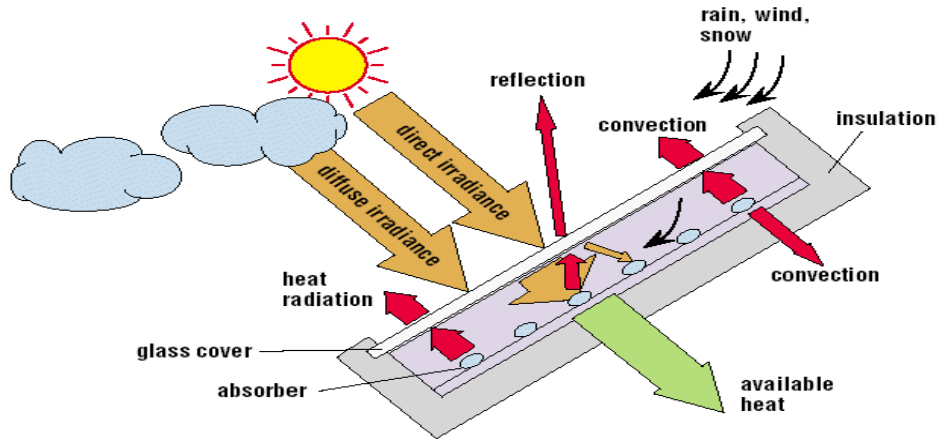


Fig 1: Flat plate Solar Collector

1.2. Evacuated Tube Solar Collector

Evacuated heat pipe operates differently than the other

collectors. This solar collector is consisting of a heat pipe that will be having a vacuum sealed tube at inner side.

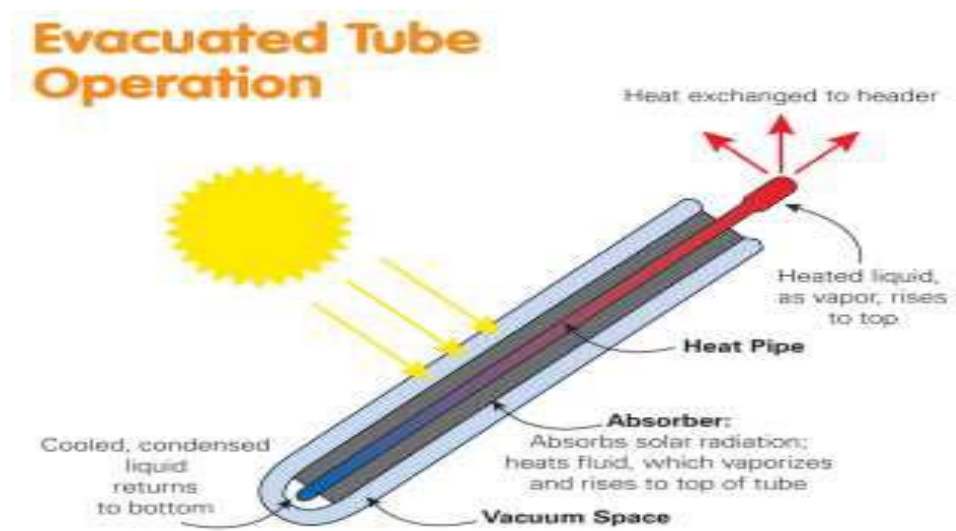


Fig 2: Evacuated Tube Solar Collector

Evacuated or Vacuum Tube Solar collector have been using for absorbing solar energy and also converting it into heat in that type of evacuated solar collectors, the heat will be dissipated from condenser section to water which is contacting with the heat pipes in evacuated tube solar collector. Evacuated tube Solar collectors are highly efficient one. it is able to use in subzero temperature conditions. it requires small roof area comparing to other solar collectors.

2. Importance of Heat Pipe in Solar Collectors

By comparing the heat pipe with other thermal conductivity materials, heat pipes are 1000 times better than that materials. Heat pipes are having lower temperature differences between hot and cold interfaces. Many researches are going on in solar collector for improving their performances by using Heat pipes and Nano fluids (which is used as working fluids in heat pipes).

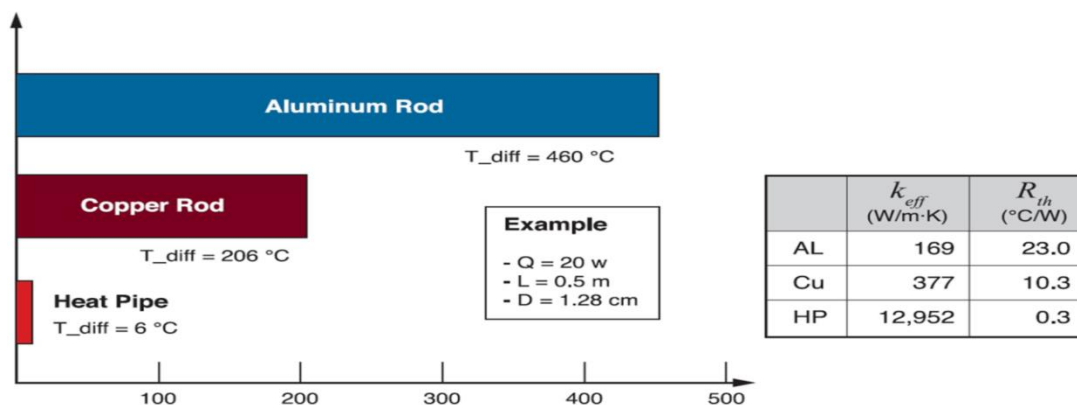


Fig 3: Comparison of Al, Cu and Heat Pipe's thermal conductivity

2.1. Working Fluid

Working fluid are plays chief task in heat pipe. The efficiency and working properties are determined by the working fluid. It should not only have the concern thermo-physical properties relates the applications, and retain chemical stability in the desired temperature range. The type of fluid identification which affects the operating condition, environmental impact, selection criteria are set out in this selection to locate the potential working fluid candidates for different cycles at different conditions. Several awareness should be there for selecting the working fluid.

2.1.1. Nano Fluid

A modern advancement in nanotechnology has been introduction of Nano fluids that are having a colloidal interruption of Nano meter sized solid particles in place of common working fluids. A Nano fluid is a fluid that contains Nano meter sized particles, called Nano particles. A conventional fluid that has mm-or μm -sized particles do not work with the emerging "miniaturized" technologies, because, they can clog the minute channels of these devices. Then, Nano fluids contain materials size is 1-100 nm, it is one of the properties of the Nano fluids. A Nano fluid is a companionable and non-companionable material.

3. Literature Review

Performance of evacuated tube collector were used in renewable energy source were most widely used in many countries save in our environment. If uses of Solar energy for generating hot water by Vacuum tube solar collector that would be helping to progress the consumptions of energy and energy efficiency. It was compared to other collectors to produce high efficiency. (Raghurajsinh.B-2016). In a Solar Collector with back filled with Nano fluid as working fluid, using solar tracking system by using a experimental setup of a flat plate collectors using the heat pipe system. Heat pipes using in each set up three identical thermosyphon (no wick) copper heat pipes are using and it has L is 620 mm and O.D of 18 mm. The working fluid of one set up was having pure water and another setup was pure water with Nano particles. The Nano particles were used in Carbon Nano Tube (CNT) that have the length 0.1-10 μm and diameter 10-12mm. The working fluid of Nano fluid gave better performance in all conditions. (R. Senthil Kumar-2012).

This energy is one of the cleaner forms of arenewable energy resource. The solar collectors using various applications such as water heating, space heating and cooling. Nowadays usage of Nano fluid, are basically liquid Nano particles of a colloidal depression as a working fluid has been found to an enhanced flat pipe TPCT solar collector thermal efficiency. The flat plate solar collector with heat pipein which working fluid is $\text{TiO}_2\text{-H}_2\text{O}$ Nano fluid surfactant provision of the solar tracking mechanism. (A.A. Pawar-2015). The Vacuum or Flat plate solar collectors were beingused to gathering a sun rays in non-concentrated way for cooling and also heating purposes. It gave efficiency is high and cost effective methods to the technology which is for the so familiar to the world. It may be used for high humidity, lower temperature and generally poor weather conditions. In more efficient and modification technology to evacuated tube collector. (Mujawar.N.H).

The rectangular performance of the characteristics

introduced on a tubular evacuated solar collector. TheCondensation effects of working fluid was disappearing, ifcritical temperature which about high T_c of the working fluid. Our heat pipe system will be chosen by the working fluid with critical temperature between 95-115°C. (F. Mahdjuri). The flat heat pipes from observation to the modelling of the capillary structure. It is made by inside six different flat plate heat pipes (FPHPs). The capillary structures are copper and silicon system are used in different size are studied. The transparent plate upper side was fully covered by the hermetically sealed. The experimental results are compared to the analytical model describing the both considering permeability and equivalent to thermal conductivity of porous medium. It will compare between the model and experimental data makes possible to the estimation of physical properties of the capillary structure. The performance of the heat pipes in a several applications with several electronic components. (Frederic Lefevre-2012). The heat pipes are heat exchanging device that transfers to the more amount of heat because of a capillary action and phase transition heat transfer, if uses of the Nano Fluid as working fluid, it reduces the dry out problems and also heat transfer capacityin solar collectors and also tilting angle is so important they said that around 60°tilting angle which gives optimum performances for wick and wickless heat pipes. (G. Kumaresan-2012). Heat transfer enhancement in heat pipe using Nano fluid. The heat transfer in heat pipe, Nano fluid vital role and new frontier in various applications. The summary of the work on heat pies using Nano fluid as a working medium. Various types of Nano fluid with different base fluid as proved it potential to improve the thermal properties of working medium in heat pipe. The heat transfer enhancing mechanism after utilization of Nano fluid in heat pipe has been explained. This paper that had been discussed about relativity of whole heat resistance between the Nano fluids filled heat pipe and the heat pipe with existing fluid. (A.A. Walunj).

The behavior of Nano fluid is for improving the thermal performance of a circular heat pipe. The heat pipes are made by copper tube using hybrid Nano fluid ($\text{Al}_2\text{O}_3 + \text{CuO}$) are water base working fluid. The setup is designed and constructed to a study thermal performance of heat pipe under different operating conditions. This study presented that a discussion on the effect of the charged volume ratio of working fluid. (Kamble D.P-2014). The flat plate collectors were used for water heating purpose. Due to problems in a conventional collector like corrosion,scaling, reverse heat flowing, small size with low efficiency and not to a possible to work early in the morning because of low solar intensity and the effective heat exchange device like heat pipe in the solar collectors. Heat pipe made by copper tube with 6mm ID and 0.5mm thickness and filled with concentration 0.3% of Al_2O_3 as Nano fluid. An efficiency of 60% is found for 60% filling ratio and 31.5° tilting angle. Results are obtained were analyzed to investigate the performance of a system for future scope point of view. (Kumudini Gharge-2015). Effect of using Nano fluid in solar collectors. According to this review of a paper presents the effect of the Nano fluids on performances of the solar collector's efficiencies and eco-friendly advantages. The effect of surface to volume ratio on thermal conductivity is higher than that of effect of the Nano particle's surface sizes. (K. Sopain).

Harvesting the solar energy is an important research around the globe due to inadequacy of the natural resources like oil, gases and other fuels. It is important to consider the efficiency of the collector and how well it transfers heat into working fluid. The overall performance in solar collector and the amount of energy and the performance of a solar collector right throughout the air. Experiments were conducted on the designed, two different solar water such as evacuated and flat plate collectors. Evacuated tube made from borosilicate was used in this research work. From the analysis of the results, it had been found that converting thermal efficiencies of an evacuated tube is 41.3% than the flat plate collector tested in earlier work of the investigator. (S. Sadhish kumar-2016). Solar energy techniques in flat plate collector. Analysis given in this paper will help to create the best design and operational conditions with the best economic characteristics for solar plate collectors. (Pravin N. Gajbhiye-2012).

A heat pipe using different Nano fluids. This paper was reviewed on the use of various Nano fluids consisting of many novel properties which helps in increasing the heat transfer from the system. The principle of a thermal conductivity and phase transition are used in a heat transfer device called the heat pipe. Silver, cu-water, alumina are the some Nano fluids are being used for enhancing the performance of the heat pipes. The heat pipe basically consists of the container, thee working fluid and the wick or capillary structures. Isolation of the working fluid from the outside environment is done with the help of container or casing. The use of Nano fluids enriches the thermal performance in a heat pipe more than water. (MS. Shaibaaz-2015). Solar thermal energy refers to the technologies that utilize the sun energy for cookery, for heating water and alternative heat transfers fluids for a range of residential, industrial and utility applications. The current is an in-depth perspective of the analysis progress arisen within the performance of solar dish victimization Nano fluids. This study is administered to estimate the potential to style a smaller solar dish that may turn out a similar desired output temperature. This is often obtainable by victimization Nano fluid as a operating fluid. (Priyanka Borkar-2015).

4. Comparison of Flat Plate and Evacuated Tube

Evacuated tube do not have same level corrosions problems as existing in flat plate solar collectors, Flat plate collectors are having more roof area than Evacuated tube solar collector, flat plate collectors are so cheaper than an evacuated tube because of simple design and easy to manufacturing. Flat plate collectors are heavier than evacuated tubes. Evacuated tube heating capacity is more than flat plate collectors. Generally, evacuated tubes lean-to snow is very poor. This is because the tubes create a strong vacuum inside the tube.if uses of a flat plate, it can lean-to snow easily with just a little sunlight.by comparing the both of the solar collectors, Evacuated tube collector is more efficient than the flat plate collector. If do some modification of design parameters and also integrating the heat pipes in flat plate solar collectors, we can improve the performance of the flat plate solar collectors.

5. Conclusion

This paper presents an over views of comparative performance study of flat-plate and evacuated solar

collector. Studies of Nano fluids reveals that high thermal conductivities and heat transfer co-efficient compared to those of conventional fluids and When compared those kind of solar collectors, high performance has been given by evacuated tube solar collectors.If modification of flat plate integrated with heat pipe, it can give better performance than the plain flat plate solar collector.Evacuated tubes are having snow shed problems due to creating vacuum inside the tube. Flat plate can shed snow very easily in little sun shed. If uses of Nano fluid in solar collectors, it reduces the dry out problems and also high thermal capacities through literatures.

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