

Fabrication and investigation of solar water heater with evacuated heat pipe using nano fluid

**Manish S. Lande¹, Sujit T Chavan², Nilesh R Dhanwate³, Avinash A Dudhbhate⁴,
Manoj R Chavan⁵**

¹ *Asst. Professor Mechanical Engineering Department, Sinhgad Institute Of Technology And Science, Pune, India.*

^{2,3,4,5} *Mechanical Engineering Department, Sinhgad Institute Of Technology And Science, Pune, India.*

Abstract

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. To overcome this losses we use SWH using nanofluid system. This system include heat pipe using nanofluid. Because of that it absorbs maximum heat and also reduces heat losses. In this paper we explained SWH using nanofluid and analysis of parameters using Taguchi Method. The term 'nanofluid' refers to a two-phase mixture with its continuous phase being generally a liquid and the dispersed phase constituted of 'nanoparticles'. In this experiment we considered three parameters such as Diameter of heat pipe, Mass flow rate, Length of glass tube. By using these three independent parameters, with each having three set values in L9 orthogonal array, we find out optimum combination of parameters. In taguchi method we take analysis of variance, regression analysis and validation test. Analysis of variance gives us Mass flow rate has stronger evidence and hence it is more effective parameter.

Keywords – Nanofluid, Heat pipe, Orthogonal Array, Taguchi method, Thermosyphon

I. INTRODUCTION

The solar energy is the most capable of the alternative energy sources. Due to increasing demand for energy and rising cost of fossil type fuels (i.e., gas or oil) solar energy is considered an attractive source of renewable energy that can be used for water heating in both homes and industry. 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. Solar energy is considered nowadays as one of the most important sources of clean, and renewable energy with minimum environmental effects.

The solar energy is widely believed to be the most sustainable form of energy among another renewable energy sources. By mid of the 21st century, renewable sources of energy could account for 60% of the world' selectricity market and 40% of this market are come for fossil fuels. Solar energy is a natural result of electromagnetic radiation released from the Sun by the thermonuclear reactions occurring inside its core. It has produced energy for billions of years, so the utilization of solar energy has received signification especially in the last ten years. For example, some studies have indicated that about 1000 times from the global energy requirements can be achieved by using solar energy;

however, only 0.02% of this energy is currently utilized .The main reasons of this huge attention in the solar energy applications are due to the increased demand of energy, limited availability of fossil fuels and environmental serious problems related with them especially the CO₂ emissions. In fact, the sun radiates every day, enormous amount of energy and the hourly solar flux incident on the earth's surface is greater than all of human consumption of energy in a year. Recently, one of the future projections is to reduce global carbon dioxide emissions by 2050 to 75% of its 1985 level if we can improve and use the solar energy equipment's such as the solar collectors. A number of systems have been developed to collect solar energy and convert it into an alternative form of energy, electricity, or to use the solar energy to perform work, such as in the case of a solar water heater. An important component of all these systems is the solar collector, which absorbs the solar radiation from the sun and transfers it to some transfer medium such as water, which delivers the heat as hot water to a house or to a heat storage unit. Among different types of solar collectors, one example of an advanced and highly effective type of solar collector is an Evacuated Tube solar Collectors (ETCs) consists of a heat pipe maintained inside a glass enclosure. Evacuated tube solar collectors are designed in such a way that heat loss to the environment is reduced. Heat loss due to convection cannot cross a vacuum as it forms an efficient isolation Mech.

Nomenclature

SWH	Solar Water Heater
ICS	Integral Collector Storage
CNT	Carbon Nanotube
PCM	Phase Change Material
HPC	Heat Pipe solar Collector

II. RELEVANCE

In actual, the project deals with study which is related to Engineering. In four year of engineering course one of the subjects from each semester is related to this project. Thermodynamics, Applied Thermodynamics and Heat transfer subjects have given idea about mode of heat transfer rate. Material science gives idea about selection of material used in frame of project. As the project basically deals with

heat transfer Solar Energy the main subject related is Renewable Energy Sources. In short the total project is based on the whole study of mechanical engineering.

III. MOTIVE

Now a days, efficiency of solar water heater is very low, because of solar shine problem and various heat losses during the operation. Also, the conventional SWH takes greater time for operation. we have to improve in that area so that's why in order to increase the efficiency of SWH by using evacuated solar collector pipe using heat pipe in system with the help of nanouid.

IV. OBJECTIVE STATEMENT

- To collect the required input parameter by referring research papers
- To design Solar Water Heater system with evacuated heat pipe
- To manufacture model of solar water heater
- To investigate system for determining efficient and convenient combination

V. WORKING PRINCIPLE

- In this project sun rays strike on a solar insulation then the solar insulation absorb heat and transfer heat from evacuated glass tube.
- After that Nano fluid vaporize in the heat pipe and transfer heat from heat pipe to cooling fluid water.
- Then the water is heat in minimum time 30 min and this hot water using for different application like Boiler, Heat exchanger, RAC System.

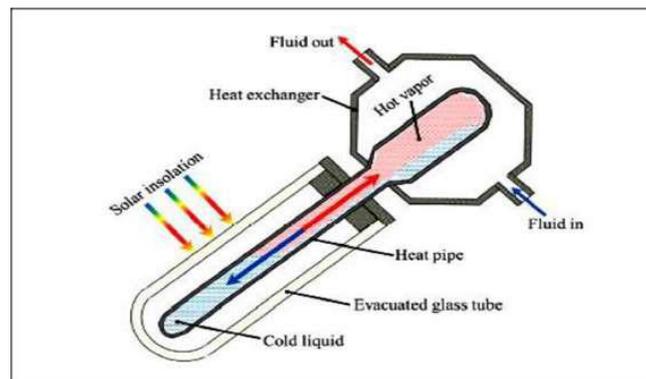


Fig .Heat pipe working cycle

vi. Selection of Nanofluid

- As listed below some of the alternatives of the nano fluid that we can use for manufacturing of SWH. From these we have selected nano fluid.
- While selecting nano fluid we have considered various factors such as Density, Melting Point, Molar mass and Cost.

Table: Properties of Nanofluid.

Nanofluid	CuO	Al ₂ O ₃	ZnO
Melting Point (°C)	1201	2977	1975
Density (kg/m ³)	6.319	3.69	5.606
Molar Mass	79.55	101.96	81.38

(gm/mol)			
Rate (Rs/gm)	40	40	182

VI. SUMMARY

We know that the solar energy is the most capable of the alternative energy source that can be used for water heating in both homes and industry. And solar water heater used for recovering waste solar energy use of Solar Water Heater extremely reduced global warming. To increase the efficiency and to overcome the problems in current Solar Water Heater we are designing a Solar Water Heater for better experiences. The research paper we studied gives us detail knowledge about basic components and their working of solar water heater. Also it gives idea of design consideration for different components of solar water heater.

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