PROJECT REFRENCE No: 46S_BE_4739

“Performance Enhancement of Evacuated Tube Solar Collector Using Oil and Nanoparticles”

RV Institute of Technology and Management

JP Nagar 8th Phase Chaithanya Layout, Bangalore 560076.

DEPARTMENT OF MECHANICAL ENGINEERING

Name of the students with USN No.

1	RACHOTTI SAIKUMAR	1RF19ME020	8970038912	saikumarrachotti2000@gmail.com
2	MILINDA CHAWAN	1RF19ME015	8277426728	milindchouhan2001@gmail.com
3	Rahul C D	1RF20ME401	8296944617	rahulcd2001@gmail.com
4	SUMAN BM	1RF20ME403	9353041808	sumanbm_mel20.rvitm@rvei.edu.in

Under the guidance of :

Dr. Lokesh Paradeshi

Assistant Professor
Department of Mechanical Engineering

RV Institute of Technology and Management, Bangalore

1. INTRODUCTION

The depletion of fossil fuels and the worst impact on environmental pollution caused of their burning have led to the search for renewable clean energies. The sun in the solo system is the main source of energy for all living beings. Solar energy is the most abundantly available energy with free of cost in all regions. This chapter deals with introduction to ETC, Problem definition, methodology and structure of thesis.

Solar energy has become an increasingly popular alternative source of renewable energy in recent years. One of the most effective ways to harness solar energy is through the use of solar thermal collectors, such as the evacuated tube collectors (ETCs). ETCs are widely used in domestic and industrial applications for water heating (Fig 1.1), space heating, and cooling. Despite their effectiveness, ETCs suffer from some limitations that affect their performance, such as heat losses due to convection and radiation.

Fig 1.1 Domestic ETC

Fig 1.2 ETC setup

Evacuated tube collectors are extensively and widely used because it's good thermal insulation characteristics and insensitivity to the direction of sunlight. There are three types of evacuated tube solar collector, namely (a) Water–in glass evacuated (b) U-type evacuated tube evacuated tube solar collector and (c) evacuated tube heat pipe solar collector. The function of an evacuated tube heat pipe is to absorb the incident solar radiation over the evacuated tube and to transfer as much of that absorbed energy in the

form of heat to the inside heat pipe, which turns heat up a secondary medium, e.g. water or oil, that is in contact of two concentric tubes, i.e. an inner and an outer tube, such that the air in between the tubes is evacuated, and then the tubes are sealed together at the end. The vacuum between the pipes plays an important role in the thermal performance of the evacuated tubes; such that it eliminates the convection loss and improves thermal insulation the inner tube is coated with a selective coating material, which has a high absorptivity and a low emissivity.

2. OBJECTIVES

The main objectives of the project include as following:

- The main objective of this project work is to improve the heating capacity of evacuated tube solar collector that comprises heat pipes.
- Thermal oil is introduced in the evacuated tube in order to increase the rate of heat transfer, such that the mode of heat transfer from the inner surface of the evacuated tube/Solar collector to the heat pipe becomes convection and conduction through the installed fin.
- The finned surface has been replaced by nanoparticles with oil and further the performance of the solar collector is studied.
- To conduct experimentation under the metrological conditions of Bengaluru.
- The experimental results are obtained and compared for the results and discussion.

3. METHODOLOGY

- An experimental setup is developed to study the effect of oil and nanoparticles on the performance of evacuated tubes or solar collector with heat pipes.
- The experimental investigation is carried out under the metrological condition of Bangalore.
- The performance of the evacuated tube collector or solar collector is compared with bare evacuated tube with heat pipe and oil filled and nanoparticle filled.

4. RESULTS AND CONCLUSIONS

The results and discussion section of the project report on "Performance enhancement of ETC using oil and nano particles" aims to present and analyse the experimental observations obtained during the study.

5. EXPERIMENTAL OBSERVATION

In this section, we present the results and analysis of the experimental observations conducted to investigate the performance enhancement of ETC using oil and nano particles. The experiments were designed to evaluate the impact of incorporating nano particles and Mobil Thermo oil on the heat transfer characteristics of the collector. The findings discussed in this section contribute to understanding the potential benefits and practical implication of utilizing oil and nano particles in enhancing the performance of ETC.

5.1.1 Solar Insolation

The solar radiation falling on the ETC tube is calculated with respect to time. The below **Fig 5.1** as shown in below figure the solar insolation at a particular time that is from morning 6 AM to evening 6 PM. By seeing this bar graph, we can say that at 12 PM we can get the maximum solar insolation that is 950W/m^2. The minimum solar insolation we got is 50W/m^2 at 7AM. From this we can conclude that the maximum solar radiation falling on the ETC tube is in afternoon rather than morning and evening.

5.1.2 Ambient Temperature

The atmosphere temperature is measured by using k type thermocouple and recorded. The ambient temperature is plotted against the time as shown in the **Fig 5.2.** From graph ,we noticed that the ambient temperature is maximum that is 32℃ at 1 PM. Due to the high solar insolation at the afternoon the maximum ambient temperature is recorded. The minimum ambient temperature is recorded at 6 AM due to less solar insolation.

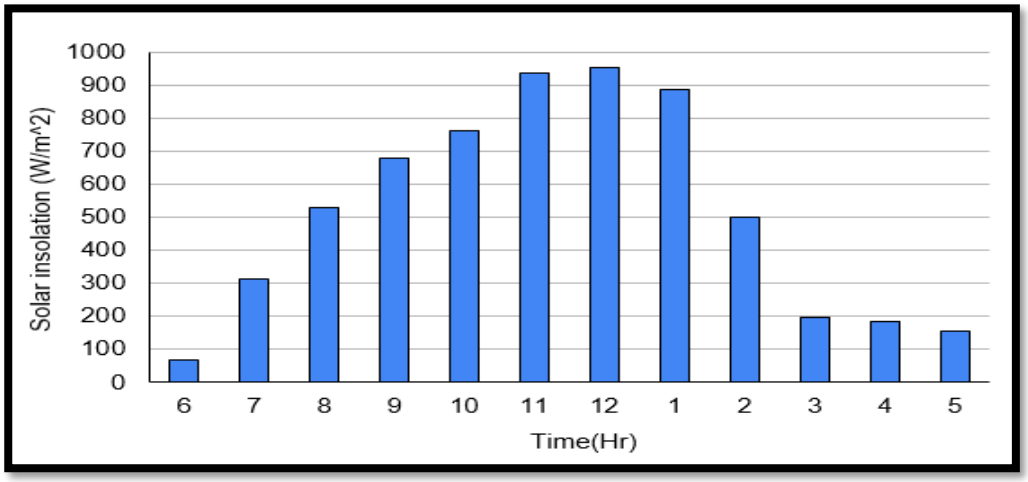

Fig 5.1 Variation of Solar Insolation Vs Time

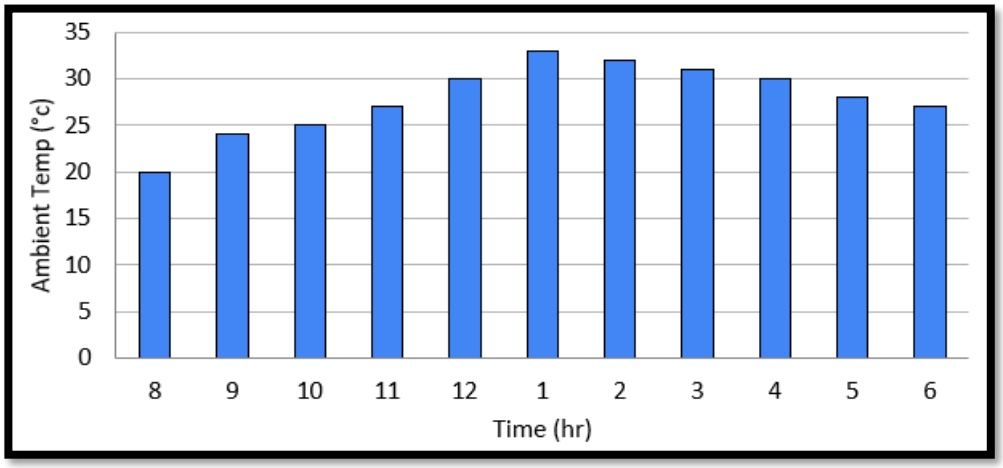

Fig 5.2 Variation of ambient temperature with respect to time

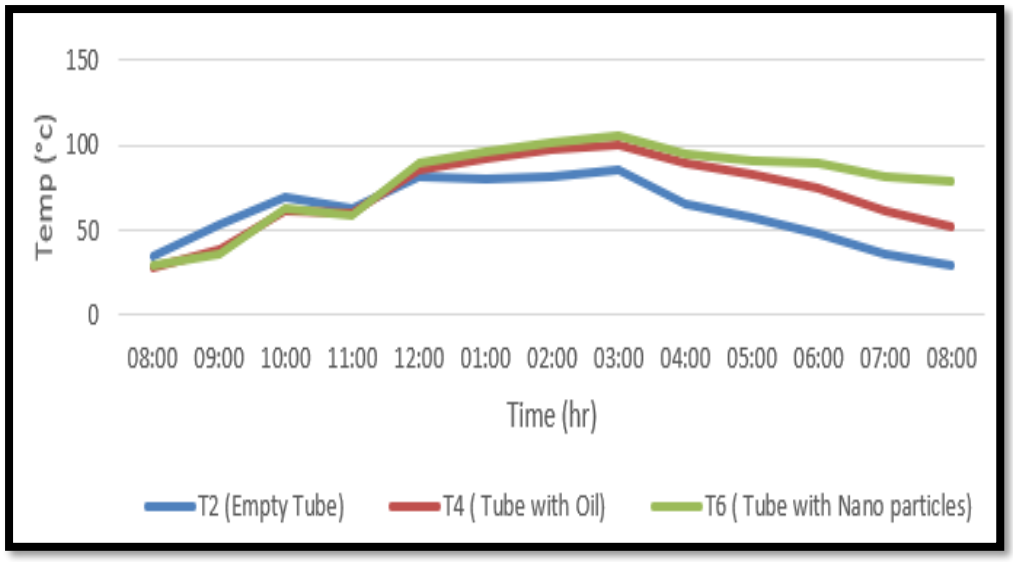

Fig 5.3 temperature v/s time (Heating Rate)

5.1.3 Heating Rate

The below **Fig 5.3** shows the heating rate of each case with respect to time, the first case shows the ETC tube without oil and nanoparticles which is represented in blue colour and in this case, we can get maximum heating rate at 3:00 pm that is 82℃. The second case shows the ETC tube filled with oil and in this case, we can get maximum temperature at 3:00 pm that is 100℃ which is represented in red colour. Coming to the final case shows the heating rate of ETC tube filled with both oil and nano particles; we get maximum temperature of 105℃ at 3:00 pm.

5.1.4 Temperature Distribution

The temperature distribution for **Case 1**: Evacuated tube collector heat pipe, **Case 2**: Evacuated tube collector heat pipe with oil, **Case 3**: Evacuated tube collector heat pipe with oil and Nanoparticles. It is seen from the **Fig 5.4** that the temperature has reached to 140℃ with case 1.i.e. heating of oil using normal evacuated tube heat pipe. In case 2, it has reached to 149℃ with oil in evacuated tube heat pipe and in case 3, it has been seen that the temperature has reached to around 156℃ during the peak time in the day.the graph clearly shows that the temperature increases by adding nanoparticles.

5.1.5 Cooling Rate

The rate of cooling is measured for each hour. The cooling rate is measured for all three cases, that is ETC tubes without oil, with oil and with oil and nanoparticles. According to the below **Fig 5.5** the ETC tube without oil will cool very fast compared to other two cases. The ETC tube with oil will cool slowly compared to the first case. But the ETC tube with oil and nanoparticles will cool slowly compared other two cases. This is because of nanoparticles which will not allow the heat to escape but they try to store the heat.

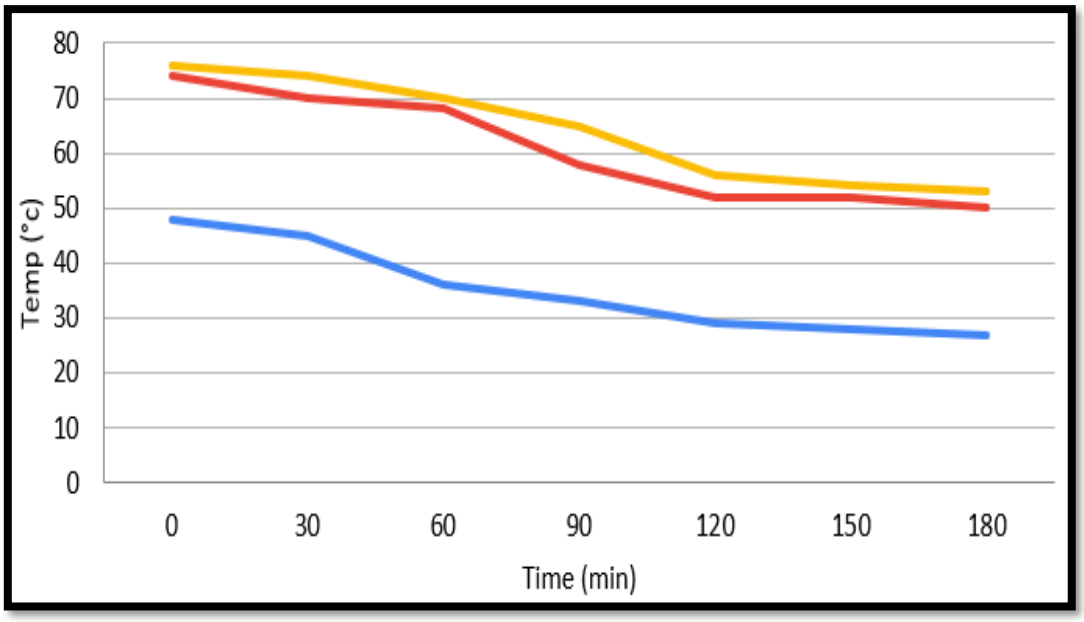

Fig 5.4 Temperature v/s Time (Cooling Rate)

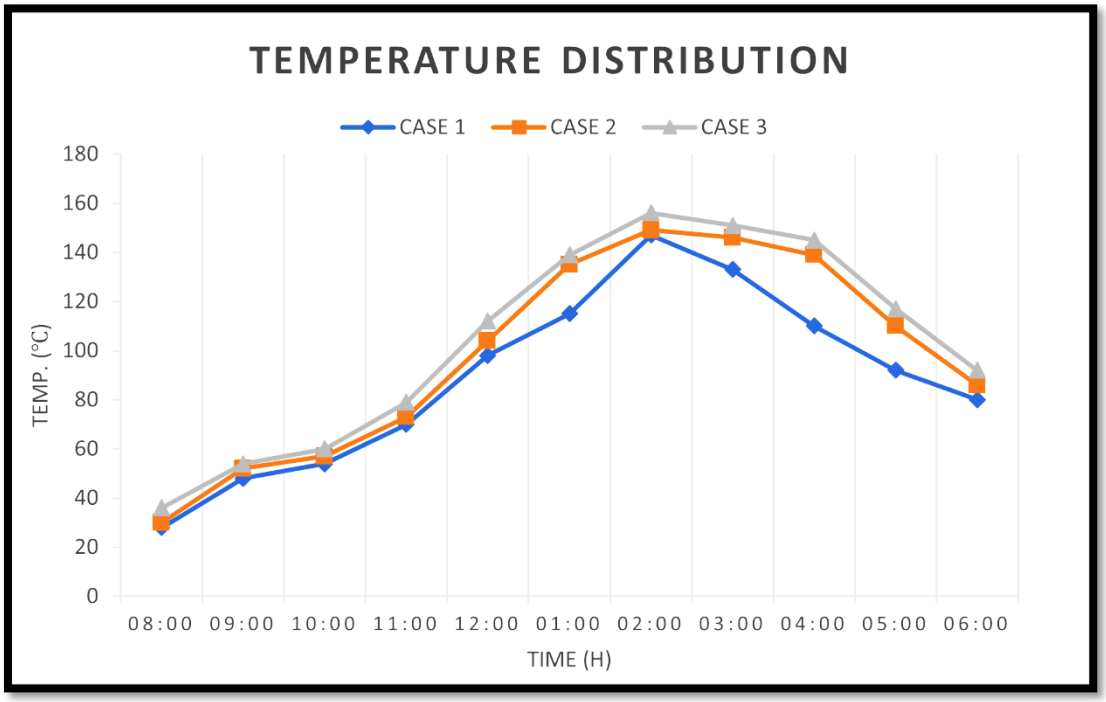

Fig 5.5 Temperature distribution Vs time (For different cases)

6. CONCLUSIONS

The experimentation has been done in RV Institute of Technology and Management under Bangalore metrological conditions. Some of the major conclusions are listed below.

- The temperature of heat pipe increases to about 15%, which improves the heat transfer rate.
- The jackets act as a Heat storage device, (even in the absence of sun after sunset), where the heat can be used for any heating applications.
- Nanomaterials increases thermal conductivity of the oil which in turn increases the temperature of heat pipe.
- The heat produced by the Evacuated Tube Collector can be utilize for drying applications.

7. NOVELTY

The novelty of the project includes

- Conventional energy consumption will reduce for the various heating applications.
- It reduces the impact of Ozone and Global warming potential.
- The project will able to deliver a cost-effective heating system (Solar dryer) for particular applications.

8. SCOPE OF FUTURE WORK

The some of the future plans are listed below to utilize the heat transferred by Evacuated Tube Collector:

- Heat transfer by ETC can be drawn using air blower at the input.
- By constructing the drying unit at the output, the heat can be used for drying applications.
- The ETC can be adopted in Parabolic Trough Collector to improve the thermal performance of the working fluid.