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Design and Fabrication of Evacuated Tube Solar Air Collector for Heating Air

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Abstract *In this project experiment we have shown the thermal performance of evacuated tube solar air collector which is experimentally investigated at various air flow rates. In this air from blower is used as a working fluid and tested in different climatic conditions. The evacuated tube solar air collector consists of nine evacuated tubes and heat exchanger. The heat exchanger consists of a hollow square pipe which passes through the centre through which air passes with the help of blower at a specified flow rate. In this we study the different outlet temperature at different ambient temperature and solar intensity and plot a graph of different temperature intervals in a day and note the variation of temperature.*

Key Words: *Solar radiation intensity, Air flow rate, Evacuated tube solar air collectors, Header (Heat exchanger).*

1. INTRODUCTION

In today's world the energy crisis is developing at a high pace. Using energy resources such as fuel, conventional energy resources such as crude oil, coal, any other fuels extracts from the earth and be renewed. Now we are at the stage where the search for other alternative methods that replace the fossil fuels has become vital. This project and work is based on the alternative methods by which we can reduce the consumption of fossil fuels and to provide a renewable source of clean energy. So we do need to consider all the other alternative resources and related activities. As the source of energy we consider about geothermal energy, solar energy, nuclear energy etc. And out of all those solar energy is available in abundance. Talking about India, we burn millions tone of coal and fossil fuels every year for energy production and also importing a lot from other countries as well as but we need to replace these conventional resources with clean resources. Solar energy is one of a kind available in abundance and the best thing about it is renewable and non polluting and also of low cost to generate electricity. In we talk in detail about 1.8 x 18^11 MW power is intercepted from the Sun which is thousand times larger than the present consumption rate on the earth.

2. EXPERIMENTAL SETUP

The objective of this experiment is heating of air. The photograph of the experimental setup is shown in Figure. The setup consists of nine evacuated tubes; the length and diameter of outer glass tube and absorber tube are 1500mm, 47mm respectively. Open ends of evacuated tubes are connected to the manifold channel and closed end is supported by frame. Manifold channel is 1.2 m length and it consists of square pipe passing through the heat exchanger. Blower with regulator is used to blow the air in the evacuated tube and to vary the air flow rate. The experimental setup consists of the following parts:

- FRAME
- EVACUATED TUBE.
- HEADER (HEAT EXCHANGER)
- EPOXY PUTTY (M-SEAL)

1. **Evacuated Tubes**. Evacuated tubes absorb solar energy and convert it into heat for use in water heating. Each evacuated tubes consists of 2 glass tubes made from extremely strong borosilicate The outer tube is transparent allowing light rays to pass through with minimal reflection The inner tube is coated with a special selective coating (Al- N/Al) which features excellent solar radiation absorption and minimal reflection properties Vacuum is maintained between the two glass layer, and in order to maintain that a barium getter is used in the tube.

Fig: Evacuated Tube Solar Air Collector

Tube Specifications

- Diameter- 47mm (external)
- Diameter- 37mm (internal)
- Length- 1500mm

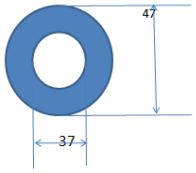

Fig 1: Evacuated Tube Dimensions 1

2. **Frame**: It is made up of cast iron having slots on both the arm. Header is fitted on the front top portion of frame. It is joined with the of nuts and bolts at all the joints.

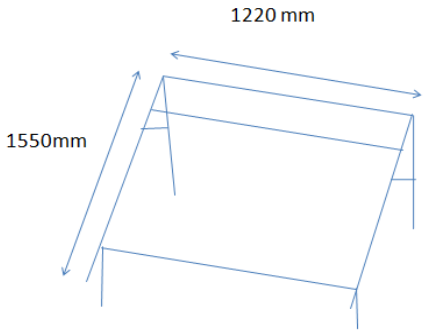

Fig:2 Frame Dimensions 1

3. **Heat exchanger:** The outer body is made up of stainless steel. There is a pipe made up of stainless steel which has got 9 holes in which evacuated tubes are paced. Open end of these evacuated tubes are in these holes and the close end are supported by frame. The header has a hollow square pipe in the centre of side 54 mm through which the air flows. Inside the header a square pipe is inserted centrally whose one end is closed and other end is opened to which a blower is attached.

4. **Epoxy putty**: M-seal is two component epoxy putty having adhesive properties and resistance chemicals. M-seal is used for sealing, joining, fixing or repairing. It is used in multiple segments, including household. It bonds almost anything its high cohesive strength. In our project work we used this adhesiveness to fix the evacuated tube in the heat exchanger. We also used this in the heat exchanger to prevent leakage of water from heat exchanger.

3. FABRICATION

- **Material Required:**

1. Cast Iron Angles 2. Aluminum Pipe 3.Rubber 4. Cover 5. Nut, bolt and washer6. Stainless Steel Sheet.

2. Tools Required: 1. Wrench 2. Scissors 3. Measuring Tape 4. Cutter 5. Abrasive saw 6. Punch Press

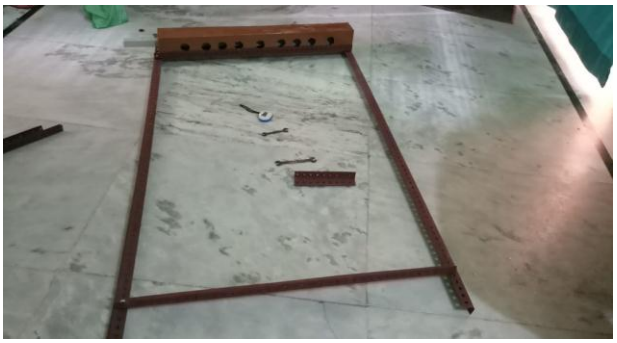

Fig: Frame

4. PARAMETERS AND MEASURING DEVICES

Different parameters are measured in these experiments:

- Outlet air temperature and ambient air temperature
- Solar radiation intensity
- Air flow rate

These parameters are measured by the following devices:

- RTD PT100 is used to measure the temperatures at different points. It is connected with a digital temperature that shows the temperature with a resolution of 1 degree Celsius
- The solar radiation intensity is measured during the day using pyranometer.
- The air flow rate is measure using Anemometer model which measure velocity of air with high accuracy of 0.1m/s. It provides fast and accurate reading at diff velocities.

5. EXPERIMENTAL METHODOLGY

- **Description**: The objective of the project is to study the thermal performance of an evacuated tube solar air heating system with one end evacuated tubes at different time. Finding the outlet temp. of air and efficiency of system. Experimental system consists of 9 evacuated tubes and a heat exchanger. The length and diameter. Of the inner and outer glass tubes is discussed already.

- **Working**: In the setup, evacuated tubes and the heat exchanger were filled with water. As the solar radiation falls on the tubes, the inner tube of the evacuated tube absorbs the radiation and heat up the water inside it. Warm water has lower density as compared to the colder water so, it goes upward in the tilted evacuated tubes and water goes down. Hot water reaches to the heat exchanger where a sq. pipe of aluminum is inserted through which air flows. This hot water exchanges heat with the air here and the air gets increase in temperature.

Table -1: Experimental Table

Time(Hour)	Outlet temp. (℃)	Ambient temp. (℃)	Solar Intensity(W/m²)
10:00	40	28	520
11:00	49	34	650
12:00	57	37	835
13:00	60	40	920
14:00	64	42	1100
15:00	61	38	904

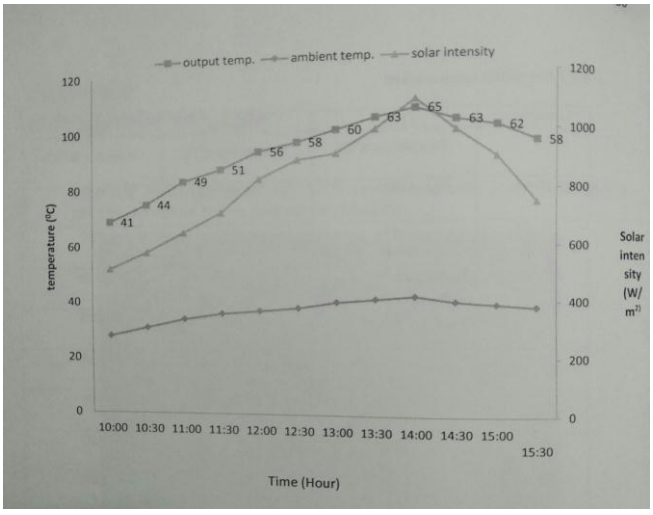

Chart -1: Time variation of outlet temperature and solar radiation of the system throughout the day

3. CONCLUSION

The following conclusions have been made from the experiment conducted that the outlet temperature of air changes as solar radiation intensity increases. This experiment is conducted in normal days between 10:00 am to 3:30 pm where ambient temperature is 28 C-42 C with air flow rate of 15.9 m/s. This experimental setup can be used as an alternative for many purposes such as air heating, water heating, and purposes related to it. This is a clean and renewable source of energy. It has many future scopes of utilization for energy generation.

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