

# Design, Fabrication and Overall working Analysis of Evacuated Tube Solar Collector

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**Abstract:** Utilization of natural energy sources has gained significant attention in recent times. As the world faces rising pollution levels and dwindling energy reserves, the preservation of the environment has become an essential aspect of global sustainability. Power technology derived from renewable assets such as solar and the utilization of generated energy can help optimize global pollution. On the contrary, this paper presents one of the structures that utilize sun's energy to raise the temperature of water for both domestic and industrial purposes. Evacuated tube sun water heater devices are highly efficient in collecting solar thermal energy for various applications. According to the experimental observation, the heat flow rate initially increases up to a specific time period and then remains constant at a constant mass flow rate, also discovered that once the setup was adjusted in the northwest direction, the heat rate would rise with time and in the southwest direction, it would also increase, but the maximum cost of heat switch rate would be at 2 pm and any other time after that.

**Keywords:** Electricity, Sun energy, Water Heating, Evacuated tube water heating.

## 1. INTRODUCTION OF SOLAR ENERGY

In today's global context, the electricity crisis is rapidly escalating. The utilization of strength assets encompasses various resources such as fuel, conventional power sources, crude oil, coal, and other fuels extracted from earth, which can be replenished. Now, we're on the importance of finding alternative methods to replace fossil fuels, as the search for such methods has become crucial. This endeavor and artwork is primarily based on the methods by which we can reduce the consumption of fossil fuels and provide a renewable source of easy electricity. So, we need to keep in mind, all of the various similar assets and associated sports. Because we consider the supply of energy from geothermal sources, solar power, nuclear energy, and other sources, and out of all the sun energy available, there is an abundance of it.

We burn millions of tons of coal and fossil fuels annually in India for energy production and also import a significant amount from other countries. However, we must transition to more sustainable sources of energy. Solar energy is one of the many types of energy available in abundance, it is renewable, non-polluting, and relatively inexpensive to generate electricity. In our discussion, we consider an element with an approximate energy of  $1.8 \times 10^{11}$ mw, which is a thousand times larger than the current energy intake price on Earth.

## 2. SOLAR ENERGY WATER HEATER

Solar water heating is a thermal technology that harnesses the energy from the solar by using a medium to absorb it, then utilizes it to heat water for various commercial or business needs. In India, there are three distinct weather patterns: Summer, Winter, and monsoon. Each season brings its own unique challenges, including hot temperatures, cold weather, and heavy rainfall. As a result, the water temperature rose above the normal level. A sun water heating device (swhd) harnesses the power of the sun's rays and transforms it into thermal energy, which is then utilized for various purposes, such as heating water. Solar water heating system comprises solar thermal collectors, water tanks, interconnecting pipelines, and the water, which circulates within the sun water heating devices. There are two devices used for heating water are flat plate collectors (fpc) and evacuated tube collectors (etc). With in the 12-month period from 2008 to 2009, and so on, has accounted for more than 30% of the total income. On July 1, 2009, there had been 61 million accredited and so suppliers and manufacturers. The emergence of evacuated tube collectors has resulted in a significant expansion of the solar water heating system, allowing for a wider range of applications. Brunold et al. mentioned that there are three distinct

designs for evacuated tube sun collectors- ones that use water in glass, ones with a warmness pipe evacuated tube, and ones with an evacuated u tube. The researchers, including Ma et al. , published a report stating that heat pipes used in tubular solar water heater have several advantages, such as preventing freezing, quick startup, resistance to excessive strain, ease of setup, and preservation. In practical utility, it is challenging to keep the vacuum surroundings clean because a significant amount of non-condensable gas can be produced in the warmness pipe when the system is operated in a jogging manner. The heat pipe's thermal performance can be affected by extreme conditions, such as the accumulation of non-condensable gas. The existence of tubes is limited, which is a significant drawback. Now a days, the use of evacuated tube is much more prevalent than that of traditional warmth pipes.

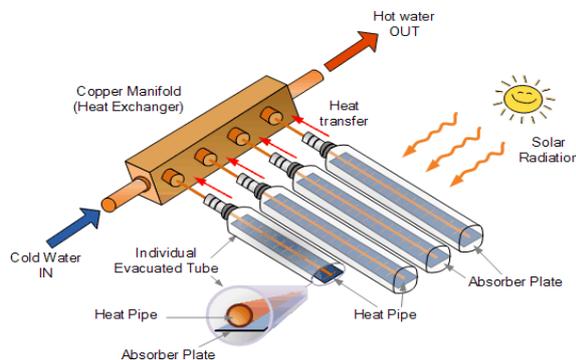


Fig:- 2.1 Working mechanism of evacuated tubes

### 2.2 Solar strength

sun power is a vast, inexhaustible deliver of strength. The electricity from the sun grab by using the earth is about  $1.8 \times 10^{11}$  MW that's particularly lots of times larger than the triumphing consumption rate on the planet of all trading enterprise power resources. for that reason, in precept, solar energy need to deliver all the existing and destiny needs of the arena on a persevering with foundation. sun is a supply of renewable power, it is largely a sphere of heat gases. It's diameter is  $1.39 \times 10^6$  km at the same time as that of earth is  $1.27 \times 10^4$  km.

## 3. EXPERIMENTAL SETUP AND WORKING PRINCIPLE

### 3.1 Design of Equipment

#### 3.1.1 Evacuated Tube

The design of evacuated tube is linear and manufactured by most resistive borosilicate glass with Al-N. every evacuated tube have glass tubes encompass from most sturdy borosilicate glass. Vacuum is present is gift among two glass tubes. The outer tube is translucent permitting solar rays to skip through with minimal reflection. The inside tube is covered with a special selective coating (Al-N/Al) which take in about the complete radiation incident and minimal mirrored image properties.

A barium getter is used to maintain the vacuum among the glass layer. In whole manufacturing process evacuated tube this getter is exposed to high temperatures which purpose the lowest of the evacuated tube to be lined with a natural layer of barium. This barium layer actively absorbs any CO, CO<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub>O and H<sub>2</sub> out gassed from the evacuated tube during storage and operation, for that reason supporting to keep the vacuum. It's silver colored barium layer will turn white if the vacuum is ever out of place.



Fig.:- 3.1 Evacuated tube

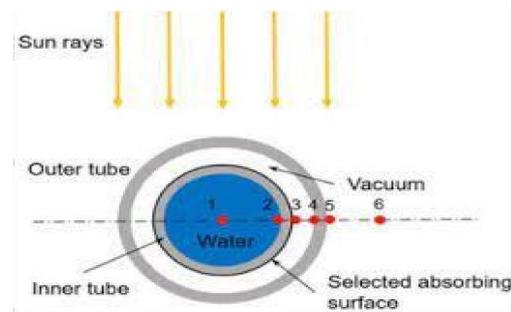


Fig.:- 3.2 Cross sectional area of evacuated tube

#### 3.1.2. Frame

A sun collector body is the structural resource form that holds the key additives of a solar collector together, usually made from steel like forged iron,

and is used to securely mount the collector on a roof, wall, or floor, protecting it from weather elements and providing a stable base for the absorber tube, and different elements in the collector; essentially acting because the "skeleton" of the evacuated tubes. The body will become made from solid iron having slots on every the arm. The body is made rigid for undertaking experiments.



Fig.:- 3.3 Experimental Setup

3.1.3 Pen Type Thermometer.

Pen kind thermometer is good for measuring water temperature and ordinary contract temperature trying out. The meter is simple for perform. Just push out the probe cover and install the battery. touch the object and press the ON button to degree the temperature.

3.1.4 Other Accessories

Other accessories

Some other needed accessories are:

- A. Water tank
- B. Inlet and Outlet tap
- C. Pipes and Stand
- D. Water heating measuring flask

2. Operating manner:

The aim of the challenge is to test the thermal performance of an evacuated tube solar water heating device with one end evacuated tubes at notable time. Note down the temp. at outlet of water, warmness flow rate and efficiency of device. Experimental gadget includes 10 tubes and a heat exchanger.

The internal and outer glass tubes materials are mentioned already.

The observations are as follows in tabular form.

Time(Hour)	Ambient temp.(°C)	Outlet temp. (°C)	Heat transfer rate Q in KW
10:00	24	32	0.4428
11:00	28	40	0.6642
12:00	34	48	0.7719
13:00	38	55	0.9409
14:00	42	61	1.0516
15:00	38	56	0.9963
16:00	35	51	0.8856

Table:- 4.1 Observation Table

inside the setup, evacuated tubes and the heat exchanger were full of water. Due to the fact the sun radiation falls at the tubes, the internal tube of the evacuated tube absorbs the radiation and warmth up the water inner it. heat water has lower density in comparison to the less warm water so, it goes upward inside the tilted evacuated tubes and water is going down. warm water reaches to the warmth exchanger in which a round pipe of aluminium is inserted thru which water flows. This heat water exchanges warmth with cold water right here and the cold water turn out to be warm water and growth the temperature.

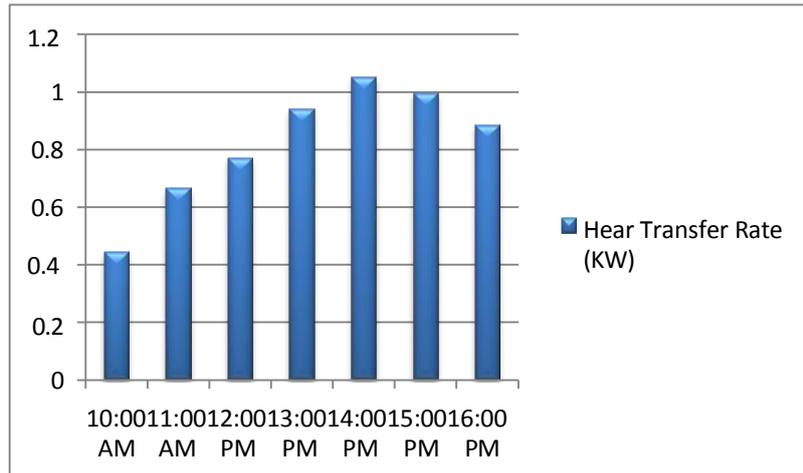
The experimental setup is prepared at workshop for the conduction of experiment. Particular focus turned into to be taken to prevent the leakage from the tubes and joints. The leaks were tested the usage of the cleaning soap bubble method via pressurizing it with air first.

4. RESULTS & DISCUSSION

4.1 Experimental Results

The experimental observations were noted from 10 am to 4 pm and calculate the heat transfer rate and efficiency of the heater on hourly basis at constant mass flow rate.

Fig.- 4.1 Graph between time and heat transfer rate



## 5. CONCLUSION AND FUTURE SCOPE

### 5.1 Conclusion

The following main points had been observed from the test performance that the temperature of water adjustments as solar radiation depth increases. This test is performed in ordinary days among 10:00 AM to 4:00 PM in which ambient temperature is 24 OC-35 OC. From the experiment and studies, it's far clear that the evacuated tube solar collector own 24% - 39 % more overall performance than flat plate sun collector underneath same running conditions. also, the cylindrical fin affords more overall performance than every different form of absorber fin. the heat transfer range will increase first after which decreases from morning to night, having its peak value at 2 pm in afternoon. that is a easy and renewable source of power. It has more destiny scopes of utilization for energy technology.

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