IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 4, April 2018

Solar Air Heater Using Evacuated Tube And Parabolic Mirror Reflector

Santosh E. Mhase[1], Swapnil P. Raut[2], Ganesh V. Musmade[3], Jeeshan M. Shaikh[4], Prof. G.B. Salunke[5]

Department of Mechanical Engineering, Savitribai Phule Pune University,

SCSCOE, Shrishivajinagar, Maharashtra, India[1-5]

Abstract: Solar energy is an important source of renewable energy. It is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as photovoltaic, solar heating, molten salt, solar thermal energy, solar architecture, power plants and artificial photosynthesis. We use the solar energy to heat the air for various applications such as food drying, air conditioning, preheating, etc.

Keywords: Solar energy, parabolic solar collectors, parabolic solar reflector.

1. INTRODUCTION

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. The large magnitude of solar energy available makes it a highly appealing source of electricity.

2. LITERATURE SURVEY

After initial experiment, a lot of researchers tried a lot of modification on the design and development of solar air heater by using combination of evacuated tube and parabolic collector to increase its performance. Some of them are as follows,

Odeh, et. al., (1984), studied on; experiment on parabolic trough collector to obtain the effect of the vacuum space between the steel tube and the glass tube on the reduction of the total thermal loss. Synthetic oil is working fluid. Calculation is down to measure the main thermal loss from the absorber tube outer wall to the evacuated glass tube (surrounding the absorber) occurs by radiation. The heat loss from the glass cover tube occurs by radiation to the sky and by convection to the surrounding air by wind or natural convection. The second part of the loss from the collector takes place between the absorber tube and the ambient via the vacuum bellows and supports. The temperature increase by this experimental setup is about 250- 400 °C. The thermal cycle uses a heat transfer fluid (synthetic oil) to transfer energy from the collector field to a Rankine steam cycle.

Kolb, et. al., (1994), studied that; in Sandia National Laboratory studied theoretically and experimentally the parabolic trough solar collector to determine the collector efficiency and thermal losses with two types of receiver selective coatings combined with three different receiver configurations; glass envelope with either vacuum or air in the receiver annulus, and glass envelope removed from the receiver. The researchers reach to decreased performance when the cermet selective coating, and progressively degraded as air was introduced into the vacuum annulus, and when the glass envelope was removed from receiver.

Folaranmi, (2009), studied that; carried out design, construction and testing of a parabolic dish collector, where heat from the sun is concentrated on a black absorber located at the focus point of the reflector in which water is heated to a very high temperature to form steam. The whole arrangement is mounted on a hinged frame supported with a slotted lever for tilting the parabolic dish reflector to different angles so that the sun is always directed to the collector at different period of the day. On the average sunny and cloud free days, the test results gave high temperature above 200°C.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 4, April 2018

3. WORKING PRINCIPLE OF PARABOLIC COLECTOR

3.1 Basic Principle

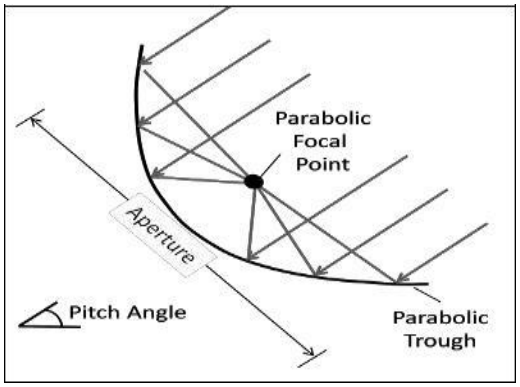

Fig.3.1 Principle behind parabolic solar collectors

The basic principle adopted in the construction of the parabolic solar air heater is that when parallel rays of light from the Sun close to and parallel to the principal axis are incident on a concave or parabolic shaped mirror, they converge or come together after reflection to a point F on the principal axis called the principal focus as shown in Fig. 3.1.

3.2 Working setup

When the Evacuated tube, solar parabolic plate collector, mounting stand are integrated the required assembly appears as shown in the following figure.

3.2.1 Working Setup

The electric exhaust fan and the temperature indicator are connected to the power supply. The electric fan sucks atmospheric air and passes it to the evacuated tube. This evacuated tube acts as an absorber and absorbs all the solar radiations falling on it. As this tube is placed at the focal line of the designed parabolic collector, it absorbs all the reflected radiations too. This increases the temperature of the air.Two thermocouple wires are used to measure the temperature of inlet and outlet air. These thermocouple wires are connected to digital temperature indicator that indicates the temperature sensed as shown in Fig. 3.2

4. COMPONENTS OF SYSTEM

4.1 Parabolic Solar Reflector

Fig.4.1.1 Solar Collector.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 4, April 2018

The Parabolic Solar Reflector is as shown in above fig. 4.1.1. It consists of pieces of mirror arranged in parabolic way, so that the reflection gets concentrated at the focal line. The evacuated tube is fixed at that focal line.

4.2 Evacuated tube

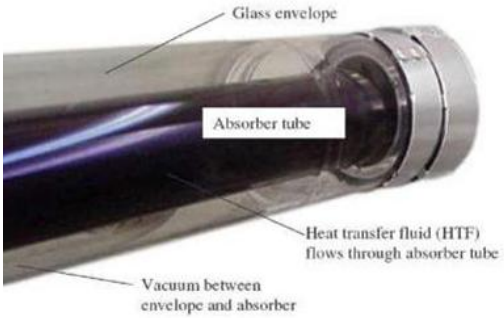

Fig. 4.2.1 Evacuated tube

The evacuated tube is as shown in above fig.4.2.1. Evacuated tube is optimized in geometry and performance. The evacuated tubes consist of two concentric glass tubes. On one side, the glass tubes are sealed in a semi-circular shape and joined to one another on the other side. The space between the tubes is evacuated and the hermetically sealed (vacuum insulation). The highly selective absorber (aluminum nitrite sputter layer) covers the external surface of the internal glass tube.

5. CONCLUSIONS

The efficiency of evacuated tube increases when it is combined with parabolic mirror reflector. This converted energy can be used for several applications like air heating, water heating. The collector can easily oriented and tilted, as per the position of sun with manual tracking mechanism. Running cost is nil. Maintenance cost is minimum. The labour cost is minimised due to its simple design, hence economic.

REFERENCES

1) Malato s., Blanco J., Richter C., Curco D. and J. Gimenez,"Examination of low concentrating CPC collectors for photocatalytic water detoxification comparison with a medium concentrating solar collector", 1997,5(2),pp.157-164.
2) Michaelides I.M, Kalogirou SA, Chrysis I, Roditis G, Hadjiyianni A. and Kambezidis H.D., "Comparison of performance and cost effectiveness of solar water heaters at different collector tracking modes in Cyprus and Greece", 1999,10(4), pp.589-625.
3) Bakos G.C., Ioannidis I., Tsagas N.F. and Seftelis I., "Examination of Design, optimisation and conversion efficiency determination of a line-focus parabolic-trough solar collector", 2001, 2(3), pp. 43-50.
4) Garcıa A. F., Zarza E., Valenzuela L. and Perez M.,"Examination of Parabolic-trough solar collectors and their applications", 2010,24(3),pp. 1665-1721.
5) Xiao G.,"A closed parabolic trough solar collector",2009,1(2), pp. 1-28.