ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 8, pp. 19349-19352, August, 2017

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

COMPARISON OF SOLAR AIR HEATER WITH AND WITHOUT PARTITIONS IN FLAT PLATE COLLECTOR HOUSING

Prakash S B*[1] and Karthik Paul[2]

Department of Thermal Power Engineering, VTU/Centre for PG Studies, Mysuru, Karnataka-570029 India

DOI: http://dx.doi.org/10.24327/ijrsr.2017.0808.0676

ARTICLE INFO

Article History:

Received 15th May, 2017
Received in revised form 25th June, 2017
Accepted 28th July, 2017
Published online 28th August, 2017

Key Words:

Solar air heater, Partitions & Thermal collector efficiency.

ABSTRACT

There has been a considerable improvement in solar air heater, especially in flat plate of solar air heater. Flat plate type of solar air heater has a simple design, fabrication and generates air temperature up to 60^0C. In this project report, comparison of thermal collector efficiency of two types of solar air heater is done. The first type of solar air heater has an empty housing, the second type of solar air heater has partitions fixed equidistant in the flat plate housing. The entire housing and partitions are coated black. Adequate thermal insulation is given to improve the thermal insulation of the solar air heater. In the report, the thermal collector efficiency for each setup is calculated individually for each day and compared.

INTRODUCTION

In the present day, where people are aware of the plethora of problems arising from the use of non-renewable sources of energy, finding an alternate source of energy is of utmost importance. Non-renewable sources of energy leads to some of the most hazardous environmental problems, global warming and melting of ice caps are naming a few of them. Non-renewable sources of energy like petroleum, diesel, gas and oil produces CO_2 and other harmful gases on combustion that covers the earth in a blanket of gases which absorbs the heat and doesn't dissipate it outside, thereby increasing the temperature of earth year by year and is commonly known as greenhouse effect. Due to the increase in temperature of the earth, the ice caps in the North Pole and South Pole starts melting thereby increasing the level of water year by year. Since 1880 the global sea levels has risen by 20 centimetres. And it is estimated that by 2100, the global sea levels will rise by 98 centimetres.

Solar air heater is a device that utilises solar energy in which the energy radiating from the sun is captured by using an absorbing medium and then it is used to transfer the heat to air which in turn gains the temperature of the medium. Solar air heaters can be said as the most cost effective technology that can be used in both commercial and industrial applications.

Solar energy is the energy obtained from the light and heat from the sun that can be either harnessed using technologies such as solar heating, photovoltaic, solar thermal energy and artificial photosynthesis to name a few. Solar energy is abundantly available in nature and can be classified into two categories namely active solar and passive solar. Active solar technologies includes the use of solar cells, concentration of solar power and solar water heating to utilise the energy from the sun whereas passive solar technologies include orientation of a building to face the sun, selection of materials that have favourable thermal mass or light dispersing properties, thermal storage capacity materials and design of spaces that naturally circulate air by density difference.

The large magnitude of solar energy makes it a highly appealing source if electricity. It is estimated that the sun radiates about 1,575-48,870 exajoules of energy, which is several times larger than the entire requirement of energy on our planet which is about 560 exajoules in the year 2015. Most of the energy from the sun travels through space and reaches earth. Most of the solar energy usually gets dissipated due to the ozone layer and the electromagnetic field surrounding the earth. Rest of the energy reaching the earth is low in

Corresponding author:* **Prakash S B
Department of Thermal Power Engineering, VTU/Centre for PG Studies, Mysuru, Karnataka-570029 India

comparison and tapping it effectively is hard. It is estimated that if we can effectively tap solar energy that's reaching the earth, then there is no need for any other alternate source of energy for the active functioning of the whole planet. Utilising solar energy also has long term benefits. Solar energy can be one of the most independent source of energy, it can reduce pollution, lower global warming rates. These advantages are globally effective and hence spending additional cost on the development and research of new improvements and technologies to increase the efficiency of solar thermal devices and photovoltaic cells can definitely provide a bright future lit by a pollution free and an abundant source of everlasting energy.

Experimental Setup

The design required needs to have a high heat absorption and also the design should feature absolute minimum heat loss to the surrounding. The housing of the setup is made from a mild steel of length breadth and height 1.2m * 0.7m* 0.6m respectively. All the sides of the housing is coated in black colour. The black colour absorbs sunlight and increases the temperature of the walls of the setup housing. These walls then transfer the heat to the surrounding air to increase the air temperature. The collector is covered using a glass of 6mm thickness. A thin film of rubber is provided between the glass and the housing. The purpose of the rubber is to provide protection of the glass and also to stop leakage of air between the contact of glass and the housing. A rectangular duct is provided for the air to escape, measuring 0.1m*0.1 m.

To increase the amount of heat absorption of the solar air heater, a circulation system is used to circulate the air within the setup, the circulation causes better heat absorption in small interval of time, hence leading to better efficiency. The back of the housing is provided with cut outs are provided for the accommodation of circulatory system. The square duct at the front of the housing is for the attachment of the blower and the circular duct at the rear of the housing is for the attachment of a pipe system. This system transfer's air within the housing to the blower and the blower circulates the air into the housing, thereby achieving a full circulatory system. The circulatory system ensures good heat transfer increasing the total efficiency of the setup.

The square duct is used for the accommodation of the blower. The blower is a device that pumps air into a system. The mass flow rate of the blower used is 0.010kg/s. The dimension of the square duct is 0.1m*0.1m. The blower is connected via pipes to the circular duct. The air is taken from the setup and it is pumped back into the system thereby maintaining a continuous circulation. Partitions are used to make obstruction between the housing. The partitions let the air take a longer path to reach from the front to the rear of the housing, thereby it's possible to achieve a better efficiency compared to normal flow solar air heater. Partitions are made with mild steel of dimensions length and breadth 50* 60mm respectively. The partitions are coated with a black colour to increase the heat absorption and to transfer it to the surrounding. A total of four partitions are used and placed in between the housing. The partitions are placed such that they are equidistant to each other. The partitions are attached to the housing using fasteners.

After proper circulation and increasing the temperature of air, removing the air for the entry of fresh air an escape air duct is used. It is made up of mild steel. It's an 'L' shaped rectangular duct with a lever mechanism. The lever can be made to open or close when required. During the conduction of the experiment the lever is closed. It is attached to the housing using fasteners and flanges. The design is made to ensure that there is minimum air loss when the lever is closed.

On the front and rear of housing two small holes of 6mm is made to accommodate the thermometers. The temperature from the thermometer is taken down manually at a set interval of time. The wind velocity is taken at the inlet and exit of the housing. The wind velocity is measured using anemometer.

Fig 1 Experimental setup

The above fig 1 shows the setup of solar air heater with partitions. The partitions are made up of mild steel and is coated black. The partitions help create obstruction for the air passage. The partitions absorb solar radiation from the sun and their surface temperature rises. The partitions then transfers the heat energy to air as the air moves through them to reach the rear of the housing. The air is supplied from the blower and it travels through the obstructions taking a longer path to reach the rear of the housing. The temperature of the air therefore increases to a higher degree comparatively to that of the setup without partitions because of the heat transfer from these partitions.

The air reaching the rear of the housing enters the exit pipe due to the pressure difference made by the blower at the inlet of the housing. The air is then circulated back to the front of the housing. The circulation takes place till the temperature reaches maximum, at which the air is let out from the escape duct. Fresh air enters the setup using the open duct near the blower. The temperature is measured at the front and rear of the housing using thermometers manually. The air velocity at the inlet and outlet is measured using an anemometer. Efficiency is found at an interval of every three hours.

RESULTS AND DISCUSSION

Without partitions

All the parameters and values are put into tabular columns. The variation of solar irradiance and maximum obtained outlet temperature is graphically represented in fig 2, for day 1 and trial 1 from 09:00 to 12:00. As we can see that the solar irradiance increases with time and the outlet temperature increases along with the solar irradiance as the time passes. At 12:00. The air is removed from the escape duct. The setup used is without partitions. The fig 2 and 3 represent setup without partitions.

The experiment is started at 12:30 by using the blower to bring fresh air into the setup. And the experiment is carried on till 15:30. The variance of solar irradiance and outlet temperature with time for day 1 trial 2 is graphically represented in fig 3. The setup used is without partitions. The solar irradiance and outlet temperature reaches max at 14:30 and then decreases with time.

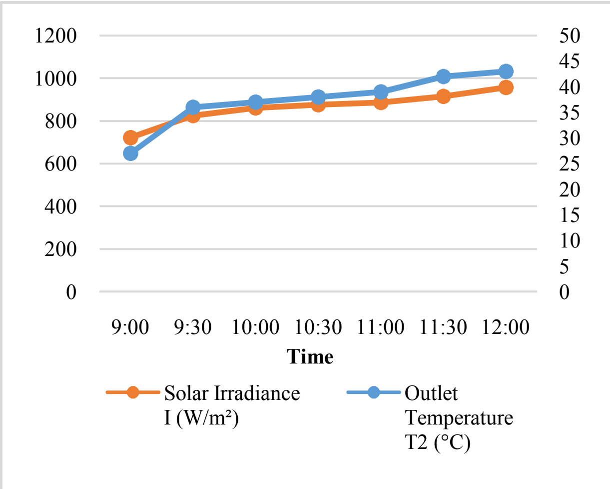

Fig 2 Variation of solar irradiance and outlet temperature with time for day 1 trial 1

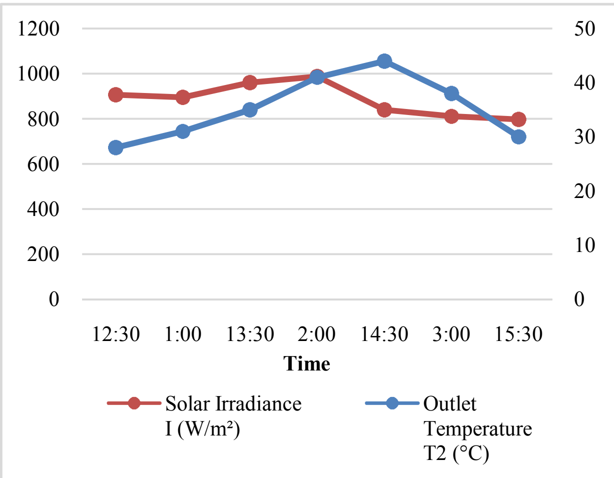

Fig 3 Variation of solar irradiance and outlet temperature with time for day 1 trial 2

With partitions

The figure 4 and 5 represents setups with partitions. The variation of solar irradiance and maximum obtained outlet temperature is graphically represented in fig 4, for day 5 and trial 1 from 09:00 to 12:00. As we can see that the solar irradiance increases with time and the outlet temperature increases along with the solar irradiance as the time passes. The experiment is started again at 12:30 by using the blower to bring fresh air into the setup. And the experiment is carried on till 15:30. The variance of solar irradiance and outlet temperature with time for day 5 trial 2 is graphically represented in fig 5. The setup used is with partitions. The solar irradiance and outlet temperature reaches max at 14:00 and then decreases with time.

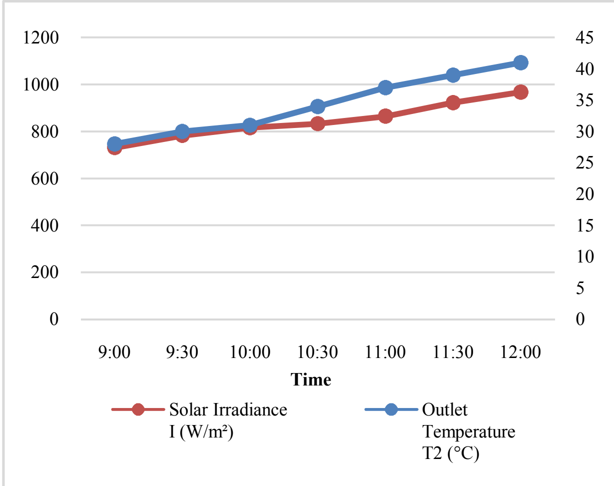

Fig 4 Variation of solar irradiance and outlet temperature with time for day 5 trial 1

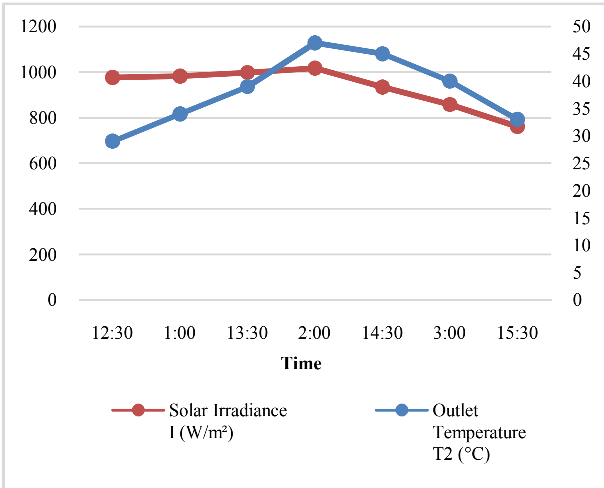

Fig 5 Variation of solar irradiance and outlet temperature with time for day 5 trial 2

Variation of thermal collector efficiency

In fig 6 and fig 7 variation of average solar irradiance and thermal collector efficiency for both the setups is graphically represented. Here the x- axis represents day and trial. First trial and second trial for each day is represented by letter 'a' and 'b' respectively.

It can be observed that in fig 6 representing the setup without partitions the maximum thermal collector efficiency obtained was 0.3188 and for with partitions in fig 7 the maximum thermal collector efficiency obtained was 0.4081

It can be observed that the setup with partitions was able to achieve a higher temperature than the setup without temperature. Therefore it can be concluded that the setup with partitions performs better by giving a higher thermal collector efficiency and also is able to achieve a higher temperature of air at the outlet. The highest temperature of air achieved by setup without partition was on day 1 second trial with a temperature of 44^0C. The highest temperature of air obtained from setup with partitions was on day 7 second trial with a temperature of 54^{0}C.

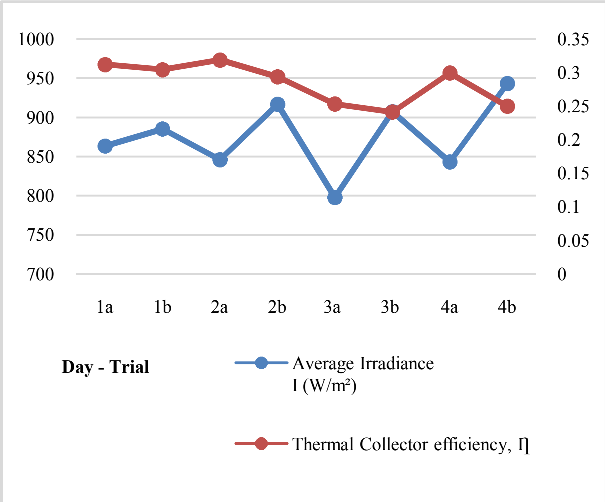

Fig 6 Variation of average irradiance and thermal collector efficiency for four days (without partition setup)

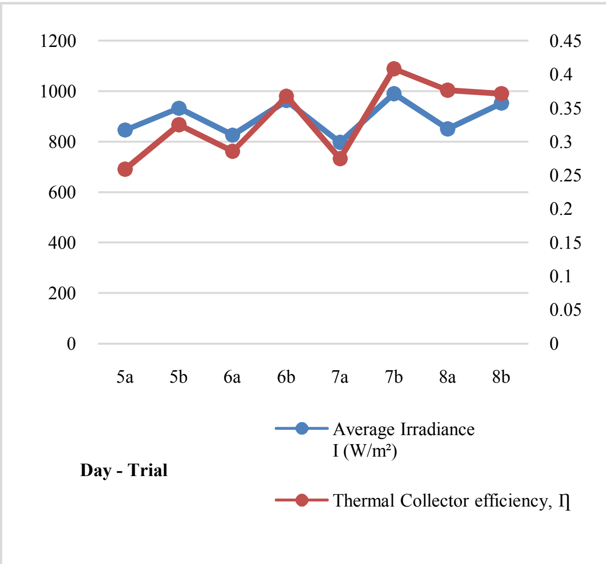

Fig 7 Variation of average irradiance and thermal collector efficiency for four days (with partition setup)

CONCLUSION

Experiment was performed on the solar air heater to get a comparison between the solar air heater having collector plate with partitions and without partitions, and was successfully performed. The experiment was to find the thermal collector efficiency of both the setup and to evaluate the result. Firstly the solar air heater without partitions was used to heat the air and the maximum temperature was successfully recorded. The setup was then modified to add partitions in the flat plate collector housing and the maximum temperature was successfully recorded manually. The experiment was conducted for eight days. Successful comparison was made and both setups were compared graphically.

Following are some of the key conclusions that can be drawn:

- Maximum thermal collector efficiency achieved without partitions was on day 2 trial 1 with an efficiency of 31.88%.
- Maximum thermal collector efficiency for the setup with partitions was observed on day 7 trial 2 with an efficiency of 40.81%.
- From setup without partitions and setup with partitions, it can be seen that thermal collector efficiency increases with the solar irradiance and vice versa.
- From comparing both the setups, we can conclude that thermal collector efficiency is higher for the setup with partitions than without partitions on an average throughout all the days of comparison.

References

1. S.S. Krishnananth K, K. Kalidasa Murugavel. Experimental study on double pass solar air heater with thermal energy storage; *Engineering Sciences* (2013) 25, 135–140.
2. Foued Chabane, Noureddine Moummi, Said Benramache. Experimental study of heat transfer and thermal performance with longitudinal fins of solar air heater; *Journal of Advanced Research* (2014) 5, 183-192.
3. Afaq Jasim Mahmood. Experimental Study of a Solar Air Heater with a New Arrangement of Transverse Longitudinal Baffles; *Journal of Solar Energy Engineering* JUNE 2017, Vol. 139 / 031004-1.
4. Irfan Kurtbas and Emre Turgut. Experimental Investigation of Solar Air Heater with Free and Fixed Fins: Efficiency and Exergy Loss; *International Journal of Science & Technology* Volume 1, No 1, 75-82, 2006.
5. Kaushik Patel, Sukritindra Soni, and Satayu Travadi. Comparative Study of Double Pass Solar Air Heater with Solar Air Heater with Baffles & With Longitudinal Fins; *International Journal on Recent and Innovation Trends in Computing and Communication* ISSN: 2321-8169Volume: 3 Issue: 5 2790-2794.
6. A. J. Mahmood and L. B. Y. Aldabbagh. Double Pass Solar Air Heater with Transvers Fins and without Absorber Plate; World Academy of Science, Engineering and Technology *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering* Vol: 7, No: 6, 2013
7. Fatih Bayrak Isı Bilimi ve Tekniği Dergisi Experimental Analysis of Thermal Performance of Solar Air Collectors with Aluminium Foam Obstacles, 35, 1, 11-20, 2015 *J. of Thermal Science and Technology* ISSN 1300-3615
8. Veena Pal1, Ajeet Kumar Rai2, Vivek Sachan Performance Study of A Solar Air Heater; Journal Impact Volume 6, Issue 7, July (2015), pp. 01-07 *International Journal of Mechanical Engineering and Technology*.
9. Khushmeet Kumar1, D.R. Prajapati2 and Sushant Samir2. Development for Solar Air Heater Duct Artificially Roughened with 'S' Shape Ribs; Experimental Thermal and Fluid Science.