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Study of Performance of Solar Air Preheater Using Different Parameters

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Abstract: Nowadays energy is the biggest concern of our society due to the rapid depletion of fossil fuel reserves. So there is need to develop and implement more energy efficient technologies based on renewable energy sources. In Solar air preheater heat is generally transferred between Air and absorber plate. Generally thermal performance of the solar air preheater is low due to minimum heat transfer rate between Air and Absorber plate. So the heat transfer rates can be improved by the use of Artificial roughness, double pass solar air preheater, aluminum spring on the absorber plate and also with the use of baffle arrangement. Further the efficiency of the solar air pre heater can be increased by the changing the orientation of the air pre heater with the change direction of the sun.

Keywords: Solar, Air heater, Artificial Roughness, Aluminum Springs, Absorber Plate.

I. INTRODUCTION

A. Working of conventional Air Pre Heater

Conventional air pre heater consists of simple cubical box made of insulating materials such as wood which is covered by thin glass on the top. The box has air inlet at one side of the box while the air outlet is present at the opposite side. Surrounding air enters the conventional air pre heater chamber from the inlet vents. Air inside the chamber gets heated by absorbing the solar radiations incident on it through top glass panel. Due to heat trapping properties of glass, the heat absorbed from the solar radiation gets trapped inside the chamber. This heat then gets transferred to the air present inside the chamber. So then by this phenomenon temperature of the air gets elevated at the outlet of the chamber.

B. Advantages

- 1) Solar air preheater can be designed using cheaper as well as lesser amount of material and it is simpler to use.
- 2) As air is used, it does not create any harm due to leakage of air from the duct.
- 3) The entire system is compact and less complicated.

C. Disadvantages

- 1) As the poor heat transfer properties of air. We have to take extra efforts to improve the heat transfer.
- 2) The need for handling large volume of air due to its low density is another disadvantage.
- 3) Air has low thermal capacity so it cannot be used as a storage fluid.

D. Application

- 1) Solar air heater is used to reduce carbon footprint by using conventional heat sources, as fossil fuels.
- 2) We can use solar air preheater as Solar dryer for foods or agriculture goods.
- 3) It is used for greenhouse season extension.
- 4) For Space heating and Ventilation application.

II. LITERATURE REVIEW

Syed E. Gilani¹, Hussain H. Al-Kayiem, Buschmann Matthias and Dereje E. Woldemicheal^[1] have suggested the use of new artificial roughness on the absorber plate to achieve the enhancement in heat transfer coefficient between absorber plate and air. The conical pins were used with 3 different relative high roughness. In this measurement we are carried out for 5 inclination angles as 10°,30°,50°,70°,90° to get optimum angles of operation for free convection solar air heater. The most efficient inclination angle was found out be 50 degrees.

Ratinun Luampon and BunditKrittakom^[2]described the use of Stainless wire mesh of different PPI (Pores per inch) are used as layers for solar air preheater in this experiment. By the results it is inferred that efficiency of solar air heater with stainless steel mesh is



greater than the air pre heater without mesh. Maximum efficiency of about 64.04 % is achieved by using 11 layers of 12 PPI stainless steel mesh.

Emmanouil Perisoglou, Joanne L Patterson, Vicki Stevenson and Huw Jenkins[3] have shown the use of transpired solar air collector (TSC) as a preheater for an air to air heat pump. In this type of solar air preheater technology system that preheats fresh air is subjected to solar energy availability. It is found that performance of the TSC technology is more efficient in vertical installation for lower solar altitudes occurring in the morning & afternoon during heating season. In this system fan is used to draw fresh external air through evenly spaced micro perforation in the surface of TSC.

Suman Saurav and M.M.Sahu[4] In this paper author suggested Instead of relative roughness pitch, relative roughness height and angle of attack, shapes of various roughness element also influence the heat transfer coefficient and friction factor different shapes of roughness element are discussed. V-ribs arranged in transverse direction which were tested recently showed outstanding performance and in future these V-rib arrays could be arranged inclined the direction.

RahelahNowzari and L B Y Aldabbagh[5]stated that the distance between the lower glass and the absorber in double pass solar air pre-heater should be 5.5cm. The results proved that conventional air pre heater is less efficient than baffled solar heater. Performance of partly perforated air collector was analyzed. Perforated cover was made up of plexiglass. A fan with speed controller was used for controlling the mass flow rate of the air. The maximum efficiency of about 58.5% was obtained in double pass solar air preheater with quarter perforated cover and at mass flow rate of 0.032 kg/s.

Sumit S. Dharmarao, Shailesh A. Nehatrao and Sagar s. Raje[6]Suggested the use of glass above the collector plate to reduce convective losses and enhance the Greenhouse effect. Solar radiations falling on the surface of solar air heater heats up the absorber plate. Air just above the surface of absorber plate is taken inside the solar air heater, as this air is slightly heated due to convective heat transfer from the surface of the absorber plate. The density of air decreases due to heating, and directs the air into the Garbage Box. So this heated air will take up the moisture from the moist garbage present in the garbage box. Thus the thermo siphon effect is produced. Rakesh Chaudhary and Lt Piyush Nema[7]Aluminum spring is attached to increase the rate of heat transfer as well as area of heat transfer between absorber plate and the collector. Aluminum springs are attached in various different orientation and the results were analyzed. N.K. Basal[8]discussed the various applications of the Solar air pre heater as follows:- Paddy drying Fruit drying Timber drying Drying of cash crops (Example: Chills, Pepper, Cardamom) Space heating Solar induced ventilation

P Mohamed Shameer [9] Suggested the use of blower for forcing the air into air heater. For thermal storage, paraffin wax is used. Aluminum is used for the collector because it is having high thermal conductivity. In this design atmospheric air is heated two times and thermal storage kit is implemented. With the help of thermocouple reading was taken.

P S Chopade[10] In this research paper various types of solar air collector are discussed.

Types of solar air collector: (1) unglazed air collector or transpired solar collector (2) glazed solar collector used for space heating

Application of solar air heater:

- 1) For reducing carbon footprint from use of conventional heat sources as fossil fuel
- 2) greenhouse season extension, space heating
- 3) Solar dryer for foods or agriculture goods

Study of two models one with fixed orientation and another with fixed orientation according to sun's position was evaluated and 23% overall improvement in efficiency than conventional air heater was achieved in the improved model.

Santosh Vyas and Dr. Sunil Panjabi[11] The setup made with Dimensions 1mX0.5mX0.1m The design is made up of rectangular box with 18mm plywood. Transverse V-porous ribs are used in this design which helps to reduce average thermal gradient. Mild steel angular bars are used for fabrication that holds the structure. 34.4% rise in overall thermal efficiency

Rajendra Karva and V. Srivastava[12] This research paper gives overview of various types of ribs- i.e, Inclined ribs, V down continuous ribs, V down discrete ribs. heat transfer enhancement in inclined rib is higher than the transverse ribs. Artificial roughness on absorber plate improves the performance of air heater. Thermal efficiency is 6-26% higher in roughened air duct heater than the smooth air duct heater.

Harish kumar patel, Saurabh singh, Alfa Tigga and Krishna kumar Darpan[13] have studied the transfer rate from the absorber plate to air may affect solar heat performance. The heat transfer rate from the absorber plate to the air can be improved by improving artificial roughness to the absorber plate. The conventional solar air heater have poor efficiency due to the lower heat transfer between the absorber plate and the air. The author said that, by establishing turbulence in the laminar sub layer region we can improve performance of the heater. This turbulence can be provided by artificial roughness element.

Mr. Prashant B Yelmeame, Prof. D.D. Palande and Prof. P.S.Desale[14] have described the use of Solar Air Heater (SAH), for the purpose of crop drying, space heating and for regenerating dehumidification agents .Solar Air Heater offers the chances of providing



cheap, low grade heat because of their inherent simplicity. Due to fins are added to the interior of the absorber plate, the desirable effect of increasing the heat transfer coefficient is achieved.

Sanket Khamitkar and Dr. O. D. Hebbal[15] in this paper thermal efficiency of a solar air collector called unglazed transpired collector (UTC) has been studied using CFD. It was found that temperature rise decreases with increasing air mass flow rates.

III. CONCLUSION

It can be concluded that the performance of solar air heater can be improved by the use of Artificial roughness, aluminum spring on the absorber plate, double pass solar air preheater, baffle arrangement and also by the changing the orientation of solar air pre heater with the change direction of the sun.

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