Scientific Journal of Impact Factor (SJIF): 4.14
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 3, Issue 10, October -2016

Experimental Investigation of Double Pass Solar Air Heater Using Multiple Aluminium Obstructions

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Abstract — *Solar air heaters are used for a variety of applications at average temperatures such as in drying of crop, timber seasoning, and space heating. Various works have been carried out to increase the efficiency and heat transfer rate of solar air heater. This includes using different absorber plate materials, artificial roughness geometry, surface roughness, length and number of pass, mass flow rate, effect of porous material etc. Different types of absorber plates had been made and experiments had been carried over it*

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Keywords*-Double Pass Solar Air Heater, Artificial Roughness, Spring Geometry*

I. INTRODUCTION

Solar Air Heaters are very common and are used where moderate temperature requirement is needed where the temperature requirement is in range of 30 ^{0}C -100 ^{0}C and/or heating application during the winter months. The solar air-heaters are widely used for the heating of buildings, ventilation air and crop-drying. Solar air heating is a renewable energy and solar air heater is a simple device that heats air by utilizing solar energy from the sun .In this type of collector an absorber plate is used which converts the solar energy into thermal energy. Solar air heaters mainly consists of wooden frame, glass cover, absorber plate, air duct and an air blower, if it's a forced convection system.

II. LITERATURE REVIEW

B.M.Ramani et al.[1] investigated performance of a double pass solar air collector. By using a porous material in the second pass of double pass solar air collector, it is found that a higher thermal efficiency compared to double pass solar air collector without the absorber matrix is obtained. It is due to the reason that the porous material provides a large surface area for the heat transfer. The thermal performance of double pass solar air collector with porous material was observed 25% higher than double pass solar air collector without porous material. **F.Ozgen et. al.[2]** investigated thermal performance of a double-flow solar air heater having Aluminium cans. The study for two different arrangements of aluminum cans on the absorber plate, namely zigzag manner and arranged manner was done. As a result, it was found that the zigzag arrangement is more efficient than the arranged one. This was because the zigzag arrangement provide greater air turbulence. Thus, due to high turbulence, the temperature of air increase and hence the efficiency of solar air heater increases**. A.A.El-Sebaii et. al [3]** investigated thermal performance investigation of double pass-finned plate solar air heater. Finned plates and v-corrugated plates were used for the experiments and the results were compared. The outlet temperature of DPVCPSAH was obtained higher than DPFIPSAH. It was because the surface waviness and roughness of the corrugated plate changed the flow structure of the fluid flowing. Due to the generated fluid flow, the turbulence of flow increases with the increasing mass flow rate. Hence, with the increase in mass flow rate and turbulence, the efficiency of solar air heater increases. **A.Fudholi et. al.[4]** investigated the performance of finned double pass solar air collector. The study involved investigation of the effect of mass flow rate and solar radiation intensity on the thermal efficiency. The efficiency of collector increases with increasing the mass flow rate. With staggered fin absorber plate, the optimum efficiency was found about 70% between mass flow rates of 0.07-0.08 kg/s. It was also concluded that the efficiency of collector is directly proportional to the solar radiation. Also, the efficiency of air collector increases as mass flow rate increases.

III. PROCEDURE

In solar air heater, air is heated by solar radiation absorbed by the absorbed plate. Air is made to flow over the absorber plate due to which heat is transferred from absorber to the air. A blower is used to suck the air from exit of the air heater. In this study, aluminium spring coil on the absorber plate is used as artificial roughness geometry which helps to create turbulence and also increase the heat transfer area. Thus, due to this the heat transfer rate increases and also the efficiency of air heater.

3.1. Methodology

The aluminium spring coil is arranged in horizontal and zig-zag way. The readings are taken for different mass flow rates for three type of arrangements, i.e. Type-I (Smooth plate), Type-II (Horizontal arrangement of spring) and Type-III (Zig-zag arrangement of spring). Measurement of the inlet temperature and outlet temperature are taken for three different mass flow rates.

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3.1.1 Type I Arrangements

Double pass solar air heater without obstacles on absorber plate, which is Type-I arrangement.

3.1.2 Type II Arrangements

Double pass solar air heater with the aluminium spring in perpendicular to direction of the air inlet, which is Type-II arrangement.

3.1.3Type III Arrangements

Double pass solar air heater with the aluminium spring in zigzag direction to the packed bed, which is Type-III arrangement.

IV. RESULTS

4.1.1 Results of Type-I arrangement

In this case, the reading of temperature of the double pass solar air heater is taken for mass flow rate of 0.014 kg/s, 0.029 kg/s and 0.044 kg/s respectively. The results obtained are shown in the graph below.

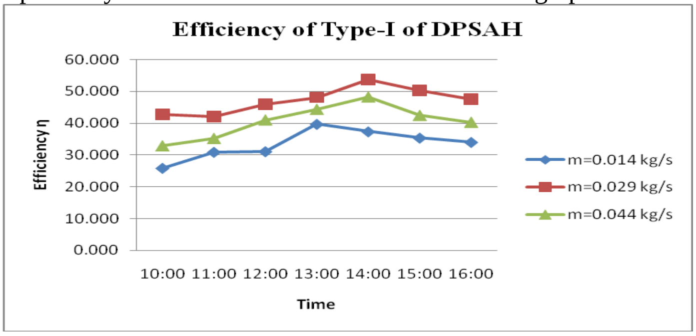

Figure 1. Efficiency of Type - I of DPSAH

4.1.2 Results of Type-II arrangement

In this case, i.e. spring arranged in horizontal direction, the temperature readings of the double pass solar air heater is taken for mass flow rate of 0.014 kg/s, 0.029 kg/s and 0.044 kg/s respectively. The efficiency obtained is shown in the graph below.

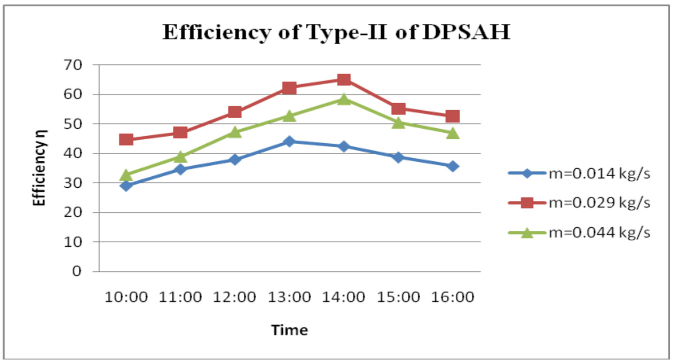

Figure 2. Efficiency of Type - II of DPSAH

4.1.3 Results of Type-III arrangement

In this case, i.e. spring arranged in zig-zag direction, the temperature readings of the double pass solar air heater is taken for mass flow rate of 0.014 kg/s, 0.029 kg/s and 0.044 kg/s respectively. The efficiency obtained is shown in the graph below.

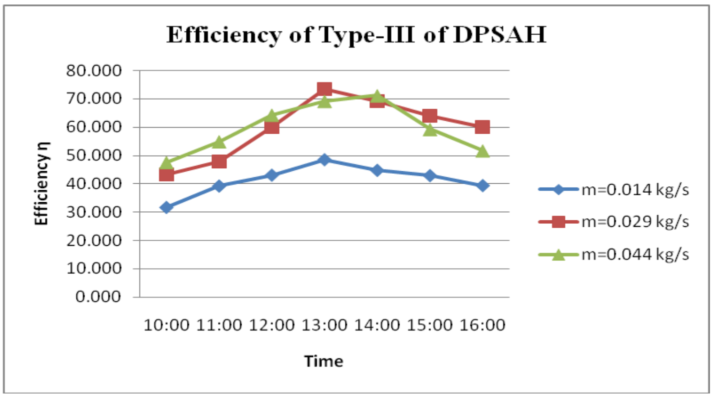

Figure 3. Efficiency of Type - III of DPSAH

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