A Review to Enhance the Efficiency of Double Pass Solar Air Heater

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Abstract: - Solar air heater is a most popular device in the space heating and industrial processes applications. But solar air heater has lower heat-transfer coefficient between the absorber plate and the air stream, which results in a lower thermal efficiency of the heater. The solar air heaters efficiency can be affected by various parameters such as collector length, number of channels, depth of channels, type of absorber plate, number and material of glass covers, air inlet temperature and air velocity. The effect of fins, Baffles and porous media on double pass solar air heater will measured by this research study. This aim is to analyze the thermal efficiency of double pass solar air heater and measured the effect of different type of media on the efficiency of it. The effects of major parameters temperature difference, air velocity, pressure difference, mass flow rate of the air has been observed for these perform study.

Keywords: *Double pass solar air heater, Fins, Baffles, porous media, mass Flow rate, Thermal efficiency.*

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I. Introduction

Solar air heater is a device, which covert solar radiation into the heat energy. This device is simple and can be constructed with less expensively. Solar air heater made up of a wooden, galvanized iron sheet, or FRP/GRP material. Absorber plate is coated with black paint to absorb maximum solar radiation and clear glass cover provided to the top to allow maximum solar radiation inside, inclination provided to the solar air heater for the maximum solar radiation receive during the day period. Insulation of glass wool, thermocol, wooden plates, asbestos, etc has been provided to the outer wall of sides to reduce the heat losses in the atmosphere. Solar air heater directly exposed to the sun light. The air flow enters through the channel and solar radiation absorbed by the absorber plate. The absorbed heat transferred to the air as it flows along the channel and its temperature going to be increases. This hot air can be used in several applications such as drying agricultural products, space heating and air conditioning, water heating and industrial process heating. There are so many advantages of solar air heater systems. Firstly, they are simple to maintain and design. After the set-up cost, a solar air heater system has no fuel expenditure. There is less leakage and corrosion, when compared to the systems that use liquid. It is also an eco-friendly system which has zero greenhouse gas emissions.

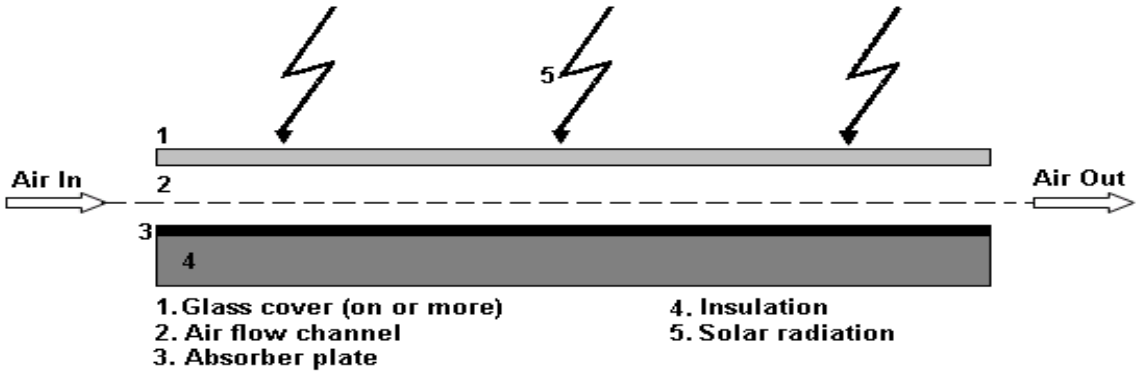

Figure 1.1. A schematic view of single flow single pass

According to the design and application of solar air heater it is divided mainly in three types. Solar air heaters without thermal energy storage, solar air heaters with thermal energy storage, Hybrid photovoltaic/thermal (PV/T) solar air heater.

II. Application

direct use of the heated air in space heating, solar assisted air drying applications, and water heating involving the use of a heat exchanger to a secondary fluid-based heat transfer medium and storage loop. Unglazed air heating collectors are mainly used in commercial and public buildings to pre-heat ambient air for space heating. Glazed air heating collectors are used in for space heating support in commercial applications, as well as for some process heating purposes. In addition, autonomous solar air heating collector units, typically with 2 m2 of collector area and an integrated PV solar driven ventilator, are used to heat air in small buildings such as weekend houses. Hot air is generated at different places and direct it to end use in the

active solar air heating systems but it can be more expensive to construct in comparison of passive systems. Simultaneously, active solar air heating systems are easier to design because of their forced air operation. Energy storage materials are widely used in active type solar air heater to supply hot air during off sunshine hours. Passive air heaters are generally regarded and used as daytime heaters.

III. Problem Definition

Solar air heater has lower thermal heat transfer coefficient, which gives lower thermal efficiency of the solar air heater. Comparative study has been required for better comparison of the model.

Objective and Goals of Dissertation

My dissertation work is focused on a new way to improve the efficiency of solar-air heater, by the use of metallic wiry sponge, and compare its results to the result of solar air heater with fins and with baffles. Metallic wiry sponge gives batter results to absorb the solar energy. So, the motive of this study is to increase the efficiency of the solar air heater with using low cost, easily available and highly effective product.

Increase the productivity of this solar air heater, Material Easily available in the market, Maintenance of the product is easy and with low cost, It makes help full for the industries and for a family, Easily operate for unskilled man, Easy to assemble and disassemble operation of this model.

If solar air heater absorber plate exposed with metallic wiry sponge to the sun light than it absorb then it gives the batter temperature of output air. It gives more effective results as compared to the fins, baffles, etc.

To implement the concept in this research study several literature survey has been carried out as following:

[1] **Chii Dong Ho, Hsuan Chang et al.** worked on "**Analytical and Experimental Study of Recycling Baffled Double-Pass Solar Air Heaters with Attached Fins".** In this experiment they design new solar air heaters with using an absorbing plate with fins and baffles, which facilitate the recycling of flowing air. They develop mathematical formulation and analytical analysis for such a recyclic baffled double-pass solar air heater theoretically and the performance of this device was studied experimentally as well. The theoretical and experimental results were compared with another design. i.e., a downward-type single-pass solar air heater without recycle and double-pass operations performed in the previous work. Significant improvement in heat-transfer efficiency was achieved with the baffle and fin design due to the recycling heating and the extended heat transfer area. The effects of mass flow rate and recycle ratio on the heat-transfer efficiency enhancement as well as on the power consumption increment are also measured.

[2] **Maulik Sukhadiya, Kaushik Savaliya et al.** performed an "**Experimental Investigation of Double Pass Solar Air Heater with Different Arrangements Using Aluminium Material".** Inthis method they improve the collector efficiency by increasing the fluid velocity and enhancing the heat-transfer coefficient between the absorber plate and air. In these design they use an absorbing plate made of aluminium cans into the double-pass channel in a flat-plate to build absorber plates of SAHs at a suitable cost. In the first type (Type I), cans had been staggered as in order on absorber plate, while in second type (Type II) they were arranged in zigzag. Third type (Type III) is a flat plate arrange with baffles. For the same flow rate, the efficiency of the double pass is found to be higher than the single pass. An efficiency test was used to find the best fin arrangement of the receiver. In these arrangements Type 2 was higher efficient with compare to other Type 1 and Type 3 arrangements. Increasing wind velocity increases the mass flow rate. As we increase the mass flow rate it the outlet temperature decreases due to decreasing the time for heat transfer process from absorber to air.

[3] **Sanda Budea et al.** worked on "**Solar Air Collectors for Space Heating and Ventilation Applications – Performance and Case Studies in Romania Climatic Conditions".** These experimental gives results of a solar collector air, in climatic conditions from South Eastern Europe. It was shown that after maximum 50 minutes, solar air collectors, with baffles and double pass of air can reach 50 % efficiency for solar irradiation of 900-1000 W/m2.The study also presents a mathematical model and the results of a computational program that allows sizing solar collectors for the transfer of the air, for their purpose to improve the natural ventilation of buildings. The article is completed with a case study, sizing the area to be covered with solar collectors to ensure ventilation of a house with two floors or for an office building. Also, the ACH coefficient was calculated and compared.

[4] **Ho-Ming Yeh and Chii-Dong Ho et al.** worked on **"Collector Efficiency in Downward-Type Double-Pass Solar Air Heaters with Attached Fins and Operated by External Recycle".** In this study the collector efficiency in a downward type double pass external recycle solar air heater with fins attached on the absorbing plate has been investigated theoretically. Considerable improvement in the collector efficiency is obtainable, if the collector is equipped with fins and the operation is carried out with an external recycle. Due to the recycling, the desirable effect of increasing the heat transfer coefficient has been compensate for the undesirable effect of decreasing the driving force temperature difference of heat transfer, while the attached

fins has been provide an enlarged heat transfer area. The order of performances in the devices of same size is: double pass with recycle and fins double pass with recycle but without fins single pass without recycle and fins.

[5] **Foued Chabane, Noureddine Moummi et. al.** worked on **"Experimental analysis on thermal performance of a solar air collector with longitudinal fins in a region of Biskra, Algeria".** This Experimental investigation carried out for thermal performance of a single pass solar air heater with fins attached. Longitudinal fins were used inferior to the absorber plate to increase the heat exchange and render the uniform flow of fluid in the channel. The effect of mass flow rate of air on the outlet temperature, the heat transfer in the thickness of the solar collector and thermal efficiency were studied. Experiments were performed for an air mass flow rate of 0.012 kg/s. Maximum efficiency has been obtained by using five longitudinal fins and without using fins. The maximum efficiency levels obtained for the 0.012 kg/s with and without fins were 40.02% and 34.92% respectively. A comparison of the results of the solar collector with and without fins shows a significant enhancement in thermal efficiency.

[6] **Irfan KURTBAS and Emre TURGUT et. al.** worked with **"Experimental Investigation of Solar Air Heater with Free and Fixed Fins: Efficiency and Exergy Loss".** In this solar air heater, the fins located in flow area to increase the heat transfer coefficient and output temperature of air. Accordingly, collector efficiency increases too. However, an increase has been observed in pressure drops as well as heat transfer. In this study, each of the fins, which are in the form of rectangular having two different surface areas, is located on the absorber surface in free and fixed manners. In the first case, the fins are located on the absorber surface in a way to be able to freely move. In the second case, it has been fixed to the absorber surface. The absorber surface area is 1.64 m2. The fixed and free fins with 8 and 32 items whose surface areas are 0.048 and 0.012 m2 are located on the absorber surface. Thus, the total fin area in the absorber surface is equaled 0.384m2. Solar air heater having free and fixed fins is compared to flat-plate solar air heater as well as each other in terms of efficiency and exergy loss ratio.

[7] **Hikmet Esen et al.** worked on **"Experimental energy and exergy analysis of a double-flow solar air heater having different obstacles on absorber plates".** This paper represents an experimental energy and exergy analysis for a novel flat plate solar air heater (SAH) with several obstacles and without obstacles. For increasing the heat-transfer area may be achieved if air is flowing simultaneously and separately over and under the different obstacle absorbing plates, instead of only flowing either over or under the different obstacle absorbing plates, leading to improved collector efficiency. The measured parameters were the inlet and outlet temperatures, the absorbing plate temperatures, the ambient temperature, and the solar radiation. Further, the measurements were performed at different values of mass flow rate of air and different levels of absorbing plates in flow channel duct. After the analysis of the results, the optimal value of efficiency is middle level of absorbing plate in flow channel duct for all operating conditions and the double-flow collector supplied with obstacles appears significantly better than that without obstacles. At the end of this study, the exergy relations are delivered for different SAHs. The results show that the largest irreversibility is occurring at the flat plate (without obstacles) collector in which collector efficiency is smallest.

[8] **C. Elaya Perumal, E. J anarthan et al.** worked on **"Fabrication and Performance Analysis of Hybrid Solar Air Heater".** The electricity and heat produced simultaneously in a Photovoltaic thermal system from solar energy is about 60-70% efficient in this experiment. The traditional Photovoltaic system conversion of electricity from solar energy is only about 6-15% efficient; where as 85% of the incoming solar energy is either reflected or absorbed in the form of heat energy, which are cooled by air coolant to utilize the all incoming solar energy on system. The main uniqueness in this project work is combination two systems as Photovoltaic Thermal and solar air heating system. The photovoltaic system wasted heat energy is absorbed in cold air. The preheating air from Photovoltaic thermal system is allowed to pass through the air heater, where the heat is much enhanced by the solar radiation and improves the efficiency of air heating system. Here analyses to configuration on with fins and baffles and with fins and without baffles experimentally compared to improve on thermal efficiency was studied.

[9] **Salah abdallah, mazen abu khader et al.** worked on **"Effect of various absorbing materials on the thermal performance of solar stills".** There is a strong need to improve the solar still thermal performance and increase the production rate of distilled water. Different types of absorbing materials have been used to increase their effect on the yield of solar stills. These absorbing materials are of two types: coated and uncoated porous media of metallic wiry sponges and black volcanic rocks. In this Experiment Four identical solar stills were manufactured using locally available materials by researcher. The first three solar stills contain black coated and uncoated metallic wiry sponges made from steel quality AISI 430 type, and black rocks collected from Mafraq Area in north-eastern Jordan. The fourth still has been used as reference still which contains no absorbing materials only black painted basin. This Experimental Results shows that the **uncoated sponge has the highest water collection during day time**, followed by the black rocks and then coated metallic wiry sponges. The

overall average gain in the collected distilled water taking into the consideration with the overnight water collections were 28%, 43% and 60% for coated and uncoated metallic wiry sponges and black rocks respectively.

IV. Conclusion

From above review we conclude that the absorber material uncoated metallic wiry sponge give the maximum efficiency in the solar still. And apart from this review study it is very beneficial in the solar air heater also. It is easily available in the market and lower cost effective too. In this research study for finding better option and for the comparison two types of solar air heater directly exposed to the sunlight is necessary. For optional solar air heater comparison absorber plate with fin and with baffles has been manufacturing too.

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