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# Solar Air Heater analysis by CFD method

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**ABSTRACT:** In the present study, a CFD review is performed to improve the efficiency of a solar air heater utilizing absorber plates with different corrugations. The study has shown that bend shaped absorber plate gives improved thermal transfer characteristics relative to the base model. In general, it is seen that an absorber plate with corrugated geometry tends to increase the amount of air media, thereby helping to increase the transmission of convective heat transfer to the medium.

**KEYWORDS**: Solar-air-heater, CFD, Thermal efficiency

## I. INTRODUCTION

Solar air heaters represent the key component of a solar energy usage device that consumes the input of solar radiation. A significant range of theoretical and experimental test experiments have been carried out to improve the thermal efficiency of plate solar thermal air heaters. Bhagoria et al.(2002) have demonstrated experimentally that the involvement of ribs raises Nusselt up to 2,4 times relative to a smooth duct and the friction factor up to 5,3 times. Based on their tests, Karim and Hawladar (2004) and Karim et al (2006) noticed that v-corrugated collectors work better than the flat plate collector. Lin et al (2006) noticed that solar heaters crosscompared to the flat-plate collector have a far higher thermal efficiency. Jaurker et al.(2006) experimentally found that the rib-grooved arrangement heat transfer coefficient is greater than the cross-shaped ones. Experimentally, Gao et al (2007) observed that cross corrugated collectors have a better thermal efficiency than flat plate collectors because of a higher surface area for heat absorption. Mittal et al.(2007) have shown that the solar air heater has inclined ribs as roughness elements in the higher Reynolds range has increased performance. Vishavjeet et al .(2009) concluded that a study of heat transfer and flow characteristics of the rugged solar air heaters must be conducted using computer fluid dynamic models (CFD) to predict optimal ruggedness element parameters. Atul et al.(2012) carried out an experimental heat transfer and friction investigation Rectangular duct roughened factor features of W-shaped ribs.

hence a CFD analysis was performed in the course of the present study to understand the heat distribution process of a solar open collector.

## II. MODELING AND ASSUMPTIONS NUMERICAL

The flow field consists of an absorber platform consisting of copper content with a length of 1.5 m, 0.5 m and a thickness of 1.0 mm. Underneath the absorber plate is an absorber air domain which is the same width and duration and

50 mm height. For stabilizing the inlet flow, an inlet air domain of 0.75 m is given upstream of the air absorber region. Similarly, an air mixing outlet domain of 0.50 m long with a convergent outlet of 0.25m long is given downstream of the absorber air domain. The following are the condition was maintained.

1. Air was a constant, compressible medium.

2. The flow is continuous with has turbulent flow.

3. The absorber 's thermal-physical properties Plate is constant with respect to temperature.

4. Numerical simulation is performed in a constant state Fluent 6.3.

5.The 3D machine domain is meshed with amount of hexahedral power. The whole domain consists of 2.6 million components Include plate, air absorber, air inlet and Outlet air domain blending. Evaluate Grid Independence was carried out to verify the validity of mesh content. The change of result by more than 0.8 % which is taken here as the appropriate mesh quality for computation. Conservation equations used to the control volume to yield the velocity and temperature fields for the air flow in the air duct and the temperature fields for the absorber plate.

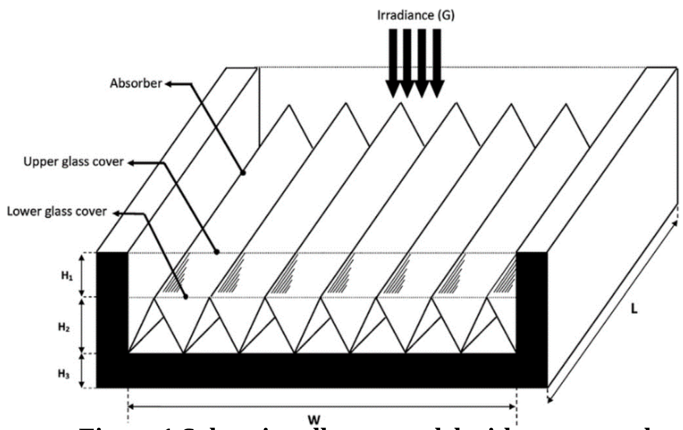


**Figure 1 Solar air collector model with corrugated**

## III. RESULTS AND DISCUSSION

The complete domain consists of more than 1.0 million elements which include the absorber plate, absorber air, inlet air and outlet mixing air domain. The grid independence test was performed to check validity of the quality of mesh on the solution. Further refinement of mesh did not change the result by more than 0.9 % which is taken here as the appropriate mesh quality for computation. Conservation equations were solved for the control volume to yield the velocity and temperature fields for the air flow in the air duct and the temperature fields for the absorber plate.The simulation is carried out at three different mass flow rates and the results. It is clearly seen that, as the absorber plate is uniformly heated with respect to different mass flow rates, the air in the absorber duct gets differentially heated with lesser temperature gradient for higher mass flow rate and also for lower mass flow rate, the temperature gradient was minimal. With respect to the different flow rates, the absorber plate temperature has higher temperature with respect to minimum velocities of flow. The convective effect brings down the absorber plate temperature with respect to the velocity of flow. When the convective heat increases with corrugations across the flow path. the air temperatures were fluctuated in corrugated configuration because of higher convective heat transfer shown in figure 1 to 5.

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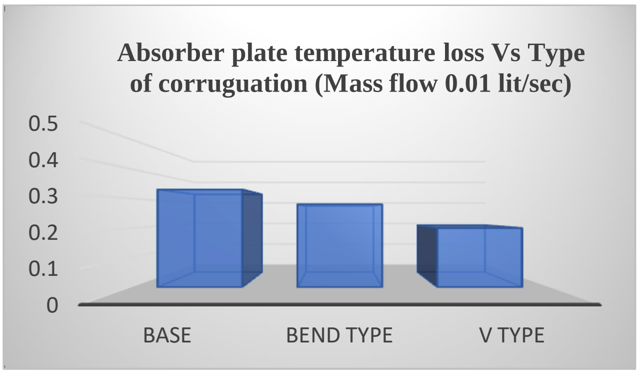


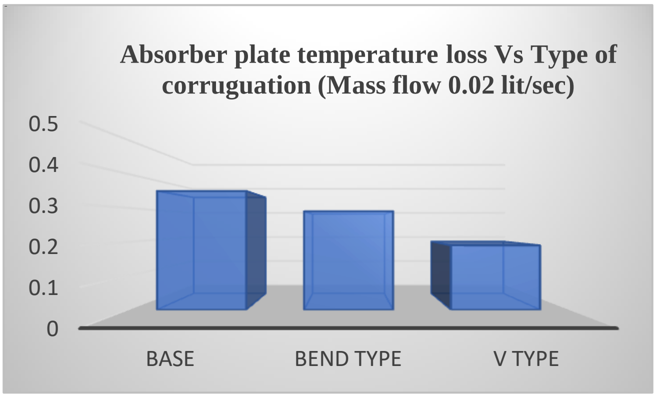


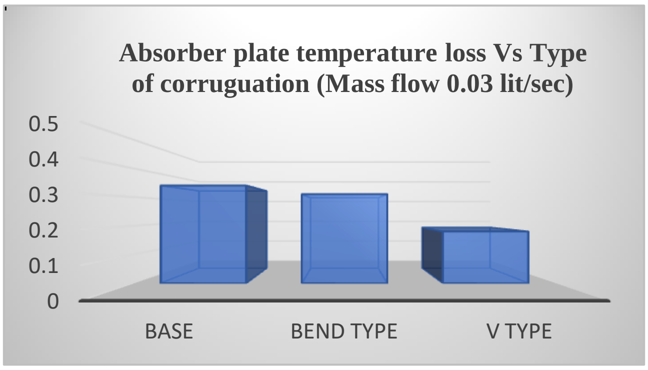


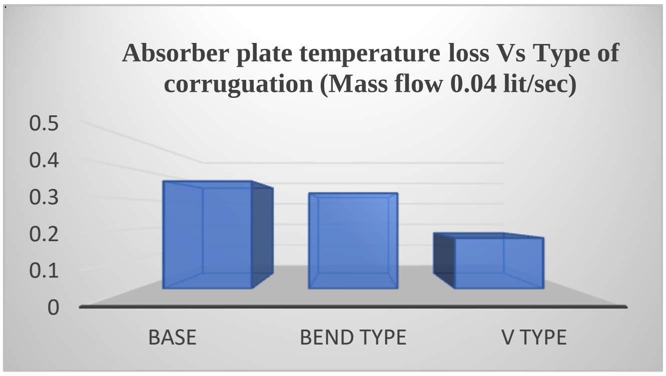


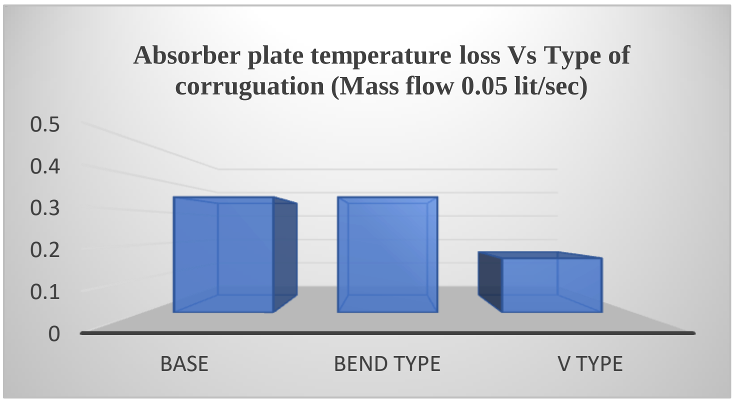


Figure 1 to 5 Absorber plate temperature loss Vs Type of corrugation

## IV. CONCLUSION

It was observed that the better heat transfer characteristics at all mass flow rates in the bend-shaped corrugated absorber plate and heat transfer rate largely at higher mass flow rates in V shaped configurations with respect to the base readings. The CFD helps in design the solar air collector by varying the different variables easily, practically which is complicated. The CFD packages help to provide the contours data, which is useful to know the performance of the solar collector.

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