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A Review on Numerical Analysis for Effect of Ribs on Performance of Solar Air Heaters

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Annotation:
Solar Air Heaters are currently being used for many purposes. One of the main uses of Solar air heater is for drying crops. For obtaining high drying rate, the air passing through it must attain high temperature. Many researchers up till now have a lot of work for enhancing the performance of solar air heater. Various researches have been carried out for variation for shapes of ribs and travel distance of air. In the present paper, work done by researchers for performance enhancement of solar air heaters has been discussed.

KEYWORDS: *Solar Air Heater, Ribs, Turbulence model, CFD analysis, Absorber plate*

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INTRODUCTION

Solar energy can be easily converted into thermal energy using Solar Air Heater. This thermal energy is cheap and can be widely used using Solar Air Heaters. Few important applications of solar air heater can be space heating, crop drying, curing of industrial products and hot air from it can also be used for curing or drying of concrete or clay building components. A traditional solar air heater generally consists of components such as:
1. an absorber plate,
2. a rear plate,
3. insulation below the rear plate,
4. transparent cover on the exposed side,

In the gap between, the absorbing plate and rear plate, the air flows. Increase in heat content of air can be done by enhancing heat transfer of SAH as it leads to saving in energy as well as cost. In the past few years many researchers have worked for heat transfer enhancement in Solar Air Heater.

LITERATURE REVIEW:

Singh et al., 2012, concluded that the artificially rib roughened solar air heaters have higher heat transfer than the conventional flat-plate solar air heater for the same operating conditions. But, increase in roughness leads to higher friction factor leading to increase in pumping power. The authors analytically studied about the exergy efficiency of a solar air heater having discrete V-down rib roughness and compared its results with the results of conventional flat place solar air heater. Optimum rib roughness parameters curves were also plotted.

Yadav, et al., 2013 presented a detailed review of the literature covering the application of CFD for design of solar air heater. The author also concluded that CFD is one of the best tools for simulating solar air heater. The results obtained using CFD are also well in acceptable limits. The authors also carried out a CFD investigation for various turbulence models for a solar air heater.

Hu et al, 2013, developed a numerical model to predict internal flow and heat transfer characteristics for mechanical ventilation solar air heater. Validation of the numerical model was also carried out. It was concluded that the baffles strengthened the convective heat transfer process and lessen the radiation heat loss, which leads to efficiency improvement. But volume occupied due to baffles causes strong flow separation. The authors covered influence of number of baffles, the thickness of air gap, the number of top glass cover and the operating conditions on the collector performance. It was concluded that the operating parameters had significant influence on the temperature rise in solar air collector.

Boulemtafes-Boukadoum et al, 2014, presented a numerical analysis for heat transfer enhancement in solar air heaters with artificially roughened absorber plate.

Numerical simulations were done to analyze the flow and heat transfer for solar air heater with transverse rectangular ribs. Because of turbulent flow, RANS formulation has been used for modelling the flow. Simulations were done for four turbulence models for 2 D mesh. And the results were found to be in agreement with the literature.

Lahori et al, 2016 carried out basic review on solar air heaters and ways to enhance the performance of Solar Air Heaters. The authors laid stress on increasing air travel length by increasing the roughness on the absorber plate.

Lahori et al, 2016 discussed the effect of air travel length on the performance of solar air heater. Performance of Solar Air Dryer was carried out for with and without conventional air heater. Effect of climatic conditions was also carried out.

Kumar et al., 2017, conducted CFD analysis for various turbulence models to find out the performance of solar air heaters for corrugated absorber plate using FLUENT 2 D flow has been taken into consideration and the heat flux is considered of a constant value of 910 W/m^2.

Prasad et. al., 2017, presented mathematical model and numerical analysis for evaluation of entropy generation for forced convection heat transfer in rectangular duct of a artificially roughened solar air heater. Entropy generation, entropy generation number, Bejan number and irreversibilities of roughened as well as smooth absorber plate solar air heaters were found out. It has been concluded that entropy generation and exergy based analyses can be used for finding the overall performance of solar air heaters.

Manjunath et. al., 2017, discussed about the effect of turbulence on thermal efficiency and thermo hydraulic performance of flat plate solar air heater. The analysis was carried out for wide values of Reynolds number. Parameters such as diameter (D) of sphere and relative roughness pitch (P/D) were worked for. Obtained CFD results have been validated with experimental values and both are in good agreement. On increasing the sphere diameter, thermal efficiency of the solar air heater increases. It has been concluded that relative roughness pitch and size of the spherical turbulator have noticeable influence on the thermo-hydraulic performance of solar air heater.

Abhay et al, 2018, used artificial roughness to increase the heat transfer rate for indirect type solar air heater. Square shaped ribs were used on the absorber plate of the solar air collector. 2D numerical simulations were done for flow through the solar air collector for various Reynolds number, relative roughness pitch (P/e), relative roughness height (e/D) and thermo-hydraulic performance parameter (THPP). The numerical results are found out to be in good agreement with existing literature.

Salih et. al., 2019, investigated the thermal performance of a double-pass solar air heater with paraffin wax-based on a phase change material PCM using multiple rectangular capsules. A mathematical model was also developed based on Finite Volume Method. Numerically obtained results were found to be in good agreement with the experimental values. It was found that on increasing airflow rate, delay in the melting period and decrease in melting temperature of the paraffin is observed.

Raj et. al, 2019, experimented on a double-pass solar air heater system using thermal lag of phase change material. The geometry of encapsulation used for storage was worked upon. It was concluded that with a small cost of construction, operational time increases.

CONCLUSIONS

From the above study it can be concluded that CFD can be easily and effectively used for analysing the performance of solar air heaters. It is boon for researchers for doing detailed analysis. Results obtained using CFD analysis bears a close comparison with the experimentally obtained results. Increase in roughness of the absorber plate leads to increase in the heat content of air travelling in Solar Air Heater which can be further used for various purposes.

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