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A Review-Experimental Investigations on Performance Enhancement of Double Pass Solar Air Heater having Inverted V-type Perforated Baffles on Absorber Plate

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Abstract: ***The performance characteristic of a conventional "double pass solar air heater"(DPSAH)is low and can be improved by usingdifferent techniques, such as, proper insulation,fins, baffles plates,etc.The objective of this paper is to enhance the convective heat transfer through flat plate by considering inverted V-typeperforated baffles on absorber plate. Thermal performanceisaffected by these parameters, such as, Reynolds number, Nusselt number, width to height ratio (W/H), relative roughness pitch (P/e), relative roughness height (e/D_h) , and angle of attack (α). The heat transfer of this roughened duct have been compared with those of the smooth duct under similar flow condition.***

Keywords: Double pass solar air heaters, Reynolds number, Nusselt number, artificial roughness, angle of attack.

I. INTRODUCTION

At present time energy is a basic component to assist our life and development work. Energy are used in different-2 forms to full-fill our daily needs. The standard of living as well as prosperity of the people is directly associated with the Energy consumption rate.

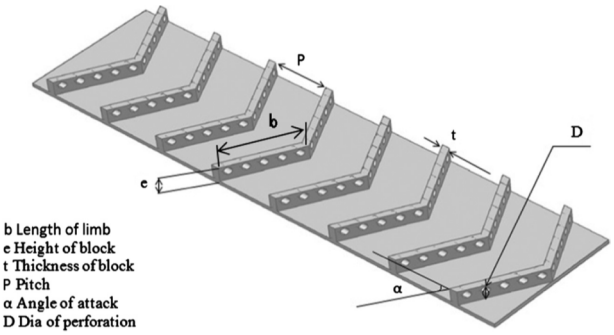

Fig:1 Arrangement of inverted V-type perforated baffles on absorber plate [1].

There is a two types of energy resourses, conventional and non-conventional. Conventional energy resourses as: (coal, crude oil and natural gas) are limited in amount, so need to search of alternate energy resources. Other is Non-conventional or alternate energy resources and it is divided into two groups, such as: renewable and non-renewable energy resources.

Among all the non-conventional energy resources, solar energy is found to be most promising energy source because of its infinite, continuum and environment friendly nature. Solar energy come from Sun on the surface of Earth in the form of solar radiation and can be utilized as solar thermal applications and direct conversion into electricity using solar photo voltaic (PV) system. We use solar collector to convert solar energy into thermal energy. Collectors are of flat plate size are generally used for low and moderate temperature. SAHs are device like a heat exchanger that provide energy in the form of heat for the purpose of space heating, drying agricultural products, such as: cash crop drying, paddy drying, fruit drying, timberdrying, etc. and some industrial applications.

The thermal performance of a conventional DPSAHs is generally low due to low convective heat-transfer coefficient between air and the absorber plate. By providing artificial roughness on the absorber plate to increase the heat transfer coefficient through breaking viscous layer. This can be done by taking the height of the roughness elements small in comparison to the duct dimensions.

II. LITERATURE REVIEW

Previous studies carried out in the form of small wires used in solar air heater utilized different geometries like transverse ribs , W-shaped ribs , V-shaped ribs, multi V-shaped ribs ,and multi V-shaped ribs with perforated baffles.

Alam et al. [2] Non-circular perforation holes was been found to result inhigher heat transfer as compared to circular holes with same open area ratio, and there is optimum non-circular shape that corresponds to a circularity of 0.69.

Chamoli and Thakur et al. [3] investigated that There is significant increase in thermal and effective efficiency of solar air heater with V-down perforated baffled roughened absorber plate. The increase in effective efficiency is up to 78% of the smooth duct solar air heater.

Patil et al. [4] observed that Multi V rib roughness is one of the most acclaimed forms of roughness tested recently showed distinct performance in case of solar air heaters.

Alam et al. [5,6] reported that larger turbulence promoters such as ribs, block, baffles, vortex generators and obstacles of larger height lead to relatively higher heat transfer with still have higher pressure drop penalty, which was the main drawback of such devices.

Liu and Wang et al.[7] numerically investigated the heat transfer and friction characteristics of the five different structures of semi attached ribs. It was observed that the semi attached rib can significantly improved local heat transfer and fluid flow performances.

R. kmar et al. [8,9] The heat transfer enhancement is a strong function of W_d/W_b and broken multiple V-type baffles outcomes in significant improvement in Nu_{rs} of air flow in a solar air channel. R. kumar et al. [10] The use of the discrete V-pattern baffle with angle of attack of 60° causes a very high Nusselt number and friction factor as compared with other values of angle of attack. The upper most thermohydraulic performance occurs at angle of attack of 60°. Discrete V-pattern baffle has better thermal performance as compared to other baffle shapes' rectangular . C. Nuntaduist et al. [11] The investigation was performed at constant Reynolds number (*Re*) of 60,000. The experimental heat transfer results via Thermochromic liquid crystal sheet are reported along with the numerical flow characteristics.Ashok et al. [12] Studied that when compared with the smooth duct, the presence of V-shaped blockages with perforation holes yields Nusselt number up to 6.38 times while friction factor rises up to 13.96 times. Kumar et al. [13] Multi V-baffles having better overall thermal performance as compared to other baffles solar air channels. Chamoli and Thakur et al. [14] carried out the experimental work to study the effect of open area ratio and relative hole position of V shapand perforated baffles of solar air heater. His work covered the range of open area ratio of 12–44%, relative hole position (l/e) 0.429–0.571 for fixedvalue of relative height (e/H) of 0.4, relative roughness pitch (P/e) of 5 and angle of attack (a) of 60_. Alam et al. [15] experimentally investigated thermohydraulic performance due to V-shapedperforated blockages in solar air heater duct. It was reported that maximum thermohydraulic was observed at relative height of 0.8, relative pitch of 8 and open area ratio of 20%.

III. OBJECTIVE

A. The main Objective of This Paper Are

1) To compare the performance of conventional double pass solar air heater with modified inverted V-type perforated baffles on absorber plate double pass solar air heater
2) To discuss about the variation of Nusselt no. and friction factor
3) To enhance the convective heat transfer towards the duct.
4) To minise the heat transfer loss through the rectangular duct
5) To enhance the effective efficiency of double pass solar air heater.

IV. PROPOSED METHODOLOGY

A. The proposed Methodology of Present Paper Are

1) To use double pass solar air heater
2) All the surface of double pass solar air heater are painted with black colour to absorb as much as heat from Sun's radiations
3) Proper insulations are provided on the side wall and bottom surface of the rectangular duct
4) Roughness in the form of perforated baffles are provided on the both side of the absorber plate to enhance the convective heat transfer.

V. CONCLUSION

A. We conclude from literature review , the use of artificial roughnessin different forms and shapes are effective and efficient way to enhance the performance of solar air heaters

B. Numbers of experimental investigations involving roughness elements of different shapes, sizes and orientations with respect to flow direction have been carried out in order to obtain an optimum arrangement of roughness element geometry.

C. A Relation between heat transfer and friction factor have been developed which are applicable to wide range of rib configurations and operating parameters.

D. The effective efficiency based criteria is found suitable for design of roughened solar air heater and design plots can be used to design the V down perforated baffled roughened solar air heater.

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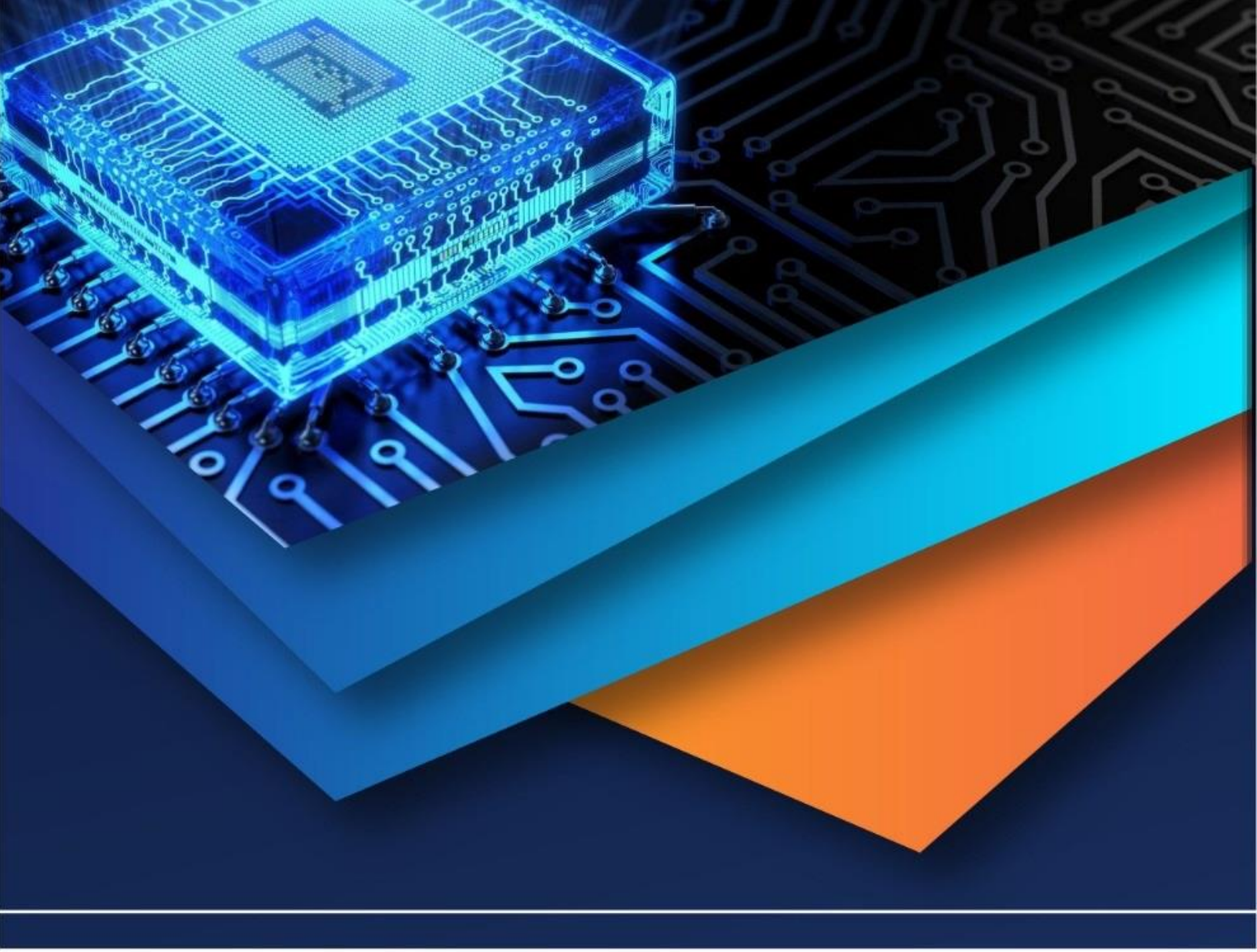

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