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Experimental Analysis of Heat Transfer Enhancement and Pressure Drop By Using Perforated Porous Baffles in Rectangular Channel

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Abstract

Design of electrical or electronic component in the present situation is getting more compact sizes, which gives results in heat generation. Reduced the life of component because this unnecessary heat generation. To reduce this problem there is a necessity of an efficient cooling system. Extended surface heat sink is one of the most popular heat sink techniques. To improve its efficiency, there are number of conventional methods available but only a few of them such as changing the shape of cross section of baffles, changing the baffles inclination with walls and baffles arrangement and using metallic foam of high conductivity like that aluminium foam material which gives good results individually. Solid baffles gives lower heat transfer rate as compare to metallic foam baffles. Across the channel pressure drop of metallic foam baffles is less as compare to solid baffles. To increase heat transfer rate the turbulence occurred is good enough due to porosity.

Keywords: Enhancement Heat Transfer, Baffles, Turbulence Flow.

I.INTRODUCTION

As the technology has rapidly advanced and is trying to design the part as compact as possible which lead to heat generation. This enhancement in heat generation will reduce the life of the device. Hence for efficient cooling scheme, a device have been accompanied with a serious requirement. So that the life of devices increases to a greater extent. Try to assemble such a condition jet

impingement cooling with fins or baffles have been widely studied Solid baffles are used in an industry for systems providing cooling effect; performance of baffle plate heat drop is of significance and have to be investigated to find out applicability as a common cooling product. The inclination and height change the presentation of baffles can be improved. The metal foam material (porous material) has got high conductivity and less dense due to which heat transfer rate is increased. Heat drop has been utilized for a similar substance. Single jet impingement heat removes for a number of works in before few days from the extensive surfaces such as pin fin, pyramid fin, mesh fin, Aluminium foam fin has been implemented and report better heat remove. Newly introduce aluminum foam equipment to enhance heat remove surfaces has high volume to surface ratio and high porosities are approximately 1.1. Foam material shows the less pressure drop across the flow of heat transfer fluid. The structure of the aluminium foam is cellular consisting of solid metal aluminum; pores filled which are containing big volume portion of gas. The pores have been form or preserved an interrelated network which gives names therefore closed cell and open cell structure foam respectively. Metallic foams typically retain some physical property from its base material. Metal foam property includes main feature such as pore size, relative density and porosity. The diameter of the void space is of pore size for every faces that composes the cell. Number of pores which are measured in a linear inch is called pore density and symbol is PPI (pores pe

The work carried out in this area by the different researchers is the objective for this study.

II.HEAT TRANSFER ENHANCEMENT TECHNIQUES

Heat transfer enhancement techniques are basically divided into three groups:

- Active method: -Some external power source for the heat transfer enhancement is required in this method. Some example of the active method are a reciprocating plunger and induced pulsation by cams, particles of flowing fluid are to be disturbed by using magnetic field etc.
- Passive method: -In this method, no external power input is required for the heat transfer enhancement. Some examples of this method are a rough surface, treating the surface, an external surface, inserts etc.
- Compound method: -Compound method is a combination of both active method and a passive method.

III. REVIEW ON WORK CARRIED OUT

A.K. Pundlik et al [1] have experimentally analyzed the various arrangement of the pin fin heat sink in the square channel. Experimentation has been carried out by changing the parameters like a cross section of fin, arrangement and using metallic foam of high conductivity. Nusselt number so obtained is greater for circular shape in comparison to the square by 45% and 63% for inline and staggered arrangement. It is also found that there is an increase in Nusselt number for a test sample with foam insert when compared to the test sample without inserting foam.

Kang-Hoon Ko et al [2] experimentation is done to calculate module average heat transfer coefficients of the rectangular duct which fixed porous baffles with the wall is uniformly heated as shown in figure-1. Heat transfer coefficients and pressure drop values are obtained for completely developed flow regularly and enhancement heat transfer which are obtained porous medium for various types and compared with the effect of foam metal baffle. The use of porous baffles provides heat transfer rate as high as 300% compared to heat transfer without baffles in the straight rectangular channel.

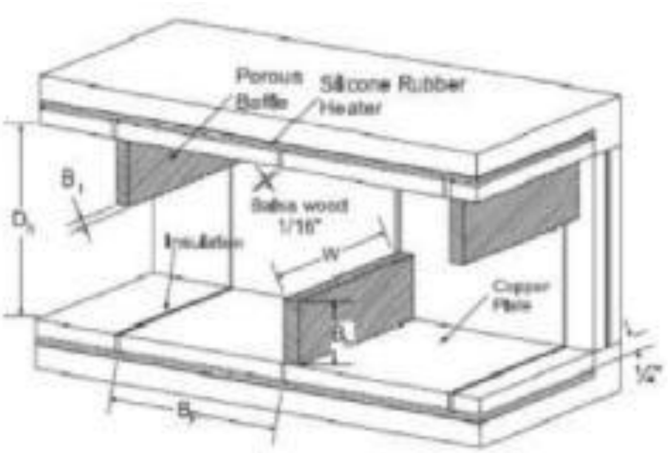

Figure-1: Schematic of test section [2]

Yue-Tzu Yang et al [3] have studied numerical simulations to know the turbulent heat transfer increase in the pipe for which porous media was used for filling it. By using the κ–ε turbulent model for analysis, two-dimensional asymmetric simulations were done to study the heat transfer characteristics of pipe which was filled with porous media. Hamidou Benzenine, Rachid Saim and Said Abboudi, Omar line et al [4] observed that the heat transfer in a complicated components such as the design of the nuclear reactor, heat exchangers, cooling industrial machine and electronic components are improved in the turbulent flow. *Wilfried et al* authors investigated on impact baffle on the heat transfer and geometry of heat exchangers. Rajendra et al investigated the heat transfer coefficient as well as friction factor on an asymmetrical rectangular channel with perforated baffle. Gupta et al investigated by using hel shaped baffles, thermal and hydrodynamic parameter. Yong-Gang lei et al observed with only single helical baffle flow passing through a channel.

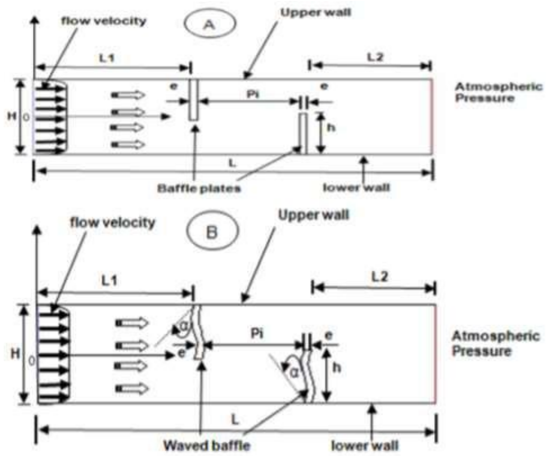

Figure-2: Schematic of test section [4]
(A) Plate baffles (B) Waved baffles

Prashanta Datta and Akram Hossain [5] The effect in a rectangular pipe of local heat transfer and friction factor with inclined and perforated baffles is studied. Two baffles are used in this experiment, one is mounted at the top and other one varied to identify an optimum configuration for an increase of heat transfer. Chandra and co-workers experimentally calculated the heat transfer and friction factor by using a number of ribs.

Sheng-Chung Tzeng [6] has calculated heat drop using a high-conductivity conductive pipe of the spatial thermal regulation of aluminum foam. The test specimens which is measured by four modes and experimental results shows that an aluminum foam heat sink of the conductive pipe is very useful in spatial thermal regulation, mainly in lateral arc gaps beside the porous conductive pipe.

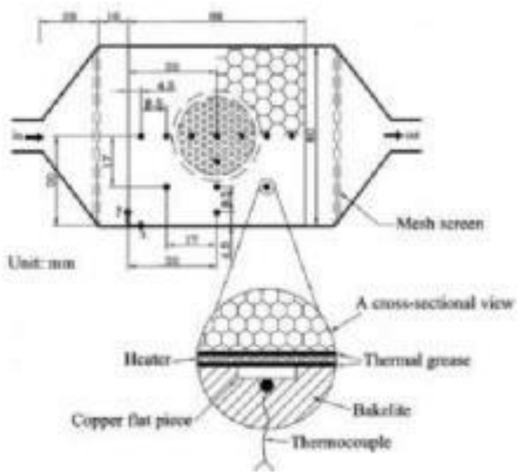

Figure-3: Position of thermocouple measured herein [6]

K. David Huang et al [7] has experimentally predicted the local heat transfer coefficient in a square channel with a perforated baffle plate. The changing parameters on the perforation baffle are the Reynolds number, the baffle height, and the whole numbers. The results found that local heat transfer rate was more in the case of the perforation and Reynolds number increases as baffle height increases. Finally, they proposed experimental formula which is provided according to the analysis of all experimental data of the position of flow reattachment point.

Sheng-Chung Tzeng et al [8] has experimentally predicted the local and average heat transfer coefficient with metallic baffles in asymmetrically heated sintered porous channels. The experiment was carried out in four modes (a)without baffles, (b) with periodic baffles on the top portion, (c)with periodic baffles on the bottom portion and (d)with staggered periodic baffles on both sides, are performed. In mode b heat transfer is maximum and in model heat transfer is minimum.

P. Promvonge et al [9] observed in a three-dimensional isothermal wall square duct for the laminar periodic flow and heat transfer which is fitted with 450 inclined baffles. Computations are carried out and introduced the finite volume method and Computations has been implemented the simple algorithm. They presented the characteristic for ranking of Reynolds number from 100 to 1200. The increase in blockage ratio due to attack angle results in considerable increase in Nusselt number as well as friction factor value. For all Reynolds numbers and baffle height, the enhancement factor of 900 baffles is found to be lesser than that of the 450 baffle.

Alberto Cavallini et al [10] have performed experimentation over electrically heated aluminum foam. They observed the heat transfer and pressure loss across the aluminum foam. The aim of the experiment was to find out of this new enhanced surfaces of the efficient thermal fluid dynamic behavior which present at the expense of high-pressure loss of high heat transfer area per unit volume. Several semi-empirical correlations were developed from experimental data.

S. Naga Sarada, A.V Sita Rama Raju, K.Kalyani Radha and L. Shyam sunder [11] In most of the heat transfer techniques in a circular duct a type of inserts have been used, particularly when turbulent flow is used. Different inserts used are coil wire inserts, brush inserts, mesh inserts, strip inserts, twisted tape inserts etc. Sarada at el observed heat transfer condition in a horizontal isothermal tube. Results were obtained in a horizontal tube on twisted tape inserts in viscous flow. To enhance the heat transfer coefficient with twisted tape in a tube in the range of Reynolds number from 5000 to 25000. For a different value of Reynolds, number experiment is done and the experimental data is obtained and compared with earlier calculated values.

Figure-4: Twisted tape inserts [11]

CONCLUSION

Heat transfer enhancement from various conditions such as types of baffles, the different inclination of baffles, varying the number of pores, Reynolds number, flow conditions etc is reviewed. It is found that heat transfer with porous baffles is more effective than solid baffles and without baffles. Heat transfer rate depends upon the inclination angle of baffles. With decreasing inclination angle up to a certain limit, heat transfer rate increases and decreases the Nusselt number and friction factor. As inclination angle of baffles increases, friction factor also increases. The heat transfer enhancement also depends upon the physical properties of foam such as pore density, pore size etc. As pore size and pore density increases, the surface area also increases which enhance heat transfer rate in a channel by using porous baffles. It is also possible that reducing the inclination angle baffles from 45° to around 20° to obtain the more enhancement in heat transfer in future.

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