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Heat Transfer in Rectangular Micro Channels at Different Plenum Shapes

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ABSTRACT

In the recent years, there is a rapid advancement in micromachining technology. This advancement leads to the development of miniaturized systems, which further leads to various applications, as in the field of medical science, electronic and bioengineering. These types of systems often contain small scale fluid channels embedded in the surrounding solids with heating sources. Due to the instability of flow at the entrance and exit regions of the micro channels needs to be clearly understood for efficient design of inlet and outlet plenum shapes and for design of micro-channels. In this work two different shape of test pieces are manufactured from aluminum and block is manufactured from copper. Heaters having 50 W and 100 W capacities are used to heat up micro-channels.. The micro-channel heat sink fabricated with different designs of inlet and outlet plenum arrangements having rectangular plenum and trapezoidal plenum. By using different heat inputs ,we found that trapezoidal plenum arrangement having better heat transfer coefficient compared to rectangular plenum arrangement. Also we found that the effect of pressure drop in micro channel heat sinks.

I INTRODUCTION

The cooling has become a very important factor when considering the design of electronic systems because of the culture of higher packaging densities. Moore's law, regarding the downscaling of electronics which says, the number of transistors on integrated circuits doubles every year. It is because of reduction in the size of transistor. P. Gunnasegaran [1] study experimentally rectangular, trapezoidal, and triangular microchannel.As the hydraulic diameter decreases heat transfer coefficient increases also there is gradual effect in terms of pressure drop and friction factor. Mohammad Rahimi, Reza Mehryar [2] investigated the effects of at the entrance and ending regions of a circular cross-section microchannel by using a conjugate mehod..As the experimentally shows nusselt no.is constant in entrance region but its gradually increases . H.A. Mohammed [3] studied the Microchannel heat sinks (MCHS) for different channel shapes such as zigzag, curvy, and step micro channels, and it is compared with straight and wavy channels they found that zig –zag cross section have lesser heat transfer coefficient compared to other also found that pressure and friction drop is higher in zig zag microchannel followed by step wise microchannel. The heat transfer coefficient having higher in straight micro channels. Omar Mokrani [4] investigates the microchannel, in rectangular cross-section having large aspect ratio and results obtained 1 mm and 100µm deviate heat transfer cofficent and after that when it exceeds 100µm it does not relate to empirical correlations. Reiyu Chein,Janghwa Chen 15] study in the inlet/outlet arrangement effects on the fluid flow and heat transfer inside the heat sinks. it is found that better uniformities in velocity and temperature can be found in the heat sinks having coolant supply and vertical position inlet/outlet ports opened on the heat sink cover plate.

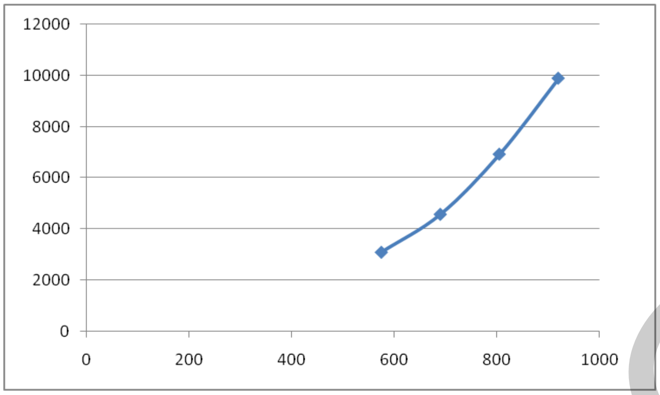
II METHODOLOGY

Higher convective heat transfer rates can be achieved with micro channel heat sink using liquid coolant. Issues related to poor thermal conductivity can overcome with convection rates of micro channel. In order to fulfill the cooling requirements of various electronic devices, different arrangements for the fluid flow within the inlet and outlet plenum of the MCHS have been proposed. As the different flow arrangements are expected to affect the heat transfer and fluid flow characteristics within MCHS, it is important to investigate the effect of inlet/outlet plenum shapes for better MCHS performance. For this purpose, two different inlet/outlet plenum shapes i.e. Rectangular, Trapezoidal have been tested. Flow instability at the entrance and exit regions of the micro channel also influence the performance, so it also need to be understand fully. Generally MCHS has an inlet plenum, from where the fluid is supplied to an array of micro channels, and an outlet plenum, where it is collected after being passed through the micro channels. To check the performance of the MCHS, the fluid inlet/outlet plenum shapes can be arranged in a number of ways. As the channel dimensions are very small, the entrance and exit effects will significantly affect the heat transfer characteristics through the channels. In order to check the performance of the heat sink, it is necessary to study the effect of inlet/outlet plenum shapes on heat transfer characteristics of the micro channels

III RESULTS

Number of experiments will conducted on the two different micro-channels heat sink manifold arrangements. Effect of change in pressure with Reynolds number for MCHS with different manifold arrangements Figure 2 shows the change in pressure with Reynolds number for MCHS with different flow arrangements for two different micro-channels heat sinks; Arrangement (A), Arrangement (B) .The arrangement A is rectangular microchannel with rectangular plenum Whereas arrangement B is rectangular microchannel with trapezoidal plenum shape.. There will be gradual change in the pressure drop with respect to the Reynolds number. It will occur due to pressure loses at inlet/outlet manifold arrangements. Figure 4-6 shows that the A-type of flow arrangement will be experienced maximum pressure drop (ΔP) followed by B-type flow arrangement .

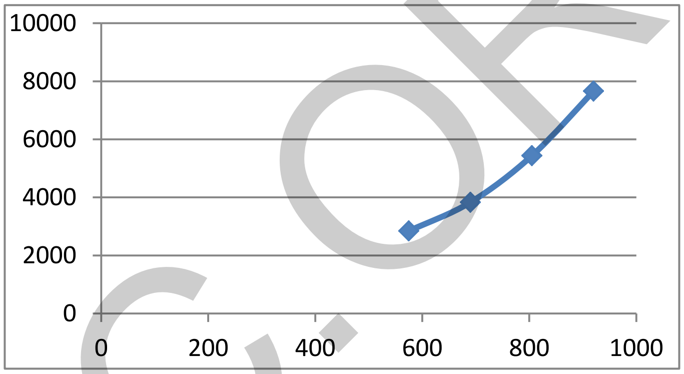
ΔP



Re

Fig.1. Effect of change in pressure with Re number for MCHS with rectangular plenum shape.

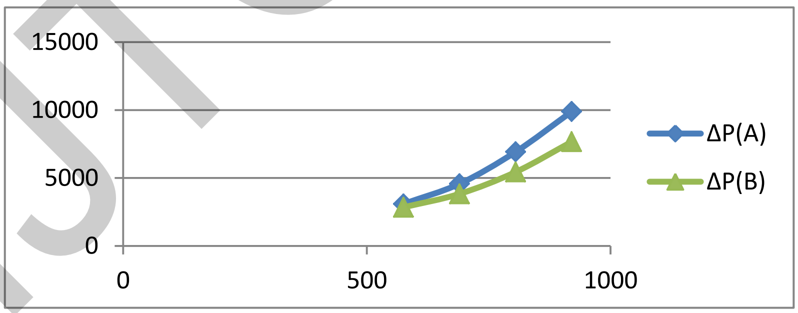
ΔP



Re

Fig.2 Effect of change in pressure with Re number for MCHS with trapezoidal plenum shape

ΔP



Re

Fig 3 Effect of change in pressure with Reynolds number for MCHS with Rectangular shape plenum (A) and trapezoidal plenum shape (B)

3.2 Reynolds number effects on Nusselt number for Rectangular and trapezoidal plenum arrangements at 50 watt heat input Performance of MCHS is better understand by obtaining the Nusselt number for the given flow conditions, through the use of average temperature obtained at the inlet/outlet of manifolds and the micro-channels heat sink wall temperature. The values of heat transfer coefficient are computed for all the values of

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Reynolds number, heat input and manifold arrangements. For a constant value of heat input, not much change in the value of Nusselt number is observed with the variation of Reynolds number. The reasons may be attributed to the fact that the internal flow of fluid within the entire heat sink causes the satisfactory velocity and the thermal boundary layer approximations, in the flow region and between the manifolds Figure 4-6 shows the change of Nusselt number with respect to Reynolds number at constant heat input 50W for arrangement (A) and (B).It shows that the arrangement (B) trapezoidal plenum shaped has the maximum Nusselt number than the arrangement (A)

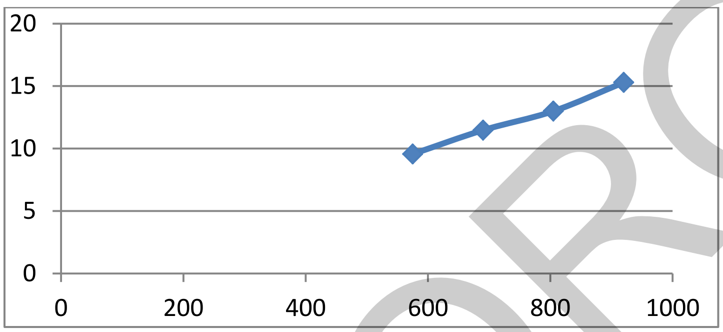

Fig.4.Reynold No. Vs Nusselt No.at heat input 50W For rectangular (A) plenum arrangement

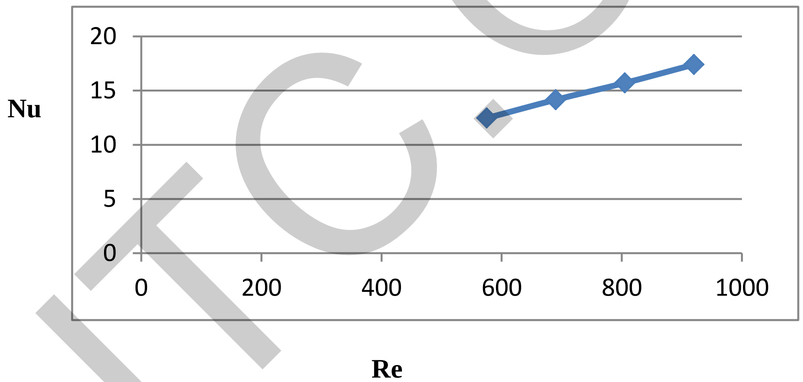

Fig.5 Reynolds No. Vs Nusselt No. at heat input 50W For trapezoidal (B) plenum arrangement

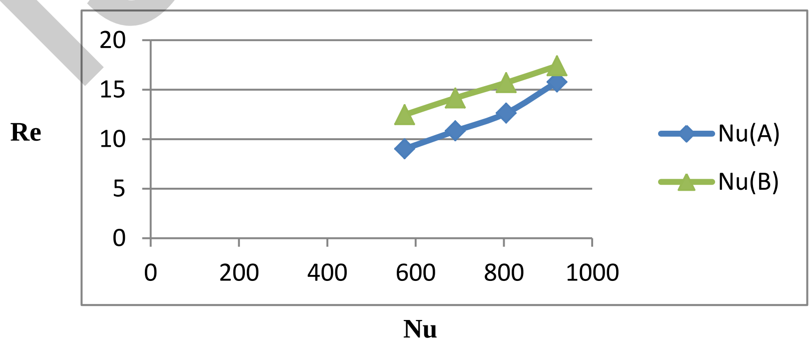

Fig.6 Reynold No. Vs Nusselt No.at heat input 50W For rectangular (A) and trapezoidal (B) plenum arrangement

IV. CONCLUSIONS

The arrangement (B) trapezoidal plenum shaped has experienced the maximum value of Heat transfer coefficient at constant values of Reynolds number and heat input than the rectangular plenu shaped (A) arrangement As the value of Reynolds number increases, the MCHS will experience gradual increase Nusselt number at a constant heat input.

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