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EXPERIMENTAL INVESTIGATION OF RECTANGULAR MICROCHANNELS WITH DIFFERENT MANIFOLD ARRANGEMENTS

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ABSTRACT

The thermal management of microelectronic using liquid cooling technique has been effective from the research community across the globe In this work we have been used rectangular micro channels in different manifold arrangements i.e in rectangular manifolds and rectangular manifold with semi-circular arrangements. Three different heat inputs 100 W,200 W and 300W applied in rectangular micro channels in different manifold arrangements. The rectangular micro channels were made of aluminium 6061. Assembly of aluminium test pieces and acrylic cover plate is made with the help of tightening screws. Thermocouples are inserted in the top surface of inlet & outlet adapters. These thermocouples further attached to the temperature indicator and data acquisition system to provide the actual value of temperature at that position..So As the reynold number increases by applying different heat inputs the nusselt number also increases. Also find out the friction drop in micro channels at different manifold arrangements. After experimental investigation it has been found that Heat transfer through rectangle with semicircle manifold is higher than the rectangular manifold arrangements. Heat transfer coefficient also increases as the reynold number increases. Heat transfer coefficient is higher in in rectangle with semicircle manifold arrangement compared to rectangular manifold arrangement. Thermal performance of rectangle with semicircle manifold arrangement slightly better than the rectangular manifold arrangements.

I INTRODUCTION

Proper thermal management in consumer electronics is very important. The immediate effect of poor temperature control in these devices is twofold; not only does it degrade the overall performance, but it will also affect the reliability of the component. If an electronic device is not properly cooled, it will only be able to operate for short periods of time, greatly detracting from its overall usability and may cause damage, shortening the lifespan of the component. Because of this, it is essential that the temperature of the device stay within its operating limits, which is only possible through effective heat diffusion methods. Another limitation caused by excess heat generation, is that it directly limits the performance potential of the component. A good example of this effect is in the case of computer processors. As the speed of the processor is increased, the amount of heat the device generates increases proportionally. Since this heat is typically dissipated by some external cooling system, the performance of the processor is directly linked to how well this system operates, so if it has limitations, those limitations will be reflected back onto the performance of the processor. Following the invention of the chip, methods for cooling of electronics have improved and sophisticated at an ever increasing pace in conjunction with the rapid development of the electronics industry. The importance of cooling for electronic components is that high temperatures not only decrease their lifetime by accelerating failure mechanisms in materials, but they also reduce the overall reliability of the assembly by accelerating failure mechanisms in connections and interfaces. The evident trend in the development of integrated circuits is that the sizes are getting smaller while the heat dissipation quantities are getting larger. To meet the rapidly rising heat densities, methods of thermal engineering applied to the cooling of electronics have evolved from primitive, passive structures to advanced systems. Manoj Siva et al. [2] experimentally study the parameters affecting the flow maldistribution such as channel hydraulic diameter, channel flow configurations (U, Z, I type) and chip power are varied to study their effect on the pressure drop and temperature distribution across the parallel channels designed for liquid cooling of a CPU using distilled water. Lei Chai et al.[2] investigated heat transfer enhancement of microchannel heat sinks with periodic expansion–constriction cross- sections experimentally and numerically. When Compared with the heat sink R, the pressure drop of heat sink with periodic expansion–constriction cross-sections is lower as Re< 300, but increases rapidly and is obviously higher as 300 <Re< 750. Satish G.Kandlikar [3] studied and comparison of previous experimental data is performed for fluid flow and heat transfer in microchannels. It is concluded that classical theory is applicable to microchannels and minichannels. Mostly paper do not account for entrance and exit losses. D. B. Tuckerman and R. F. W. Pease [4] pointed out that decreasing liquid cooling channel dimensions to the micron scale will lead to increase in heat transfer rates.

II METHODOLOGY AND EXPERIMENTAL SET UP

The overall thermal performace of micro-channels heat sink is depends upon the flow characteristics within micro-channels as well as within inlet and outlet manifold arrangments and these flow characterisics are influenced by channel aspect ratio, hydraulic diameter of channel and inlet and outlet manifold arrangements. In the present research work experimental analysis has been carried out to understand how heat will be transfered and pressure difference attributes will very with different manifold arrangements under different flow rates. For this purpose micro-channels test pieces with three different inlet and outlet manifold arrangements have been tested under four different flow rates.The liquid from inlet manifold passed through the array of channels and then from the outlet manifold it was returned to resevoir through the use of outlet adapter. The temperatures of inlet/outlet fluid were obtained with the help of J-type thermocouples The main purpose of valve has to provide the required flow rate, to obtain Reynolds number range from 590 to 1400

III RESULTS

A. Effect of reynold number vs pressure drop in different manifold arrangements.

It has been shown in fig 1 as the reynold number increases the pressure drop also increases. The range of reynold number lies between 380 to 1400. Fig 1, shows that pressure drop gradually increases as reynold number increases in rectangular manifold arrangement and rectangular with semicircle manifold arrangement. Also shows that rectangle with semi circle has slightly more pressure drop than the rectangular manifold arrangement.

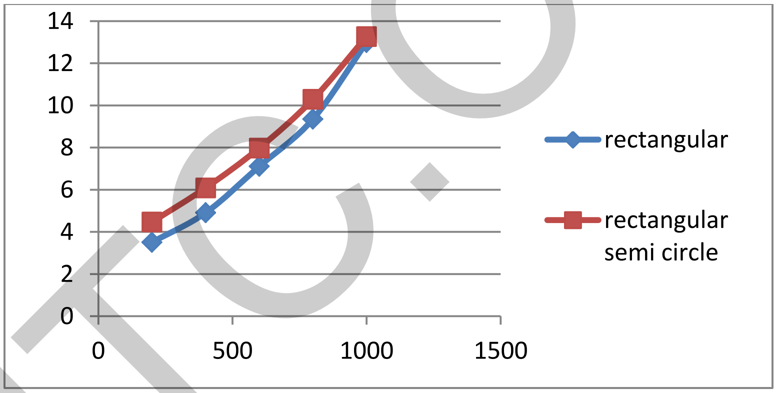

Fig.1. Reynold no vs pressure drop at rectangle and rectangle with semicircle manifold arrangements

B. Effect of reynold number vs nusselt number in different manifold arrangements at different heat inputs.

It has been shown in fig.2 the effect of nusselt number values as the reynold number increases by applying a different heat inputs. The three heat inputs are 100 W,200 W and 300 W. The results of 100 W and 200 W can give better trends of heat transfer coefficient rather than 300 W. Also we have seen than rectangle with semicircle manifold arrangement has slightly larger value of nusselt number values compared to rectangle manifold arrangements.

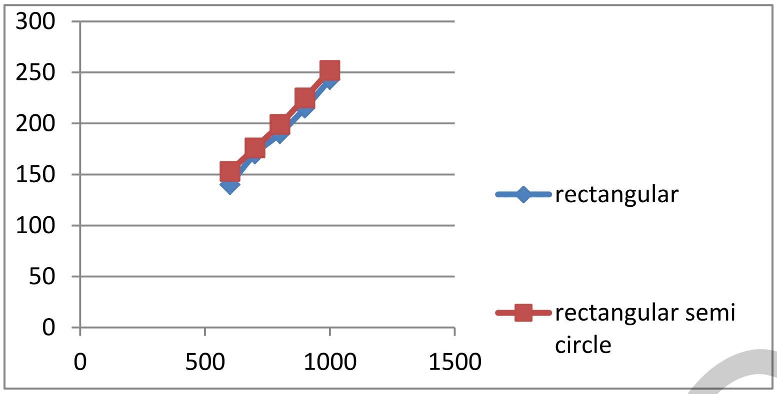

Fig.2 Reynold no vs heat transfer coefficient. at 100 W in rectangle and rectangle with semi-circle manifold arrangement

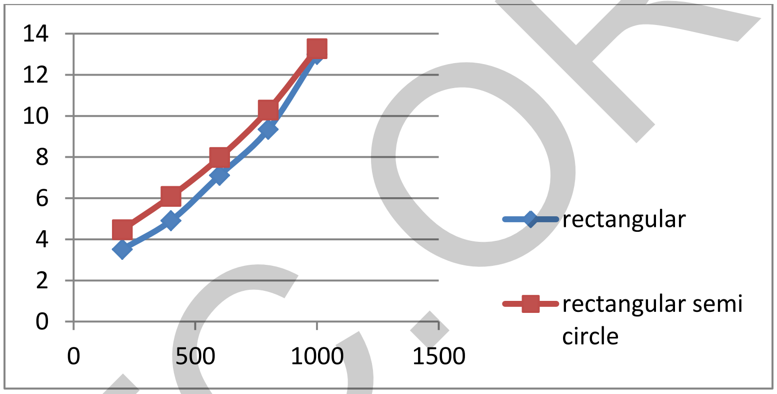

Fig.3 Reynold no vs Nusselt no. at 200 W in rectangle and rectangle with semi-circle manifold arrangement

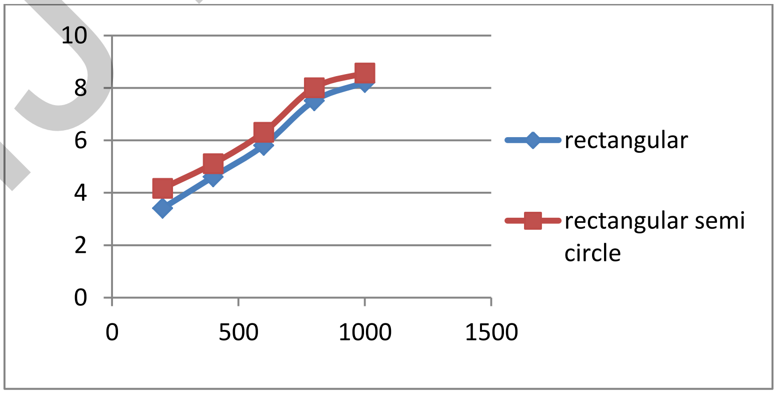

Fig. 4 Reynold no vs Nusselt No. at 300 W in rectangle and rectangle with semi-circle manifold arrangement

IV. CONCLUSION

- It has been found that as the reynold number increases nusselt number also increases.
- It shows that better result obtained on heat input 100 W and 200 W rather than 300W.
- Heat transfer through rectangle with semicircle manifold is higher than the rectangular manifold arrangements.
- Pressure drop is higher in rectangle with semicircle manifold arrangement compared to rectangular manifold arrangement.

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