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**TITLE : ANALYTICAL AND EXPERIMENTAL STUDIES OF FLUID FLOW AND HEAT TRANSFER IN MICROCHANNELS**

# ABSTRACT

Electronic equipments have undergone a sea change in the recent times necessitating their redesign to give efficient performance. Heat dissipation in high performance electronic components becomes a significant parameter in their efficient and stable operation. The rapid development of high-density microelectronic circuits requires more and more effective ways of cooling the microchips. As a possible solution Microchannel-based circuit with liquid cooling media can be employed, for which microchannels provide a very high heat transfer coefficient because of their small hydraulic diameter. Development of Micro heat exchanger is an important area of interest in many fields of developing technology that requires compact high heat energy removal such as micro miniature refrigerators, micro heat pipe spreader, microelectronics, biomedical, fuel processing and aerospace etc. It is, therefore, necessary to not only investigate theoretical aspects but also experimental study of fluid flow and heat transfer in micro channel heat sink. In view of above an experimental exploration was conducted to check the validity of classical correlations based on conventional sized channels for predicting the thermal behavior of single-phase water flow through circular microchannels.

Study covers review of literature regarding fluid flow and heat transfer through microchannels. A critical analysis of literature review shows that even high experimental methods/techniques result errors for reported Nusselt number. This study also include theoretical investigation which covers the role of friction factor, Reynolds number, surface roughness and Prandtl number in heat transfer and fluid flow through microchannels under different constraints. It was found that friction factor enhanced Nusselt number in the turbulent regime. Moreover, on decreasing the hydraulic diameter of the channel, the heat transfer coefficient increases but at the

same time this also results in increasing the pressure drop across the channel. The thermal conductivity of the working fluid plays the major role in the heat transfer coefficient i.e. fluid having large thermal conductivity results in high heat transfer coefficient as compared to those having less thermal conductivity.

Experiments were conducted to find out heat transfer and fluid flow characteristics of water flowing through circular microchannels. The length and hydraulic diameter of each microchannel under observation are chosen as 279 µm and 45 mm respectively based upon fabrication limitations. Microchannel Heat Exchanger (MHE) capacity had a total of seventy nine channels arranged in circumferential manner. The experiments were conducted with water as working fluid of Reynolds number ranging from approximately 300 to 3000. Pressure drop and flow rates were measured to analyze the flow characteristics. On the basis of experimental data the correlation for friction factor was proposed in term of Reynolds number. The proposed correlation for friction factor agrees very well with the experimental data as well as previous existing correlations. This proposed correlation for friction factor help to predict the flow characteristic of fluid under the imposed condition. The experimental values for average Nusselt number in the low Reynolds number range i.e $300<Re<1000$ does not match with the existing correlations (Stephan- Correlation Hausen correlation, Sieder and Tate equation), but experimental results are more close to Stephan-Correlation as compared to other two correlation. Therefore the modified Stephan- Correlation matches very well with the experimental results. This indicates that this modified Stephan-Correlation can be used to predict the results of average Nusselt number in this range of Reynolds number. While in the high Reynolds number range i.e. $1000<Re<3000$ experimental average Nusselt number showed excellent agreement with the Dittus-Boelter equation. The result also shows the early transition of laminar to turbulent in microchannels as compared to conventional pipe. Moreover it was found that average Nusselt number increases with increase in pressure drop.

The study has far reaching ramifications in the area mentioned above and in Coronary Heart Bypass surgeries which has wide scope for future work to ensure zero fatalities.