Dynamic Fluid Flow and Heat Transfer in Different Micro-Channels with Numerical techniques: Case Study

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Abstract: In this paper we discuss these micro-fluidic systems; micro channels have been identified to be one of the essential elements to transport fluid within a miniature area. In addition to connecting different chemical chambers, micro channels are also used for reactant delivery, physical particle separation, fluidic control, chemical mixing, and computer chips cooling. Hence, the study of fluid flow and heat transfer in micro channels which are two essential parts of such devices, have attracted more attentions with broad applications in both engineering and medical problems. Heat sinks are classified into single-phase or two-phase according to whether boiling of liquid occurs inside the micro channels. Primary parameters that determine the single phase and two-phase operating regimes are heat flux through the channel wall and coolant flow rate.
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Keywords: fluid flow, single phase or micro channels.

Introduction

A large percentage of the active research in micro channel heat transfer involves two-phase flows. Two-phase heat transfer does indeed dissipate large heat fluxes on the order of tens of MW/m^2. However, the two-phase flow system comes with a few more complications versus a comparable single-phase flow system. The two-phase pressure Drop will be much higher than the single-phase. In addition, the two-phase flow system would also require a condensation step in the closed loop system. Micro channel condensation is also a developing technology that requires further work to understand all of the physics involved. [1]

Over the last decade, micromachining technology has been increasingly used for the development of highly efficient cooling devices called heat sink because of its undeniable advantages such as less coolant demands and small dimensions. One of the most important micro-machining technologies is micro channels. Hence, the study of fluid flow and heat transfer in micro channels which are two essential parts of such devices, have attracted more attentions with broad applications in both engineering and medical problems. [2]

With all of the attention that two-phase micro channel heat transfer is getting, a great opportunity for understanding the fundamental physics that occurs in single-phase micro channel heat transfer is being missed. This is not to say that the two-phase heat transfer is not important and will not provide the technology to cool future microprocessors. The transition at hand for this industry is from advanced air-cooling to the next cooling medium. The authors believe that there is tremendous benefit to transition into single-phase micro channel heat transfer prior to implementing two-phase micro channel heat transfer.

Utilizing single-phase micro channel heat transfer for high heat flux microprocessors is a viable option for several reasons. First, the overall system complexity is reduced for a single-phase system. Secondly, the micro channels can be enhanced to provide improved overall heat transfer coefficients. [1]

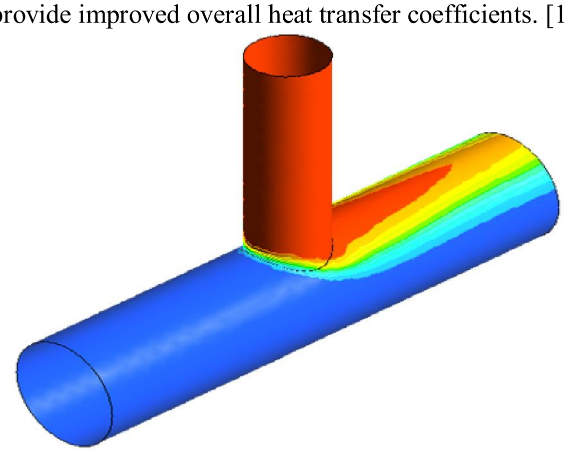

Figure 1.

Literature Review of this Study

Peng et al had investigated experimentally the single-phase forced convective heat transfer characteristics of water/methanol flowing through micro-channels with rectangular cross section of five different combinations, maximum and minimum channel. size varying from (0.6 × 0.7 mm2) to (0.2 ×

0.7 mm2). The results provide significant data and considerable insight into the behavior of the forced-flow convection in micro-channels **[4]** had also investigated experimentally the single-phase forced convective heat transfer micro channel structures with small rectangular channels having hydraulic diameters of 0.133–0.367 mm and distinct geometric configurations. The results indicate that geometric configuration had a significant effect on single-phase convective heat transfer and flow characteristics. In this Paper we will expand the continuum momentum and energy equations for laminar forced convection in two-dimensional V-Shaped micro-channels and nano-channels under hydro dynamically and thermally fully developed conditions with the first-order velocity slip and temperature jump boundary conditions at the channel walls. Closed form solutions are obtained for the fluid friction and Nusselt numbers in the slip-flow regime.[3]

Fluid flow Effect in geometric parameters

It is known that the height-to-width ratio has great effect on the flow friction and heat transfer in the rectangular micro channels [6,7]. For the trapezoidal micro channel, its cross-sectional shape is determined by two aspect ratios, the height-to-top width ratio H=W and the bottom-to-top width ratio W b=W. Therefore, there are three geometric parameters including W t,H=Wt and length-to-diameter ratio L=D, which affect the friction and heat transfer in the trapezoidal micro channels. These micro channels were etched under the same conditions in the same silicon wafer, they have approximately the same order of surface roughness (9:85 x10^{-5}–4:30 x 10^{-5}) and same surface hydrophilic property. [5]

EXPERIMENTAL UNCERTAINTIES IN MICROCHANNELS

The experimental uncertainties can become quite large for a micro channel heat exchanger. Some of the challenges include the physical size of the system being measured and the magnitudes of the measurements. The heat transfer occurring in micro channels is very efficient. Therefore, the temperature differences between the liquid and the walls can be very small.

The ΔT can be only a few degrees or less. Fortunately, several of the standards for experimental uncertainties still apply at the micro scale. The two best standards for determining experimental uncertainties are ASME PTC 19.1 (1998) and NIST Technical Note 1297 (1994). There are many similarities between these standards and many published works. In general, the total uncertainty is comprised of two parts - systematic error and random error. [1]

Conclusion

In this paper we discuss the all experimental methods of heat transfer techniques. The transition at hand for this industry is from advanced air-cooling to the next cooling medium. In this dynamic fluid flow believe that there is tremendous benefit to transition into single-phase micro channel heat transfer prior to implementing two-phase micro channel heat transfer.

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