A Computational Fluid Dynamic Flow and Heat Transfer in two phase Micro-Channels: case review

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Abstract: In this paper we will discuss the all numerical methods are extensively used to analyze the performance of the behavior for computational flow and also to design the two phase micro-channels heat exchanger. Computational Fluid Dynamics (CFD) is a computer-based numerical tool used to study the fluid flow and in this we can transfer the flow dynamically, heat transfer behavior and also its associated phenomena such as chemical reaction. A set of mathematical model equations are first developed following conservation laws. These equations are then solved using a computer programmed in order to obtain the flow variables throughout the computational domain. A theoretical study of single phase micro channel heat exchanger has been carried out. 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.

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Introduction

Here two phase micro channel heat sinks constitute an innovative cooling technology for the removal of a large amount of heat through a small area and it is transfer the heat dynamically using the computational flow. It is one of the potential alternatives for replacing conventional finned tube heat exchangers, mainly used in industries such as automobiles, air conditioning and refrigeration at present. 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. [1]

Literature Review of this Study

[3] 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]

Computational Fluid Dynamics (CFD) for heat Transfer

Computational fluid dynamics is a software key tool using in the pharmaceutical industry and many industry. This technology allows engineers to visualize and predict manufacturing processes, device performance and the effectiveness of drug delivery systems. Numerical methods are extensively used to analyze the performance of the behavior and also to design the micro channels heat exchanger. Computational Fluid Dynamics (CFD) is a computer-based numerical tool used to study the fluid flow, heat transfer behavior and also its associated phenomena such as chemical reaction. [9]

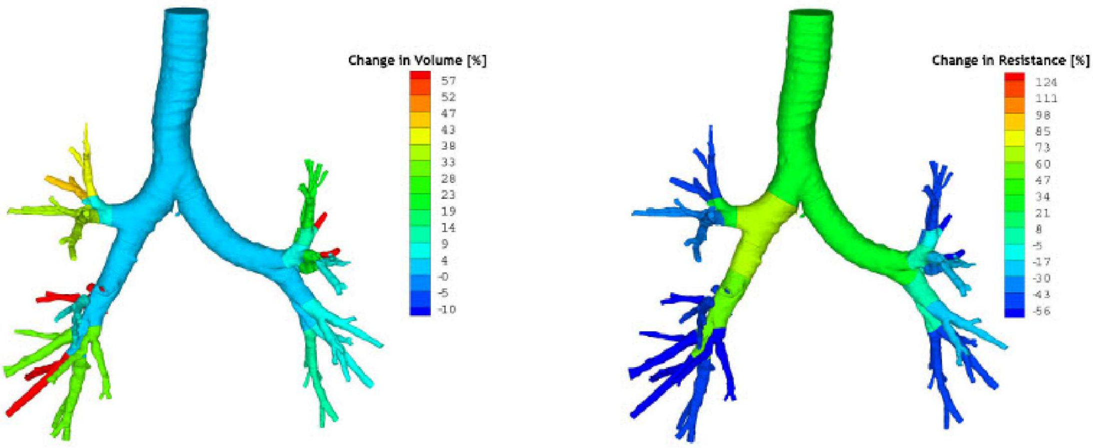

Figure 1: Computational fluid by google

Effect of geometric parameters in CFD

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 two phase Micro channels

The experimental uncertainties can become quite large for a two phase 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. [10]

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. [11]

Conclusion

In this paper we discuss the all experimental computational fluid dynamics methods for heat transfer techniques. This technology allows engineers to visualize and predict manufacturing processes, device performance and the effectiveness of drug delivery systems. The transition at hand for this industry is from advanced air-cooling to the next cooling medium. Computational fluid dynamically method believe that there is tremendous benefit to transition into single-phase or two phase micro channel heat transfer prior to implementing two-phase micro channel heat transfer.

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