عنوان مقاله:

۳D Numerical Investigation of Heat Transfer Performance in Liquid-liquid Taylor Flow

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خلاصه مقاله:

With recent advances in semiconductor technology, conventional cooling methods and standard coolants are no longer adequate to manage electronic chips' enormous heat generation. Therefore, innovative cooling solutions are required to maintain these devices at optimum operating temperatures. Taylor flow in microchannels is an effective technique that allows excellent mixing of two fluids, which is crucial for heat transfer. A ۳D numerical analysis of the heat transfer performance of liquid-liquid Taylor flow in a rectangular microchannel was carried out by ANYSY Fluent. Water droplets were dispersed in either ethylene or propylene glycol, with the interface between the two fluids captured using the Volume of Fluid method. For optimal computational time, two symmetries in the XY and XZ planes are considered. Furthermore, mesh size refinement was performed in the near-wall region to capture the liquid film. An analysis of the effect of plug/slug length and liquid film thickness is conducted with initially constant thermo-physical properties. This assumption was considered to analyse the heat transfer process and determine the most critical parameter affecting heat transfer performance. A user-defined function is then implemented in ANSYS Fluent to examine the effect of working fluids temperature-dependent viscosity change on the heat transfer rate. Conjugate heat transfer and axial conduction are also examined, as these two factors can significantly affect the thermal behaviour inside the microchannel and enable the achievement of realistic and accurate results. The results reveal that Taylor liquid-liquid flow can increase the heat transfer rate by up to ۴۴۰% over single-phase flow. It was also found that the temperature-dependent viscosity of the working fluids significantly affects the plug/slug length and liquid film thickness, resulting in a ۲۰.۸% improvement in heat transfer rate compared with constant thermo-physical properties. This study will improve the state of knowledge on heat transfer by Taylor flow in microchannels and factors that can influence it, and highlight the significance of this flow pattern in enhancing heat transfer performance over single-phase flow.

کلمات کلیدی:

۳D simulation, Taylor flow, heat transfer, liquid film, microchannel