HEAT TRANSFER MECHANISM IN LIQUID-LIQUID SLUG FLOW IN MINICHANNELS

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ABSTRACT

The capability of Taylor slugs to enhance heat transfer rate compared to that obtained from single-phase flow is well-documented. This study numerically investigated the hydrodynamics characteristics and heat transfer mechanism in liquid-liquid Taylor flow. A novel analysis method was introduced by comparing fluid flow and heat transfer parameters distributed at the axial and radial planes of the channel. In order to investigate transport phenomena, the unit cell length and frequency of slug generation over a wide range of void/phase fractions were examined. The simulations showed that the viscosity difference between the phases is a critical parameter of the slug frequency; a higher amount increases the frequency much more. Conversely, a lower viscosity ratio between the phases allows water slugs to expand axially more. The higher temperature gradient and recirculation in the liquid plug region enhance the heat transfer rate leading to the highest cooling performance over the channel wall within a unit cell. The results also showed the significant importance of establishing shorter slugs, which not only improves the cooling performance in the slugs but also enhances the heat transfer rate in the liquid plug region. The developed numerical model was verified by the results found in the literature showing good agreement.