Proceedings of the Canadian Society for Mechanical Engineering International Congress 2022
CSME Congress 2022
June 5-8, 2022, Edmonton, AB, Canada

Heat Transfer and Transport Phenomena for Taylor Flow in a Straight Mini-channel

Amin Etminan*, Yuri S. Muzychka, Kevin Pope
Department of Mechanical Engineering, Faculty of Engineering and Applied Science
Memorial University of Newfoundland (MUN), St. John's, NL A1B 3X5, Canada
*e-mail: aetminan@mun.ca

ABSTRACT

This study numerically investigates the hydrodynamic characteristics and heat transfer analysis of developing and fully developed laminar liquid-liquid Taylor flows. The problem is analyzed in circular mini-channels with different diameters subjected to a constant wall temperature boundary condition. A numerical simulation is conducted utilizing an open-loop water/oil two-phase non-boiling flow through mini-scale tubing with sizes of 1.42, 1.52, and 1.65 mm. Three silicone oils with 1, 3, and 5 cSt at several volumetric flow rates are used to establish segmented flow. The impacts of the channel diameter, viscosity, and volumetric flow rate ratio on the flow patterns, pressure drop, film thickness, and heat transfer rate are investigated. The results reveal that slug length affects pressure drop and heat transfer rate significantly. The numerical procedure is validated using experimental and numerical data from the literature. The numerical results of this study present a greater understanding of two-phase Taylor flow in capillary channels, and the methodology can be extended to mass transfer applications in slug flow.