Abstract

The present study aims to investigate draining characteristics and hydrodynamics of gas-liquid downflow from circular tubes in mesoscale. To understand the influencing parameters, extensive experimentation and theoretical analysis have been performed. Prior to investigating two-phase downflow, the characteristics of liquid draining from closed top millichannels has been studied. The experiments have been performed over a wide range of tube diameter (0.0025 m -0.0125 m), liquid surface tension (0.038 - 0.0783 N/m) and tube inclination (0°- 90°). We observe that draining from closed top tubes can be enhanced by just a minute top pierce and also by inclining the tube from vertical orientation

Interestingly, the physics of draining is different in closed top and pierced top tube and a draining regime map denoting the different types of draining in the mesoscale has been presented in terms of Eötvös number and fraction of top opening. A mechanistic model based on basic physics has been proposed to predict time and rate of draining.

The hydrodynamics of gas-liquid two-phase downflow has been studied. Experiments have been performed to understand the influence of phase flow rate, tube diameter and entry section on flow patterns, pressure drop and void fraction in vertical pipes of diameter 0.0025 -0.0125 m. Mechanistic models have also been proposed to predict flow pattern transitions. Drift flux model and two fluid model have been formulated to predict void fraction and pressure drop in mixed and separated flow patterns respectively. The phenomenological models show good agreement with experimental data of the present work and those reported in literature.

Keywords: Mesoscale; Liquid draining characteristics; Two-phase downflow; Flow pattern; Void fraction; Pressure drop.