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Investigation of the Taylor bubble under the effect of dissolution in microchannel

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Abstract

In the present study, a three-dimensional (3D) numerical investigation of the mass transfer of the Taylor flow in an integrated T-junction is presented based on the Volume of Fluid (VOF) method, in which a mass transfer model is developed and implemented. The dissolution processes of CO_2 bubbles in ethanol and methanol are numerically studied and compared with the experimental results from literature, which shows good agreement. It is shown that the Taylor bubbles are formed at the mixed region and taking the bullet-shape, and the profiles of streamlines and the corresponding CO_2 concentration in the liquid slug present apparent vortices. The relationship between the mass transfer and the thickness of liquid film is studied quantitatively in a series of slices. It is shown that the mass transfer through the thin liquid film around the Taylor bubble is dominant during the dissolution while the dominance disappears with the thickening of the liquid film, and the mass transfer peaks at the top end of the caps within the cap region. The overall mass transfer coefficients are estimated by the bubble volume change and compared with the empirical correlations in the literature.

Keywords: Mass transfer; Taylor bubble; Dissolution; Thin liquid film

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