Volume-of-Fluid Simulations of Gas-Liquid-Liquid Flows in Minichannels

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Volume-of-Fluid Simulations of Gas-Liquid-Liquid Flows in Minichannels

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Abstract

Three-phase segmented gas-liquid-liquid (G/L/L) flows in minichannels are important to several chemical process applications involving gas-liquid-liquid reactions. In the present work, we have investigated segmented G/L/L flows in a double T-junction minichannel, with cross-section of 0.95 mm x 1 mm, through high-speed imaging experiments and Volume-of-Fluids (VOF) simulations. The dynamics of bubble/slug formation at the 1^{st} T−junction and importantly that of water drop/slug formation at 2^{nd} T−junction was simulated under different flow conditions (Ca_{oil} = 2.63×10^{-3} − 1.101 ; We_{air} = 4.24×10^{-4} − 2.62×10^{-3}; We_{water} = 0.0431 − 7.14) and different surfactant concentrations (0.3 and 2 wt/wt %) in aqueous phase. The predicted formation mechanisms, three-phase flow regimes, and drop/bubble/slug lengths were compared quantitatively with the measurements. The different mechanisms of bubble/slug formation, prevailing under the values of the Ca_{oil} and We_{air}, and bubble/slug lengths were predicted in a satisfactory agreement with the measurements. The complex formation mechanism of water drops/slugs that was governed by viscous