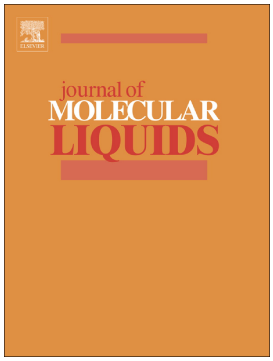

Three-dimensional simulation of microdroplet formation in a co-flowing immiscible fluid system using front tracking method

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Three-dimensional simulation of microdroplet formation in a co-flowing using front tracking method immiscible fluid system

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Abstract

Liquid-jet breakup in a co-flow system can occur in two regimes: dripping and jetting. A finite difference/front-tracking method is used to simulate the jet breakup. This method has rarely been used in cases where breakup or coalescence occurs during flow simulation. This is due to the lack of a general algorithm for topology change of the interface mesh. In this paper, three-dimensional liquid-jet breakup has been studied in dripping and jetting regimes. A new algorithm has been developed that is capable of changing the topology of the interface mesh. The dripping and jetting regimes are simulated numerically and a new transition criterion between two regimes is defined that is in agreement with existing studies. Also, the drop size formed after breakup in jetting regime is consistent with experimental data. The effect of the capillary number, the Weber number, the viscosity ratio and the density ratio on the size of drops formed is investigated. It is found that the drop size decreases when the Weber number is raised. The same trend is observed when the capillary number increases. The drops increase in size when the velocity ratio of the co-flowing medium increases (the velocity ratio is the ratio of the velocity of inner fluid to that of the surrounding medium). Increasing the density ratio also increases the drop size. The rate of increase in drop size is large at unity density ratio and it decays as the density ratio increases. Also, increasing the viscosity ratio reduces the drop size. Finaly, the breakup of liquid jet exiting from an elliptic nozzle is investigated and its behavior is compared with a circular jet.