Simulation of Multiple Breakup of Droplets in a Shear Flow by Phase-field Lattice Boltzmann Method

Jingchang Zhang[1], Shuli Shu[2], Xiaoping Guan[1], and Ning Yang[1]

[1]Institute of Process Engineering Chinese Academy of Sciences
[2]Institute of Process Engineering, Chinese Academy of Sciences

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Abstract

Multiple breakup refers to a sequence of events through which a single droplet eventually produces multiple daughter droplets at a given flow condition. It is a more common phenomenon than binary breakup assumed in the existing breakage kernel models. Using phase-field lattice Boltzmann method, this work investigates the effects of Reynolds number, capillary number and soluble surfactant on multiple breakup in shear flow. We find that the critical capillary number in multiple breakup decreases as Reynolds number increases, and the regime map for a surfactant-free system could be classified into the non-breakup, elementary breakup, multiple breakup, filament and coalescence regimes. In the system of surfactants, the multiple breakup regime widens and the coalescence regime narrows. A correlation is then proposed to predict the number of breakup events and daughter droplets at a confinement ratio of 0.5. This may provide some clues on developing new breakage kernels in population balance modeling.

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