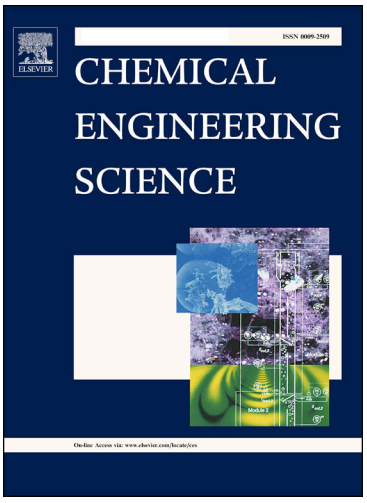

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A novel multiscale theoretical model for droplet coalescence induced by turbulence in the framework of entire energy spectrum

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Abstract: This work mainly focused on the droplet coalescence induced by turbulence. Two kinds of interaction mechanisms between turbulent eddies and droplets were proposed, and the corresponding coalescence model for each mechanism has also been proposed by counting the number of collisions that can lead to coalescence directly. Most of previous coalescence models only considered the contribution of the turbulent eddies of size equal to the size of droplets since the droplet velocity was assumed to be equal to the velocity of turbulent eddies of same size. In contrast, the contribution of multiscale turbulent eddies (i.e. turbulent eddies with various sizes, not just the turbulent eddies of size equal to the size of droplets) to the coalescence of droplets of given sizes was considered in the proposed model. This work also simulated the coalescence in the framework of entire energy spectrum. Simultaneously, the influences of the average collision free path between droplets and turbulent eddies as well as the lifetime of turbulent eddies on the coalescence were considered. Furthermore, this work proposed a novel second-order longitudinal structure function, which showed a good agreement with the results of direct numerical simulation. Finally, the predicted droplet size distributions of the proposed model were in agreement with experimental data.

Keywords: coalescence; multiscale; droplet; entire energy spectrum; turbulence

1. Introduction

The dispersed multiphase flows such as gas-liquid and liquid-liquid flows, involving mixing, extraction, distillation, interfacial reactions and other applications, widely exist in chemical process industries. This is because the coalescence and breakage dynamics of fluid

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