中国化学工程学报 2003 11 (6): 715-725 ISSN: 1004-616x CN: 44-1063/R

RESEARCH PAPERS

表面活性剂溶液中单液滴的非稳态运动

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收稿日期 修回日期 网络版发布日期 接受日期

摘要 A numerical investigation of the unsteady motion of a deformed drop released freely in another quiescent liquid contaminated by surfactant is presented in this paper. The finite difference method was used to solve numerically the coupled time-dependent Navier-Stokes and convective-diffusion equations in a body-fitted orthogonal coordinate system. Numerical simulation was conducted on the experimental cases, in which MIBK drops with the size ranging from 1.24 mm to 1.97 mm rose and accelerated freely in pure water and in dilute sodium dodecyl sulphate (SDS) aqueous solution. The applicability of the numerical scheme was validated by the agreement between the simulation results and the experimental data. Both the numerical and experimental results showed that the velocitytime profile exhibited a maximum rising velocity for drops in SDS solutions, which was close to the terminal velocity in pure water, before it dropped down to a steady-state value. The effect of the sorption kinetics of surfactant on the accelerating motion was also evaluated. It is also suggested that introduction of virtual mass force into the formulation improved obviously the precision of numerical simulation of transient drop motion.

关键词 surfactant single drop unsteady motion sorption kinetics numerical simulation

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Unsteady Motion of a Single Droplet in Surfactant Solutions

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Received Revised Online Accepted

Abstract A numerical investigation of the unsteady motion of a deformed drop released freely in another quiescent liquid contaminated by surfactant is presented in this paper. The finite difference method was used to solve numerically the coupled time-dependent Navier-Stokes and convective-diffusion equations in a body-fitted orthogonal coordinate system. Numerical simulation was conducted on the experimental cases, in which MIBK drops with the size ranging from 1.24 mm to 1.97 mm rose and accelerated freely in pure water and in dilute sodium dodecyl sulphate (SDS) aqueous solution. The applicability of the numerical scheme was validated by the agreement between the simulation results and the experimental data. Both the numerical and experimental results showed that the velocitytime profile exhibited a maximum rising velocity for drops in SDS solutions, which was close to the terminal velocity in pure water, before it dropped down to a steady-state value. The effect of the sorption kinetics of surfactant on the accelerating motion was also evaluated. It is also suggested that introduction of virtual mass force into the formulation improved obviously the precision of numerical simulation of transient drop motion.

Key words surfactant; single drop; unsteady motion; sorption kinetics; numerical simulation

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