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Main Factors Controlling the Emulsification Process under Turbulent Conditions. Experiment and Data Interpretation

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We present a systematic experimental study of the effects of surfactant type and concentration on the mean drop size during emulsification in turbulent flow. The electrolyte concentration is also varied to clarify the role of the electrostatic repulsion between the droplets. The experimental results are analyzed by considering the processes of drop breakup and drop-drop coalescence. We found that the drop size at high surfactant concentration is determined mainly by the equilibrium interfacial tension (which is a characteristic of the used surfactant) and by the density of power dissipation in the emulsification chamber. In this “surfactant-rich regime”, the measured values of d32 are described very well by the Kolmogorov-Hinze theory of emulsification, which indicates a negligible contribution of drop-drop coalescence. In contrast, at low surfactant concentration, the mean drop size is strongly affected by coalescence. The theoretical analysis and the experimental results show that two qualitatively different cases can be distinguished: (1) For emulsions with suppressed electrostatic repulsion, the mean drop size is determined by a certain critical value of the surfactant adsorption, above which the drop coalescence is hindered. (2) In the presence of significant electrostatic repulsion, the drop coalescence and the mean drop size are governed by the electrostatic repulsion between the drops.

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