Comparative efficiency of shear, elongation and turbulent droplet breakup mechanisms: Review and application

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Mots-clés	Breakup mechanisms [5], Complex flows [6], Elongation [7], Shear layer [8], turbulence [9], Vortex generator [10]
Résumé en anglais	The study of phase dispersion of two immiscible fluids in different flows requires identifying the relevant breakup mechanisms. We propose here a detailed investigation of droplet breakup in a multifunctional exchanger-reactor of the vortex generator type in which transfer intensification is due to longitudinal vortical structures. We compare the efficiency of the mean gradients and turbulent mechanisms in droplet breakup in this industrial reactor. This efficiency is essentially characterized by the resulting distribution of droplet diameters. Then, the roles of the mean flow and the turbulent field, intensity, energy spectrum, and turbulence scales are examined in relation to the liquid/liquid dispersion in order to explore the governing mechanisms of drop breakup. In the complex flow considered here – nonhomogeneous and anisotropic turbulence at moderate Reynolds numbers (<15,000) – with weak turbulence intensity (about 10%), it can be demonstrated that turbulent breakup mechanisms largely dominate mean flow effects; elongation and shear effects are shown to have minor effects on the breakup mechanisms. Moreover, the global characteristic scales of the flow are not the relevant parameters in predicting the final size of the emulsion, but instead the Kolmogorov microscale, implying that the residence time in the reactor is not a limiting factor. Hence, the local dissipation rate governs the performance of the actual multifunctional reactor. This study provides some insight in the design and scaling-up of multiphase reactors.
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