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Effects of small concentration surfactants on the coalescence of viscous drops

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— Boundary integral simulations, employing Dai and Leal’s code [Phys. Fluids 20, 040802 (2008)], are used to study the effects of small concentrations of insoluble surfactants $C_s$ on head-on collisions of two equal-sized viscous drops in a matrix of equal viscosity in a hyperbolic extensional flow, for low Reynolds numbers. The parameters were chosen to mimic the experiments of Yoon et al. [Phys. Fluids 19, 023102 (2007)], which were performed with polymeric drops stabilized by block-copolymer insoluble surfactants in a polymer matrix, where both fluids acted as Newtonian viscous fluids. In these experiments a discontinuous transition in the coalescence process was found for low $C_s$ as the Capillary number $Ca$ was increased. Thus, for $Ca>Ca_c$, a minimum surfactant concentration exists below which the system behaves like a clean interface system. Here, by varying $C_s$, i.e. the Marangoni number $Ma$, and the surface diffusivity, i.e. the interfacial Peclet number $Pe_s$, we explain the origin of the transition and its dependence on the parameters. The transition occurs if $Pe_s>Pe_{sc}$, $Ca>Ca_c$ and $Ma<Ma_c$.

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