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Computation of shear-induced collective-diffusivity in emulsions
ABHILASH REDDY MALIPEDDI, KAUSIK SARKAR, The George Washington University — The shear-induced collective-diffusivity of drops in an emulsion is calculated through simulation. A front-tracking finite difference method is used to integrate the Navier-Stokes equations. When a cloud of drops is subjected to shear flow, after a certain time, the width of the cloud increases with the $\frac{1}{3}$ power of time. This scaling of drop-cloud-width with time is characteristic of (sub-)diffusion that arises from irreversible two-drop interactions. The collective diffusivity is calculated from this relationship. A feature of the procedure adopted here is the modest computational requirement, wherein, a few drops ($\sim$70) in shear for short time ($\sim$70 strain) is found to be sufficient to get a good estimate. As far as we know, collective-diffusivity has not been calculated for drops through simulation till now. The computed values match with experimental measurements reported in the literature. The diffusivity in emulsions is calculated for a range of Capillary (Ca) and Reynolds (Re) numbers. It is found to be a unimodal function of Ca, similar to self-diffusivity. A sub-linear increase of the diffusivity with Re is seen for $Re < 5$. This work has been limited to a viscosity matched case.

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