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Capillary flows of non-Brownian suspensions

Many fluids of our everyday life, from paint to concrete, actually contain solid particles suspended in a liquid. Applications such as inkjet printing require the fragmentation of such suspensions into droplets. Depending on the scale at which one looks at it, a suspension may seem homogeneous or heterogeneous. Heterogeneity appears during the breakup because the scale of the flow locally vanishes. For the physicist, the most simple approach is to consider hard spheres in a Newtonian liquid, however reality is more complex. Particles usually come in a range of shapes and sizes, and the suspending liquid may be a complex fluid, like a polymer solution. We study the pinch-off of drops of suspension of non-Brownian particles, either with a single size (monodisperse) or with two sizes (bidisperse). We first address the case of a Newtonian viscous liquid (silicone oil and PEG) and then turn to viscoelastic dilute polymer solutions. For a viscous Newtonian suspending fluid, we find that the suspension thins like a Newtonian equivalent liquid down to a critical length scale that describes the stability of the suspension against a concentration fluctuaiton. This length scale may be two orders of manitude larger than the particle size. In the viscoelastic case, we observe that particles accelerate the coil-stretch transition of the polymer chains. These results lead to scaling laws for the local deformations of the liquid phase and for the viscosity of the suspension.