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The Effect of a Yield Stress on the Drainage of the Thin Film Between Two Colliding Newtonian Drops SACHIN GOEL, ARUN RAMACHANDRAN, Chemical Engineering and Applied Chemistry, University of Toronto — Coalescence of drops immersed in fluids possessing a yield stress has been of interest to many industries such as the oil extraction, cosmetics and food industries. Unfortunately, a theoretical understanding of the drainage of the thin film of Bingham fluid (a model yield stress fluid) that develops between two drops undergoing a collision is still lacking, with the exception of two prior studies (Can. J. Chem. Eng., vol. 65, pp. 384-390, 1987, and J. Phys. Chem., vol. 90, pp. 6054-6059, 1986.) that make ad-hoc assumptions about the film shape. In this work, we examine this problem via a combination of scaling analysis and numerical simulations based on the lubrication analysis. There are four key features of the film drainage process of Bingham fluids. First, the introduction of a yield stress in the suspending fluid retards the drainage process relative to Newtonian fluid of the same viscosity. Second, the drainage time shows a minimum with respect to the capillary number. Third, the effect of yield stress on the drainage process becomes more pronounced at higher capillary numbers and lower Hamaker constant. Lastly, below a critical height, drainage can be arrested completely due to the yield stress. This critical height scales as $\tau_0^2 R^3/\gamma^2$, where τ_0 is the yield stress, R is the drop radius and γ is the interfacial tension, and is, surprisingly, independent of the force colliding the drops. This and other distinguishing characteristics of the drainage process will be elucidated in the presentation.

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