MAR06-2005-004206

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Surfactant mass transfer effects on drop detachment[1]

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When a buoyant viscous drop is injected into a viscous fluid, it evolves to form a distended shape that detaches via the rapid formation and pinching of a neck. The effects of surfactants in altering this process are studied numerically. In the absence of surfactants, surface contraction is fastest in the vicinity of the neck. When surfactants are present, they accumulate there and alter the ensuing dynamics by reducing the surface tension that drives the contraction. When surfactant adsorption-desorption is very slow, interfaces dilute significantly during drop expansion, and drops form necks which are only slightly perturbed in their dynamics from the surfactant-free case. When adsorption-desorption dynamics are comparable to rate of expansion, a family of drop necks are predicted. Drops break at the primary neck at low surfactant coverage, at both the primary and secondary necks at moderate coverages, only at the secondary neck at higher coverages, or fail to neck at elevated coverages. When adsorption-desorption kinetics are rapid, the surface remains in equilibrium with the surrounding solution, and drops break like surfactant-free drops with a uniform surface tension. A map of neck/no-neck thresholds is constructed as a function of surfactant coverage and sorption dynamics, suggesting that drop detachment can be used as a means of characterizing surfactant dynamics. Co-authors: Mr. Fang Jin, Prof. Nivedita Gupta.

[1]This research was supported by NASA NCMR (Grant number NCC3-812).