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Surfactant Effects on Buoyancy-Driven Coalescence of Spherical Drops

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Collision efficiencies are calculated by a trajectory analysis for two contaminated spherical drops in buoyancy at low Reynolds number with arbitrary surfactant surface coverage. The time-dependent convective-diffusion equation is solved for the bulk-insoluble surfactant concentration on the drops' surfaces by expansion in spherical harmonics with Lamb's singular series used for the velocity field. A series of nonlinear ordinary differential equations results which is solved numerically with fast-convergent, biconjugate-gradient iterations at each time step. To determine the many requisite trajectories with maximum efficiency, rotational reexpansions of Lamb's series are employed. It is anticipated that, under conditions when the surfactant concentration remains nearly uniform when the drops are well separated, significant deviation in coverage may occur in the region of close approach for weak diffusion, causing the interfaces to become immobile. Film drainage would be retarded, considerably decreasing the collision efficiency from spherical-drop results for nearly uniform coverage.

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