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A multiphase ion-transport analysis of the electrostatic disjoining pressure: implications for binary droplet coalescence LACHLAN MASON, Department of Chemical and Biomolecular Engineering, The University of Melbourne, FELIX GEBAUER, Chair of Separation Science and Technology, Technische Universitt Kaiserslautern, HANS-JRG BART, Chair of Separation Science and Technology, Technische Universitt Kaiserslautern, GEOFFREY STEVENS, DALTON HARVIE, Department of Chemical and Biomolecular Engineering, The University of Melbourne — Understanding the physics of emulsion coalescence is critical for the robust simulation of industrial solvent extraction processes, in which loaded organic and raffinate phases are separated via the coalescence of dispersed droplets. At the droplet scale, predictive collision-outcome models require an accurate description of the repulsive surface forces arising from electrical-double-layer interactions. The conventional disjoining-pressure treatment of double-layer forces, however, relies on assumptions which do not hold generally for deformable droplet collisions: namely, low interfacial curvature and negligible advection of ion species. This study investigates the validity bounds of the disjoining pressure approximation for low-inertia droplet interactions. A multiphase ion-transport model, based on a coupling of droplet-scale Nernst-Planck and Navier-Stokes equations, predicts ion-concentration fields that are consistent with the equilibrium Boltzmann distribution; indicating that the disjoining-pressure approach is valid for both static and dynamic interactions in low-Reynolds-number settings. The present findings support the development of coalescence kernels for application in macro-scale population balance modelling.

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