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Strongly nonlinear deformation and instability of a viscous droplet in an electric field ETIENNE LAC, GEORGE M. HOMSY, Dept. of Mechanical and Environmental Eng., U.C. Santa Barbara — We consider a neutrally buoyant and initially uncharged drop in a second liquid subjected to an electric field. The liquids are taken to be leaky dielectrics, with the jump in electrical properties creating an electric stress that is balanced by hydrodynamic and capillary stresses. Creeping flow conditions are assumed to prevail, and the problem is solved numerically with the boundary integral method. The system is characterized by the physical property ratios R (resistivities), Q (permitivities) and λ (dynamic viscosities). The relative importance of the electric stress and of the drop/ medium interfacial tension is measured by a dimensionless parameter called electric capillary number (C_E). We present a survey of the various behaviours obtained for a wide range of R, Q, and λ. When $\lambda = 1$, we delineate the regions in the (R, Q) plane, in which the deformation either asymptotes to a steady value or reaches a limit point past a critical C_E. We identify the latter with linear instability of the steady shape to axisymmetric disturbances. Other break up modes are also identified, as well as more complex behaviours such as subcritical bifurcations and transition from unstable to stable solution branches. We also show how the viscosity contrast λ can stabilize the drop or advance break-up.

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