

459d Interface Rupture and Formation of Finite Time Singularities in an Electric Field

Osman Basaran

Electric fields are either being used or contemplated being used in applications as diverse as separations (extraction and distillation), chemical analysis (electrospray mass spectrometry), manufacture of ceramic particles and polymer beads, and electrospinning of micro/nanofibers. What all of these applications have in common are the formation of finite time singularities and breakup of fluid interfaces. When a fluid interface breaks in the absence of an electric field, the type of singularity that arises is referred to as the pinch-off singularity. Such a singularity occurs when the radius of a thinning liquid filament tends to zero. As the radius approaches zero, the curvature and the surface tension generated pressure diverge. Moreover, the rate at which liquid evacuates the thinning neck also diverges. In an electric field, in addition to this type of singularity, a second type of singularity arises in which the interface takes on a conical profile and a fine jet issues from the tip of the cone. Although there are slight variations of this second type of singularity, they will all be lumped here under the category of the cone-jet singularity. This talk will present a detailed theoretical analysis of both the pinch-off and the cone-jet singularities under an applied electric field. In particular, the subtle effects of physical properties such as viscosity and electrical conductivity on the two types of singularities will be highlighted through detailed computational analyses of the breakup of fluid interfaces under an applied electric field. Comparisons will also be provided to apparently unrelated situations of breakup of fluid interfaces of complex fluids and interface rupture under imposed flow fields.