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Simulation of electrostatically driven jets from non-viscous droplets using Level Sets

Drop size control in liquid break-up has been widely achieved by applying an external electric force to influence the jet evolution. Various electro-spray patterns have been observed in the laboratory, the results depending upon the physical settings and parameters. However, some aspects of the fluid behavior are as yet not very well understood. Numerical simulations, using a coupled level set boundary integral method, have been carried out for a perfectly conducting non-viscous drop immersed in dielectric fluid, subjected to a uniform electric field E_∞ at infinity. In agreement with theory, the results show that when the electrical field strength exceeds a critical value, the drop will develop pointed ends (Taylor cone), become unstable and emit very long and thin jets. The predicted shape and size of the jets are in very good agreement with those seen in the laboratory experiments by Grimm and Beauchamp. Taking advantage of the level set capabilities, an initial attempt to continue the calculation through the subsequent break-up of the jets has been carried out; however, due to the very different time and space scales involved, these simulations have proven to be very difficult. Nevertheless, jet bursting frequency and other known flow features have been well reproduced by the simulations. A series of numerical experiments have been performed to study the convergence properties of the algorithm, and these results, along with comparisons with theory and with previously published computations, will be shown.