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Breakup of an electrified viscous thread with charged surfactants[1]

DEVIN CONROY, RICHARD CRASTER, DEMETRIOS PAPAGEORGIOU, OMAR MATAR, Imperial College London — The dynamics and breakup of electrified viscous jets in the presence of ionic insoluble surfactants are investigated. Axisymmetric configurations are considered and the jet is surrounded by a concentrically placed cylindrical electrode with at a constant voltage potential. The annular region between the jet and the electrode is taken to be inviscid and an electric field is set up there and drives the flow, along with other physical mechanisms including capillary instability and viscous effects. The jet fluid is taken to be a symmetric electrolyte and modeling of the cationic and ionic species is used by consideration of the Nernst-Planck equations in order to find the volume charge density that influences the electric field in the jet. A positively charged insoluble surfactant is present at the interface and its evolution as well as the resulting value of the local surface tension coefficient, are coupled to the voltage potential at the interface. The resulting coupled nonlinear systems are derived using a slender jet approximation. We show the jet ruptures in finite time provided the outer electrode is sufficiently far away, and demonstrate how the dimensionless parameters can be used to control the size of the satellite drops and time to breakup. Pinching solutions follow the self-similar dynamics of clean viscous jets at times close to the breakup time.

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