Spray-Formation in Viscoelastic Fluids

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Droplet formation of non-Newtonian fluids is of central importance to numerous industrial applications; these include spray-drying, atomisation of fertilizers and paint applications, involving large interfacial deformations and complex spatio-temporal dynamics. In this work, first we study the entire jetting and breakup process of a polymeric solution, including the flow through the nozzle, which results in an inhomogeneous initial radial polymeric stress distribution that affects the subsequent breakup dynamics. Our study demonstrates that the flow is accompanied by the development of unique flow structures often termed “beads-on-a-string” that result from capillary action, which drives the stretching of the dissolved polymeric chains, for which there is no analogue in simple fluids. We also aim at optimising and extending the performance of available extensional rheometry protocols. Hence, we focus on Dripping-on-Substrate (DoS), which is a conceptually-simple, but dynamically-complex, probe of the extensional rheology of low viscosity non-Newtonian fluids. It incorporates the capillary-driven thinning of a liquid bridge, produced by a single drop as it is dispensed from a syringe pump onto a solid substrate. By following the filament thinning process, the extensional viscosity and relaxation time of the sample can be determined. To achieve all the above, we employ a *computational rheology* approach using adaptively-refined axisymmetric numerical simulations with the open-source Eulerian code, Basilisk. The volume-of-fluid technique is used to capture the moving interface, and the log-conformation transformation provides a stable and accurate solution of the viscoelastic constitutive equation.