SAND2011-5559C

A mesoscale study of shear pinch-off (Marco Arienti, SNL*; Xiaoyi Li, UTRC)

The dynamic behavior of a liquid thread undergoing thinning and pinch-off is in the presence of shear is simulated using the particle method Many-body Dissipative Particle Dynamics (MDPD). The mesoscale nature of this method is first verified in the well-known capillary pinch-off case, where the cascade of self-similar regimes up to pinch-off – inviscid (2/3 power law), inertial-viscous (linear power law), and stochastic (0.418 power law) – can be fully captured by a single simulation. Imposing the axial stretching of a liquid thread requires an additional step in that periodic boundary conditions cannot be used to simulate the opposing motion at the ends of the thread. A new algorithm that implements non-periodic boundary conditions (NPBC) is therefore introduced in the context of this study. It is shown that the algorithm can enforce a prescribed liquid-gas interface at the boundary while maintaining a constant number density for both components. The first requirement makes the particle method more flexible, since the computational boundaries can cut through the liquid thread, while the latter is crucial because the repulsive interaction is density-dependent in MDPD. We will then show how the strain rate due to an outer fluid can be introduced as a parameter in the dynamic balance of surface tension, viscous, and inertial forces leading to pinch-off. A discussion of the effect of thermal fluctuations at the liquid surface under shear concludes this study.

* Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.