ABSTRACT

Xue, Zhengjun Ph.D., Purdue University, December 2008. Axisymmetric Free-Surface Flows of Non-Newtonian Fluids with Surfactants: a Direct Numerical Simulation Study. Major Professor: Carlos M. Corvalan.

Small scale interfacial flows are commonly observed in nature and in engineering practices. Two typical phenomena are studied in this thesis, namely the breakup of liquid jets and the dynamics of an annular liquid film lining the inside of a capillary tube. Two-dimensional numerical models based on the first principles, i.e. simultaneously solving the coupled set of continuity, momentum and constitutive equations governing the fluid flow and the convection-diffusion equation governing the transport of surfactants on the interface using finite element method, are developed in this study. With the abundant information from direct numerical simulation models the synergistic effect of non-Newtonian fluid rheology and surfactants on the nonlinear dynamics of liquid jets and annular liquid films are investigated in detail. This computational study provides a better understanding of the underlying physics and could help to drive the practical processes based on these two phenomena in the direction of interest.