Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Slender body theory for tip streaming: The formation of concentrated emulsions composed by micron-size drops ELENA CASTRO-HERNADEZ, F. CAMPO-CORTES, J.M. GORDILLO, Área de Mecánica de Fluidos, E. T. S. I., Universidad de Sevilla — Under creeping flow conditions a liquid of viscosity μ_i is injected through a cylindrical capillary tube immersed into an outer immiscible fluid with a viscosity μ_o. The outer fluid flows parallel to the axis of the tube. If the outer capillary number $Ca_o > 1$ and the inner to outer flow rate ratio $Q_i/Q_o \ll 1$, the interface exhibits a cone-jet transition similar to that observed in electrosprays. The jet emanating from the tip of the cone is so small that the drops formed can be several orders of magnitude smaller than the diameter of the injector. We present a slender body theory that provides a third order ordinary differential equation for the shape of the interface. The theoretical shape, which is found by shooting with just a single parameter from far downstream towards the tube exit, faithfully reproduces the cone-jet transition observed in experiments for arbitrary values of the three dimensionless numbers that control this physical situation: Ca_o, μ_i/μ_o and Q_i/Q_o. This theory is a powerful design method since it can be used to check the efficiency of new geometrical designs to generate monodisperse emulsions, avoiding the need to build and test them in the laboratory. Drop size is well predicted by the classical Tomotika's stability analysis.

Elena Castro-Hernadez
Área de Mecánica de Fluidos, E. T. S. I., Universidad de Sevilla

Date submitted: 26 Jul 2011 Electronic form version 1.4