THE EVOLUTION OF JETS OF VISCOELASTIC FLUIDS OF OLDROYD-B, FENE AND GIESEKUS TYPE

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It is well known that a viscoelastic jet breaks up much more slowly than a Newtonian jet. Typically, it evolves into the so-called beads-on-string structure, where large drops are connected by thin threads. The slow breakup process provides the viscoelastic jet sufficient time to exhibit some new phenomena. We investigate the drop dynamics of the beads-on-string structure. This includes drop migration, drop oscillation, drop merging and drop draining. We use a 1D Oldroyd-B model for the viscoelastic jet, and solve this model numerically by an explicit finite difference method. Close to exponential draining of the filament, we found that the variation of the axial elastic force in the filament is roughly four times larger than the variation of the capillary force with opposite sign. This fact implies that the elastic force is responsible for the drop migration and oscillation.

Our study of the drop draining process shows that the elastic force also plays an important role here, allowing the liquid to flow from smaller drops into larger drops through the filament. At times much larger than the relaxation time, we show that the solution consists of exponentially thinning threads connecting almost spherical drops. Both experiment, numerical and theoretical analysis reveal a self-similar structure of the corner where a thread is attached to the neighbouring drops. This self-similarity is key in the understanding the dynamical behaviour of drops during the evolution and the balance between capillary and elastic forces that takes place. We shall also discuss the behaviour in nonlinear constitutive models of Giesekus and FENE type.

References

[1] C. Clasen, J. Eggers, M. A. Fontelos, J. Li and G. H. McKinley, The beads-on-string structure of viscoelastic threads, to appear in Journal of Fluid Mechanics, 2006.
[2] J. Li and M. A. Fontelos, "Drop dynamics on the beads-on-string structure for viscoelastic jets: A numerical study" , *Physics of Fluids*, **15(4)**, 922–937, 2003.
[3] M. A. Fontelos and J. Li, " On the evolution and rupture of filaments in Giesekus and FENE models " , *J. of Non-Newtonian Fluid Mechanics.* **118(1)**, 1–16, 2004.

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