FLOW OF A WORMLIKE MICELLAR SOLUTION OVER A LONG CAVITY

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ABSTRACT

Flow instabilities are well known to occur in viscoelastic flows due to the presence of streamline curvature in simple geometries. We investigate the flow of a viscoelastic and shear-thinning wormlike micellar solution over a long cavity, more appropriately described as a sudden one-sided expansion followed by a sudden one-sided contraction. We employ μ-particle image velocimetry to measure the flow field as a function of the applied Weissenberg number (Wi). Experimental data are supplemented by simulations using the Giesekus constitutive model, with parameters corresponding to the measured rheology of the experimental test fluid. We find formation of lip vortices upstream of the expansion and salient corner vortices immediately downstream of the expansion, both of which we quantify against Wi. For the lip vortices we differentiate three regimes: No vortex, steady vortex, and unsteady vortex. Upstream of the contraction, a corner-filling vortex appears, which we attribute to shear-banding. Our results confirm previous numerical studies[1,2] and are in-line with related geometries, such as flow around a sharp bend[3].

REFERENCES

1. Poole, R. J.; Alves, M. A.; Oliveira, P. J.; Pinho, F. T. Plane sudden expansion flows of viscoelastic liquids. *J. Non-Newt. Fluid M.* **2007**, 146 (1), 79–91. DOI: https://doi.org/10.1016/j.jnnfm.2006.11.001.
2. Poole, R. J.; Pinho, F. T.; Alves, M. A.; Oliveira, P. J. The effect of expansion ratio for creeping expansion flows for UCM fluids. *J. Non-Newt. Fluid M.* **2009**, 163 (1), 35–44. DOI: https://doi.org/10.1016/j.jnnfm.2009.06.004.
3. Hwang, M. Y.; Mohammadigoushki, H.; Muller, S. J. Flow of viscoelastic fluids around a sharp microfluidic bend: Role of wormlike micellar structure. *Phys. Rev. Fluids* **2017**, 2, 043303. DOI: https://doi.org/10.1103/PhysRevFluids.2.043303.