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Simulation of stretch in non-uniform filaments.

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Abstract

We consider the rapid stretching of a liquid filament under the action of a constant imposed tensile force. This problem was first considered experimentally by Matta and Tytus (1990). A liquid bridge formed from a dilute polymer solution is established between two cylindrical disks. The upper disk is held fixed while the lower cylinder falls due to gravity.

With this constant force pull (CFP) technique it is possible to impose very large material strains and strain rates so that the maximum extensibility of the polymer molecules may be quantified. This characteristic of the experiment is analyzed numerically using FENE type models and two alternative kinematic descriptions. The axisymmetric filament is described by a Lagrangian approach based on an average stretch of axial elements (see Renardy (1990)). A no-slip boundary condition is imposed indirectly at the end-plates according to a method described by Tuck *et al.* (2000). An alternative uniform filament description is developed and compared to the more accurate Lagrangian model. The agreement between the two numerical techniques is evaluated in the time domain as well as in terms of Hencky strain.

References

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