Numerical Simulation of the Weissenberg Effect

José A. Cuminato

Instituto de Ciências Matemáticas e de Computação
Universidade de São Paulo - USP - Brazil

Abstract

The Weissenberg effect, or Rod-Climbing experiment, is encountered in many important industrial applications involving mixing processes. In this experiment a rotating rod is inserted into a container filled with a viscoelastic fluid. The behavior of the viscoelastic fluid is striking, the fluid moves in the opposite direction of the centrifugal force and climbs up the rod. This effect has been experimentally reproduced by many researchers. However, in the context of numerical results, there are few works dealing with a rigorous study about this effect. One of the main challenges imposed in this simulation is to provide numerical methods which achieve high elasticity rate and that represent the correct shape of the free surface. In this work a finite difference scheme to simulate the Weissenberg effect is presented. The numerical technique is based on the projection method to simulate viscoelastic two-phase flows. The conformation tensor is employed to solve the viscoelastic fluid model. The interface between the fluids is modelled by the efficient least squares volume-of-fluid interface reconstruction algorithm (ELVIRA). A second-order operator-split method is used to solve the advection equation and obtain the volume fraction in the next step.In this work, we shall present simulations of the Weissenberg effect for the Oldroyd-B model.

References

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