

Numerical modeling and simulation of viscoelastic fluid flows: Challenges and approaches

Marília Pires

Mathematics Department, Évora University, Portugal.
marilia@uevora.pt

Tomáš Bodnár

Institute of Mathematics, Czech Academy of Sciences, Czech Republic.
bodnar@math.cas.cz

Abstract

This presentation addresses the modeling and numerical simulation of viscoelastic fluid flows, with a particular focus on the Oldroyd-B model. We begin by motivating the study of viscoelastic fluids, highlighting their relevance in polymer processing, hemodynamics, and industrial applications. The mathematical formulation is presented, including the governing equations and dimensionless parameters, with emphasis on the High Weissenberg Number Problem that arises in regimes of strong elasticity. We then discuss numerical challenges and stabilization techniques, such as artificial stress diffusion, essential for ensuring robust and accurate simulations. Finite element approximations are introduced as a framework for numerical discretization, and the interplay between Eulerian and Lagrangian perspectives is discussed. Finally, simulation results for two-dimensional channel flows are presented, illustrating both steady-state solutions and the limitations of the models under high elasticity. Concluding remarks highlight the potential for further research and improvement in computational modeling of viscoelastic fluids.

Keywords: viscoelastic fluids, Oldroyd-B model, numerical stabilization stress diffusion. .

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