A NEW LOG-CONFORMATION FORMULATION FOR VISCOELASTIC FLUIDS

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**ABSTRACT**

A new log-conformation formulation of viscoelastic fluid flows is presented in this paper. This new formulation is non-singular for vanishing Weissenberg numbers and allows a direct steady numerical resolution by a Newton method. Moreover, an exact computation of all the terms of the linearized problem is provided. The use of an exact divergence-free finite element method for velocity-pressure approximation and a discontinuous Galerkin upwinding treatment for stresses leads to a robust discretization. A demonstration is provided by the computation of steady solutions at high Weissenberg numbers for the difficult benchmark case of the lid driven cavity flow. Numerical results are in good agreement, qualitatively with experiment measurements on real viscoelastic flows, and quantitatively with computations performed by others authors. The numerical algorithm is both robust and very efficient, as it requires a low mesh-invariant number of linear systems resolution to obtain solutions at high Weissenberg number. An adaptive mesh procedure is also presented: it allows representing accurately both boundary layers and the main and secondary vortices.

Figure: the Oldroyd-B problem on the driven cavity: adapted mesh (left) and stream function isovalues (right) for the Weissenberg number \( \text{We}=3 \).