COMPUTATION OF VISCOELASTIC FLOW IN A THREE-DIMENSIONAL CONTRACTION WITH THE LOG-CONFORMATION TENSOR APPROACH

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Abstract

A numerical work was carried out to investigate creeping flows of viscoelastic fluids through a 4:1 square-square three-dimensional abrupt contraction using the finite-volume method. The UCM, Oldroyd-B and PTT constitutive equations were used to properly assess the effect of different rheological behaviour on the flow patterns and solution stability. The calculation of the polymer stress contribution is carried out with both the standard technique and with the log-conformation methodology proposed by Fattal and Kupferman [1].

For the UCM fluid, the critical Deborah number at which a time-dependent solution sets in is rather small, of around 2, and the log-conformation approach did not change this critical value. For the Oldroyd-B and PTT models, the onset of a time-dependent solution occurs at a higher Deborah number, and the use of the log-conformation technique increased this critical value, thus emphasizing its advantages relative to the standard methodology. At sub-critical

conditions, when both methods converge to a steady solution, the use of the log-conformation technique provides solutions with similar accuracy as the standard approach.

[1] R. Fattal and R. Kupferman, 2004, Constitutive laws of the matrix-logarithm of the conformation tensor, J. Non-Newtonian Fluid Mech. 123, pp. 281-285.