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NUMERICAL SIMULATIONS OF NON-NEWTONIAN FLOWS BETWEEN ECCENTRIC CYLINDERS BY DOMAIN DECOMPOSITION AND LOCAL TRANSFORMATIONS IN STREAM-TUBE METHOD

Clermont, J. R.^(a); Greco, D.^(b)

^(a)Laboratoire de Rhéologie, CNRS, Université Joseph-Fourier, INPG

^(b)Department of Chemical Engineering, McGill University, 3610 University Street, Montreal, Que., Canada, H3A 2BZ

In this study, we investigate the influence of rheological properties of inelastic and viscoelastic fluids in flows occurring in the annulus of rotating cylinders. To compute these flows where vortex regions are encountered, the physical domain is split up into a finite number of sub-domains that are mapped into domains where open and closed streamlines are parallel and straight (D. Greco, M. Normandin & J.R. Clermont, *Comput. Methods Appl. Mech. Engrg.*, 2002) by means of local mapping functions to be determined numerically. Such simplicity for the mapped streamlines makes it easy to handle time-dependent constitutive equations in viscoelasticity. The (non-linear) governing equations are solved by an optimization algorithm. The results point out the role of shear-thinning properties and the influence of elasticity. The study also permits to underline the complex behaviour of non-Newtonian fluids for large gaps and for journal bearing conditions, concerning the kinematics (velocities, vortex regions) and the stresses, that are highlighted notably for variations of the torque on the inner cylinder, versus the rotating rate and the eccentricity parameter.

LOCAL LOSS COEFFICIENT IN SUDDEN EXPANSION LAMINAR FLOWS OF INELASTIC SHEAR-THINNING FLUIDS

Miranda, J.P.^(a); Pinho, F. T.^(b); Oliveira, P. J.^(c)

^(a)Instituto Politécnico de Bragança

^(b)FEUP, Universidade do Porto

^(c)Universidade da Beira Interior

A numerical investigation of the laminar flow of shear-thinning inelastic fluids in a round sudden-expansion is carried out with the aim of quantifying the local loss coefficient. The fluid viscosity is represented by a power law and the expansion has a diameter ratio of 1/2.6.

The numerical investigation was carried out using a finite-volume method for collocated meshes and second-order interpolation and discretization schemes were used throughout: the Linear Upwind Differencing Scheme (LUDS) for the convective terms of the momentum equation and Central Differences (CDS) for the molecular diffusion.

The investigation quantified the effects of shear-thinning intensity (measured by the power law exponent n) and Reynolds number (Re) on the length and intensity of the recirculating region and especially on the local loss coefficient. As with Newtonian fluids, at low Reynolds number the loss coefficient varies inversely with the Re , whereas at high Reynolds number it tends to a constant value. As far as the effect of n was concerned, at low Reynolds numbers increased by more than 100% when n was reduced from 1.0 (Newtonian) to 0.2 (highly shear-thinning), whereas at high Reynolds numbers the constant decreased by more than 50%. This inversion of behaviours is shown to be related to the definition of Reynolds number.

Notes: