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Viscoelastic secondary flows in homogeneous and stratified pipe flows PENGTAO YUE, CHUNFENG ZHOU, University of British Columbia, JOSEPH DOOLEY, The Dow Chemical Company, JAMES FENG, University of British Columbia — The second normal stress difference N_2 experienced by non-Newtonian fluids flowing in a pipe amounts to an extra body force that may give rise to secondary flows in the transverse direction. In polymer extrusion, such secondary motion may distort the interface in two-component coextrusion and affect layer uniformity. In this paper, we perform numerical and theoretical studies on the secondary flow in both one-component homogenous and two-component stratified viscoelastic fluids. The simulations are performed based on a phase-field method using finite elements with adaptive meshing. For homogenous systems, we propose a general criterion for the direction of the secondary flow based on the second normal stress coefficient Ψ_2 and the shear viscosity η_s: if $\Psi_2(\dot{\gamma})/\eta_s(\dot{\gamma})$ is an increasing function of the strain rate $\dot{\gamma}$, the fluid flows from high shear region to low shear region along the walls, and vice versa. For two-component flow in circular pipes, the fluid with the larger magnitude of Ψ_2 tends to protrude into the other component in the center of the pipe. If the cross section is non-circular, the secondary flow is a superposition of two effects: one caused by the geometry as in a homogenous fluid, and the other due to elasticity stratification as in a circular pipe. The outcome is determined by the competition of these two factors.

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