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Quick Time Behavior of Viscoelastic Liquid in Planar Flow Described by the Leonov Model

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Finite element analysis of 2D planar viscoelastic flows has been performed employing the Leonov constitutive equations. Quick time behavior of the fluid immediately after the application of traction forces on the inlet and outlet boundaries has been analyzed. In order to understand elastic effect during the flow, the magnitude of the Newtonian viscous term is kept minimized. Stable numerical scheme in high Deborah number flow simulation employing the tensor-logarithmic formulation is established, which yields convergent solutions over 50 in the Deborah number for 4:1 contraction flow geometry. When the inertia force is neglected, the flow rate instantly reaches as high as 1000 in the Deborah number, and then decreases followed by elastic oscillation and steady state. The flow behavior near contraction before reaching the steady state exhibits quite complicated behavior. In the beginning of the flow, multiple vortices coexist in the flow domain and then they are coalesced into 1 big corner vortex when the flow reaches the steady state. Study of this type of complex elastic flow behavior seems quite important in understanding high Deborah number flow phenomena such as the filling stage in injection molding processes.