STARTUP STEADY SHEAR FLOW FROM THE OLDROYD 8-CONSTANT FRAMEWORK

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One good way to explore fluid microstructure, experimentally, is to suddenly subject the fluid to a large steady shearing deformation, and to then observe the evolving stress response (Figure. 1.). If the steady shear rate is high enough, the shear stress and also the normal stress differences can, overshoot, and then, they can even undershoot. We call such responses *nonlinear*, and this experiment *shear stress growth*. This paper is devoted to providing exact analytical solutions for interpreting measured nonlinear shear stress growth responses. Specifically, we arrive at the exact solution for the Oldroyd 8-constant constitutive framework. This framework includes a rich diversity of special cases, including, for instance, the corotational Jeffreys and the Johnson-Segalman fluids. In this paper, we test these special cases against the measured behaviours of wormlike micellar solutions. We find that, at high shear rates, these solutions overshoot in stress growth without subsequent undershoot. We find that the corotational Jeffreys fluid to be inadequate at high shear rates for shear stress overshoots, and that the Johnson-Segalman predicts these more accurately (Figure. 2.).

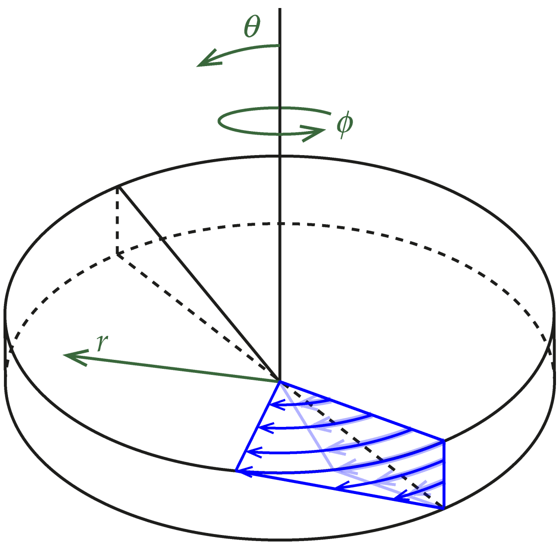

Figure. 1. Startup of steady shear flow in profile in cone-plate rheometer.

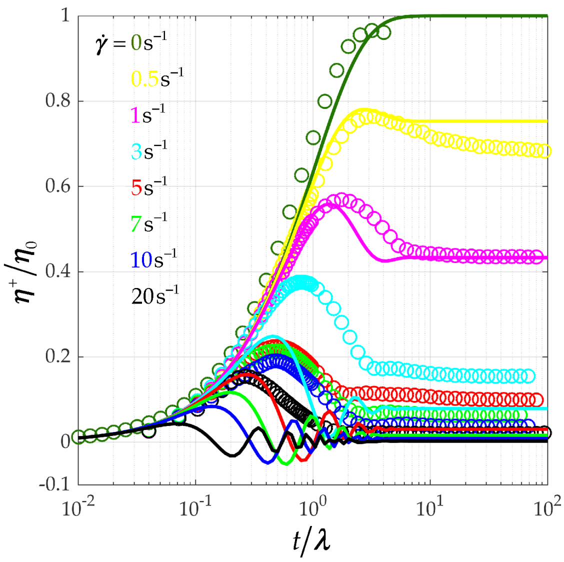

Figure 2. Model predictions from the Johnson-Segalman fluid.