SIMULATION OF VISCOELASTIC AND VISCOELASTOPLASTIC DIE SWELL FLOW

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The study focuses on the modelling of viscoelastic and viscoelastoplastic fluid flow in steady free-surface die swell situations. This common benchmark problem introduces a discontinuity at the die-exit extrusion plane and the shape of the free-surface must be determined apriori. New algorithmic approaches are introduced to incorporate the die-exit singularity into the problem, and alternative dynamic free-surface location strategies are investigated.

The momentum and continuity flow equations are solved by a semi-implicit time-stepping Taylor-Galerkin/pressure-correction finite element method, whilst the constitutive equation is dealt with by a novel cell-vertex finite volume (*cv/fv*) algorithm. This hybrid scheme is performed in a coupled fashion on the nonlinear differential equation system using discrete subcell technology on triangular elements. The hyperbolic aspects of the constitutive equation are addressed discretely through upwind Fluctuation Distribution techniques.

The work explores both inertial Newtonian and non-Newtonian fluid flow response. Viscoelasticity is introduced through the network class of models, of exponential Phan-Thien Tanner (EPTT) type; shear-thinning, strain-hardening/softening, moderate-high Trouton ratios. The influence of variation in Weissenberg number on swelling ratio is described. The analysis is then extended into viscoelastoplasticity through the viscous-limiting Papanastasiou approximation, coupling this with the Phan-Thien Tanner model. There, the representation and tracking of yield front movement is pertinent.