

Finite Element Simulations of Thermal Annular Stick-Slip and Die-Swell and Pressure-Tooling Problems for Non-Newtonian Fluid with Feedback Treatment

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Abstract - The viscoelastic fluids for pressure-driven velocity flows are delicate to calculate the converging solution since the outcome value at high Weissenberg number (We) normally goes to infinity. The results of the numerical simulation for the die-swell flow with heat condition have shown that the pressure drop and stresses increase as well as We . In contrast, the pressure drop and stresses of the wire coating flows are reduced when We increases for both the isothermal and non-isothermal effect. In this simulation, the mathematical model of the conservation of momentum is proposed under Navier-Stokes equation while the convection-diffusion non-isothermal equation is derived from the conservation of energy. The behavior of non-Newtonian flow namely Oldroyd-B fluid is considered so the objective of this research is to study thermal annular flow for stick-slip, die-swell and pressure-tooling problems based on creep effect in the two-dimensional spatial system. Since the ordinary procedure is not enough as mention above of diverse solution, the feedback treatment process is applied to feed the optimal values back through inlet boundary after the numerical technique of the semi-implicit Taylor-Galerkin pressure-correction finite element method is proposed to solve the governing and viscoelastic constitutive equations. The streamline upwind/Petrov Galerkin scheme is very important for complex flow as high engine drive the solution accelerating to converging solution. Furthermore, in the case of viscoelastic polymer fluid pass over pressure-tooling die at $We = 2$, the pressure drop of non-isothermal condition is 6.73 times higher than isothermal case, that is the same trend to the shear rate and elongation rate under non-isothermal process which are 7% and 4% more than isothermal effect, respectively.

Keywords: Thermal; Stick-slip; Die-swell; Non-Newtonian Fluid; Pressure-tooling; Feedback Treatment