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Steady State Visco-Elastic Rimming Flow ANTON MAZURENKO, Massachusetts Institute of Technology, SERGEI FOMIN, CSU Chico, BRENT NELSON, University of Illinois, Urbana-Champaign, JARED DEBRUNNER, CSU Chico — Using scale analysis and the method of perturbations, a theoretical description is obtained for the steady-state non-Newtonian flow on the inner wall of the rotating horizontal cylinder. The Maxwell upper-convective equation is chosen to model the visco-elastic properties of the fluid. In the general case, the derived governing equations can be solved only numerically. However, since the polymeric solutes used in roto-molding and coating technologies exhibit the relatively weak elastic properties, the Deborah number for such flows is rather small (De<1). Exploiting this fact, the perturbation method is applied for simplification of the model. As a result, the first order non-linear differential equation for the thickness of the fluid film is derived. An approximate analytical solution of this equation is found. The accuracy of analytical solution is verified by the direct numerical solution of the derived equation. The obtained equation is rather complex and contains several critical points. These points are classified by the analysis of the corresponding autonomous system. The type and location of these critical points are accounted for during numerical solution of the equation. Using the obtained solutions, the criteria which guarantee the stable steady-state flow of the liquid polymer and the uniform final thickness of the coating film are determined. The bounds for the different flow regimes and principal controlling parameters are identified.

Anton Mazurenko
MIT

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