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# Linear stability analysis of the stick-slip flow of a viscoelastic fluid following the Phan-Thien Tanner model

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## Abstract

It is well known that during extrusion of viscoelastic fluids various flow instabilities may arise resulting in a distorted free surface. In order to investigate the factors generating these instabilities we perform a linear stability analysis at zero Reynolds number around the steady solution of the cylindrical or planar stick-slip flow for a viscoelastic fluid following the PTT model. The stick-slip flow is an important special case of the extrudate swell problem, since the latter reduces to it in the limit of infinite surface tension. We will show that the flow becomes unstable as the Weissenberg number increases above a critical value, due to a Hopf bifurcation suggesting that the flow will become periodic in time. Both the critical value of the Weissenberg number and the frequency of the instability depend strongly on the rheological parameters of the viscoelastic model. The elasticity alone can be responsible for the appearance of instabilities in the extrusion process of viscoelastic fluids and the often used assumptions of wall slip or compressibility, although they might be present, are not required. Finally, the mechanisms that produce these instabilities are examined through energy analysis of the disturbance flow.


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