# Stability of BMP shear flows in the Yield Stress Limit

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The BMP model [1] is an attractive **T**hixo-**E**last-**V**isco-**P**lastic (TEVP) model that is popular and widely used because of both its intuitive use of the fluidity as a structural parameter and its ability to fit rheological data of a wide variety of materials. When the zero-shear fluidity ($\varphi_0$) is set to zero the fluid exhibits a yield stress and the inelastic version of this model dates back to the 1970s [2]. Elastic linear instabilities of plane Poiseuille flows of the BMP model have recently been extensively studied in [3]. Here the focus of the study is on flow stability using this constitutive model as a relaxation of a yield stress fluid (i.e. setting $\varphi_0$=0 throughout), and in particular how the model compares with that of a simple yield stress fluid.

Borrowing the notation of [3], we first show that the limiting case of zero timescale ratio and zero thixoelastic number (inelastic and non-thixotropic) does indeed recover the key dynamic characteristics of a simple yield stress fluid: (i) supporting a static solution in the presence of applied forcing for yield stress above a well-defined critical value; (ii) global stability and finite time decay to zero for yield stresses above the critical value; see [4]. Both these features are not shared by many TVP models currently studied and this makes the BMP model of interest for studying some paradoxical stability features associated with simple yield stress fluids.

Having determined the underlying dynamics of the yield stress system, we then relax inelastic and non-thixotropic assumptions to explore how static stability is affected. These results are illustrated with a simple 1D example: a pressure driven plane Poiseuille flow for which the forcing is suddenly stopped.

[1] F. Bautista , J.M. de Santos , J.E. Puig , O. Manero, “Understanding thixotropic and antithixotropic behavior of viscoelastic micellar solutions and liquid crystalline dispersions. I. The model.” Journal of Non-Newtonian Fluid Mechanics **80** (1999) 93–113.

[2] A.G. Fredrickson, “A model for the thixotropy of suspensions.” AIChE Journal **16** (1970) 436–441.

[3] H.A. Castillo, H.J. Wilson, “Elastic instabilities in pressure-driven channel flow of thixotropic-viscoelasto-plastic fluids.” Journal of Non-Newtonian Fluid Mechanics **261** (2018) 10–24.

[4] I. Karimfazli, I.A. Frigaard, “Flow, onset and stability: Qualitative analysis of yield stress fluid flow in enclosures.” Journal of Non-Newtonian Fluid Mechanics **238** (2016) 224–232.

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