Local power-law approximation method for computing critical flow reversal conditions

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One-dimensional Couette-Poiseuille (C-P) flow is frequently used to model the micro-sized flow that forms between the stationary slot die lip and the moving substrate. Under a specific pair of pressure gradient and flow rate, the shear stress at the stationary wall vanishes, signaling the onset of flow reversal. This critical state is of particular interest in the coating flow because it is related to the vortex birth in the actual coating flow.
Analytical expressions for the flow reversal condition are known for the C-P flow of Newtonian and power-law fluids. The conditions for more realistic viscosity models are, however, obtainable only through numerical methods.
In this study, we present an analytical approximation method for predicting the flow reversal conditions by locally approximating the fluid viscosity as that of the power-law fluids. The prediction error was reasonably low and was only high near the transition zone of the viscosity curve.