

Vortex birth in slot coating flows of shear-thinning fluids

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We explored the feasibility of applying the flow reversal condition in the Couette–Poiseuille (C–P) flow of shear-thinning fluid to the prediction of vortex birth in the slot coating flow. We analytically derived the simple criterion and compared it with the numerically computed vortex birth conditions to evaluate the accuracy. The criterion was found to be able to predict the onset of vortex birth satisfactorily in the downstream region of the coating bead. The simple criterion could not be applied to the upstream region due to the intrinsic two-dimensional nature of the flow.

In the slot coating process, the prescribed flow rate determines not only the wet thickness of the film but also the operability of the process. Therefore, it is the key operating parameter that needs to be precisely controlled. The simple criterion derived in this study, expressed in terms of the flow rate, was proven useful as a guideline for choosing vortex-free operating conditions in such flows, without the help of full-blown computational analyses.