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Shear-thinning effects on vortex breakdown in swirling pipe flows: experiments and simulations DAVID DENNIS, University of Liverpool, TOM PETIT, University of Liverpool and Ecole Centrale de Nantes, DEACON THOMPSON, ROBERT POOLE, University of Liverpool — Laminar pipe flow with a controllable wall swirl has been studied both numerically and experimentally to explore the behaviour of inelastic shear-thinning fluids. The pipe consists of two smoothly joined sections that can be rotated independently about the same axis. The circumstances of flow entering a stationary pipe from a rotating pipe (decaying swirl) and flow entering a rotating pipe from a stationary pipe (growing swirl) have been investigated. A numerical parametric study using a simple power law model is conducted and reveals the axial length of the recirculation region is increased for shear-thinning fluids and decreased for shear-thickening (in comparison to the Newtonian reference). The critical swirl ratio required to induce the breakdown at a range of Reynolds numbers and extent of shear-thinning is investigated and a method of scaling is presented that collapses all the data for all fluids (shear-thickening, Newtonian and shear-thinning) onto a single universal curve. Experimental visualisations using an aqueous solution of Xantham Gum (shear-thinning) confirm the conclusions drawn from the numerical results.

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