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Controlling vortex breakdown in swirling pipe flows: experiments and simulations DAVID J.C. DENNIS, University of Liverpool, CHRISTOPHE SERAUDIE, University of Liverpool and Ecole Centrale de Nantes, ROBERT J. POOLE, University of Liverpool — A laminar, incompressible, viscous pipe flow with a controllable wall swirl has been studied both numerically and experimentally across a Reynolds number range of 2 to 30. 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. Flow visualisations show that at a certain swirl ratio, which can be different for growing and decaying swirl at the same Reynolds number, vortex breakdown occurs. The variation of this critical swirl ratio with Reynolds number is explored and good agreement is found between the experimental and numerical methods. At high Re the critical swirl ratio tends to a constant value, whereas at low Re the product of the Reynolds number and the square of the swirl ratio tends to a constant value in agreement with an existing analytical solution. For decaying swirl the vortex breakdown manifests itself on the pipe axis, whereas for growing swirl it forms near the pipe wall. The vortex flow formed at critical conditions is found to increase radially and axially with increasing Reynolds number and swirl ratio.

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