Abstract Submitted
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Feedback stabilization of vortex flows in a finite-length straight pipe S. WANG, R. GONG, U Auckland, Z. RUSAK, L. XU, RPI, S. TAYLOR, L. JENG, U Auckland — The properties of a recently proposed[1] feedback stabilization method of swirling flows in a finite-length pipe are studied. In the natural case, when swirl is above a critical level, linearly unstable modes appear in sequence as swirl increases and evolve to a vortex breakdown state. Based on a long-wave approach, the feedback control methodology is shown to enforce decay of perturbation's kinetic energy and to quench all instability modes at above critical swirl. In the case of a solid-body rotation, the effectiveness of this control approach is further analyzed through a mode analysis of the full linearized flow control problem. We first establish the asymptotic decay of all modes with real growth rates. We then compute growth rates of all modes according to the linearized flow control problem for swirl up to 50% above critical level. Flow stabilization in the whole swirl range is demonstrated. However, control effectiveness is sensitive to choice of the control gain. An inadequate gain, either insufficient or excessive, could lead to a failure of control at high swirl levels. Predictions of controlled flow cases agree with numerical simulations using the full unsteady and axisymmetric Euler equations with fluidic actuation along the pipe wall.

[1]Rusak et al JFM 2012.

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