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Flow Simulations of The Dynamics of a Perturbed Solid-Body Rotation Flow SHIXIAO WANG, Auckland University, CHUNJUAN FENG, Northwestern Polytechnical University, FENG LIU, University of California, Irvine, ZVI RUSAK, Rensselaer Polytechnic Institute — DNS is conducted to study the 3-D flow dynamics of a base solid-body rotation flow with a uniform axial velocity in a finite-length pipe. The simulation results describe the neutral stability line in response to either axisymmetric or 3-dimensional perturbations in a diagram of Reynolds number (Re, based on inlet axial velocity and pipe radius) versus the incoming flow swirl ratio (ω). This line is in good agreement with the neutral stability line recently predicted by the linear stability theory of Wang *et al.* (2016). The Wang & Rusak (1996) axisymmetric instability mechanism and evolution to an axisymmetric breakdown state is recovered in the simulations at certain operational conditions in terms of Re and ω. However, at other operational conditions there exists a dominant, 3-dimensional spiral type of instability mode that agrees with the linear stability theory of Wang *et al.* (2016). The growth of this mode leads to a spiral type of flow roll-up that subsequently nonlinearly saturates on a rotating spiral type of vortex breakdown. The computed time history of the velocity components at a certain point in the flow is used to describe 3-dimensional phase portraits of the flow global dynamics and its long-term behavior.

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