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Swirling flow states of compressible super-critical fluids NGUYEN LY, ZVI RUSAK, Rensselaer Polytechnic Institute, SHIXIAO WANG, U. Auckland, New Zealand — Steady states of axisymmetric swirling flows of a super-critical fluid in a rotating finite-length pipe are studied. The fluid thermodynamic behavior is modeled by the Van der Waals equation of state. A nonlinear partial differential equation for the solution of the flow stream function is derived in terms of the inlet flow total enthalpy, entropy, and circulation functions. This equation reflects the nonlinear thermo-physical interactions in the flows, specifically when the inlet state temperature and density vary around the thermodynamic critical point, flow compressibility is significant, and inlet swirl ratio is high. The approach is applied to an inlet flow described by a solid-body rotation with uniform profiles of the axial velocity and temperature. Bifurcation diagrams of steady compressible flows of real fluids are formed as the inlet swirl level and the centerline inlet density are increased. Focus is on fluids with low values of R/Cv. Computed results provide predictions of the critical swirl levels for the loss of stability of the columnar state and for the appearance of non-columnar states and of vortex breakdown states as a function of inlet centerline density. The difference in the dynamical behavior between that of a perfect gas and of a real gas is explored.

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