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Vortex breakdown in gaseous swirling jets[1] ANTONIO L SANCHEZ, University of California San Diego, JAIME CARPIO, Universidad Politecnica de Madrid, FORMAN A WILLIAMS, University of California San Diego — Numerical integrations of the axisymmetric Navier-Stokes equations are employed to describe the structure of low-Mach-number gaseous swirling jets with jet-to-ambient density ratios ρ_j/ρ_a of order unity. The integrations consider moderately large values of the Reynolds number on the order of a few hundred and values of the swirl ratio S of order unity. Slender jets are found to exist for values of S below a critical value of order unity, at which vortex breakdown occurs. As in the case of constant density jets (Billant, Chomaz, and Huerre, JFM 1998), two different types of axisymmetric vortex breakdown are identified, namely, a bubble state and a cone configuration. The critical values of S characterizing the existence of the different solutions are determined as a function of ρ_j/ρ_a. Additional computations based on the quasi-cylindrical approximation are employed to describe slender subcritical jets. The results indicate that the breakdown of the quasicylindrical approximation provides an accurate prediction for the transition from the slender solution to the bubble state, whereas a prediction for the transition to the cone state can be obtained by consideration of the structure of the flow at small distances from the jet exit.

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