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Blow out and flashback in axisymmetric lean premixed combustion with swirl ZVI RUSAK, RPI, CHUKWUELOKA UMEH[1], GE, Global Research Center — Modern ground-based lean premixed gas turbine combustors achieve flame stabilization by the use of inlet swirl and a chamber expansion into a larger domain. This predisposes the premixed inlet vortex flow to transition to a vortex breakdown state, with stagnation and recirculation zones near the dump plane. This creates a compact turbulent and highly mixed reaction zone, which enables the use of leaner combustion to reduce emissions drastically. However, when the swirl level is too low, the flame cannot be stabilized and blows out. On the other hand, when swirl is too high, flame flashback may occur into the injection region. This work describes numerical simulations of non-reacting and combusting flows, which provide insight into the characteristics of the axisymmetric vortex breakdown in an expanding pipe. Results show good agreement with available theoretical predictions for the first appearance of breakdown downstream of the pipe expansion plane as well as its first appearance in the inlet pipe section as upstream swirl level is increased. It is demonstrated that the theoretical criteria can be used to predict the occurrence of flame blow out and flashback. The effects of inlet flow temperature, Mach number and global pressure on the reacting flow are also investigated.

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