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Vortex Breakdown in a Swirl-Stabilized Combustor ZVI RUSAK, RPI, COU UMEH, Nestoil PLC, EPHRAIM GUTMARK, UC — Results of lean premixed reacting flow tests in a swirl-stabilized combustor show the complex interaction between the flame and the vortex breakdown (VB) zone and oscillations in the position of both. PIV measurements give the detailed velocity field, from which the swirl ratio for a given swirler is computed. Position and size of the VB zone are also determined at various equivalence ratios. Simultaneous OH chemiluminescence snapshots identify the location of the flame. For the given setup with a fixed swirler, upstream pressure and mass flux, it is found that the VB zone occurs near the expansion plane in the nonreacting cold flow case and is pushed downstream when flow is preheated. For low equivalence ratio (Φ) near the flammability limit (0.48 to 0.52), the VB is anchored at the expansion plane and the flame oscillates inside it. At higher Φ (0.55 to 0.65), the VB zone apex and flame front are close to each other and oscillate together near the expansion plane. At even higher Φ (> 0.7), the flame is anchored at the expansion corners while the VB zone oscillates downstream of it. A theoretical discussion that is based on the compressible flow vorticity transport equation sheds light on the various mechanisms that govern VB position in reacting flows.

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