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Experimental Study of Reaction and Vortex Breakdown in a Swirl-Stabilized Combustor CHUKWUELOKA O.U. UMEH, General Electric Aviation, ZVI RUSAK, RPI, EPHRAIM J. GUTMARK, University of Cincinnati — Non-reacting and lean reacting flow experiments are conducted in a swirl-stabilized combustor with several configurations of a TARS fuel injector. The test chamber is composed of the TARS swirler at the inlet of a straight cylindrical fuel pre-mixing section, followed by a sudden expansion and a finite-length concentric chamber, open to the atmosphere and with optical access. Non-reacting flow tests are conducted with air at 300K and 600K, while reacting flow tests use premixed air (at 600K) and gaseous propane fuel. Simultaneous PIV measurements and OH chemiluminescence is taken and used to describe the velocity field and location of vortex breakdown and reaction zones. Results show the complex dynamical interaction between the flame and breakdown zone, and the oscillations in the position of both. In the non-reacting cold flows, the breakdown zone appears near the expansion plane. In the non-reacting pre-heated flows it is pushed downstream of the expansion plane. For reacting flows with equivalence ratios near the lean blow out point, the breakdown zone is anchored near the expansion plane, while the flame oscillates inside it. At higher equivalence ratios, the flame is anchored near the expansion plane while the breakdown zone oscillates behind it. Measured swirl numbers show nice correlation with breakdown position and satisfy necessary theoretical conditions.

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