Characteristics of Lean Axisymmetric Bluff-Body Stabilized Propane Flames Under Premixed or Stratified Inlet Mixture Conditions.

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The control and extension of the stability margin in a wide range of combustion applications without compromising emission levels and safety requirements is a key technology issue in the design and development of future combustors [1, 2]. Lean premixed combustion has become widely exploited as it addresses some of the above issues and tackles the problem of harmful emissions such as NO_x and soot. However, the anticipated operation of future combustion systems under increased loads, mixing and burning rates may result in complications such as sensitivity to mixing, low reaction rates, extinctions and instabilities. Recently combustion technologies based on partially premixing and stratifying the reactive mixture has attracted attention as a promising methodology to mitigate these effects in the effort to expand the usefulness of the lean fully premixed concept [3, 4, 5, 6].
The present work describes an experimental investigation of some differences and similarities in the operating characteristics between fully-premixed and stratified propane flames stabilized in axisymmetric bluff-body burner configurations[7]. The studied configuration employs a double cavity propane-air premixer formed along two concentric disks and an axisymmetric afterbody flame stabilizer [8]. The premixer system supplies with a regulated radial equivalence ratio gradient the afterbody recirculation, where flame anchoring is established under, either fully premixed or stratified inlet mixture conditions. The objectives are to provide further insight into the behavior of these flame configurations operating with variable inlet mixture uniformities under lean and ultra-lean, closer to blow off conditions. Identification of the individual characteristics such as near wake development, flame anchoring topologies, pollutant emissions and ultra-lean behavior, of each set up, may help determine suitable methodologies to extend operational margin in a fashion tailored for the particular flame topology.
Measurements of turbulent velocities, temperatures, simultaneous chemiluminescence imaging of OH* and CH*, and gas analysis provided information for a range of flames and inlet mixture conditions for different afterbody shapes. This initial study helped to elucidate some aspects regarding the interaction of the toroidal flame fronts with the recirculation stabilization region and the flame front behaviour at lean or closer to blow-off conditions under operation across variable inlet fuel-air mixture stratifications up to the fully premixed condition and under different blockage ratios. The above information and a future work program will provide insight into the benefits that may be gained from suitable management of the fuel injection strategy for the expansion of the useful ultra-lean operation.

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