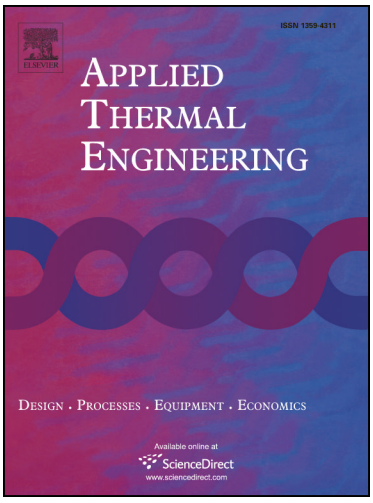

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Effects of stratification on flame structure and pollutants of a swirl stabilized premixed combustor

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Abstract

As mixing of fuel and air before combustion is not perfect in many practical premixed applications, the mixture is not spatially and temporally uniform and burns in partially premixed regime. Depending on the degree of mixture non-uniformity, the structure, amount of emissions and even flammability limits of a flame in this intermediate regime could be totally different from a premixed one. To investigate this effect on lean premixed combustion (LPM), a reduced scale swirl-stabilized burner is built and analyzed experimentally and numerically in premixed and two different partially premixed configurations. Experiments are initially done visually using a digital camera for a confined flame over a wide range of swirl numbers and all configurations from stoichiometry to lean blow out. Measurements of CO, NO/NO_x are performed for the confined cases at the exit of the combustor using a Nondispersive Infrared (NDIR) and a Chemiluminescence analyzer (CLA) respectively. Numerical simulation is done by solving a system of partial differential equations including mass, momentum, species for confined cases under iso-thermal conditions using large eddy simulation. Results show that spatial and temporal non-uniformity of mixture, stratification not only affect the structure of turbulent premixed flames but also alternate the stability and pollutant emissions of the swirl burner at the same global operating conditions. In addition, NO_x emission for axial stratified flames is more pronounced at medium to high swirl numbers.

Keywords:

Polluting measurements, Visual observation, Large Eddy Simulation (LES), Major Pollutant