Effects of the vortex in the burnt gas on flame interaction by the offsetting counter-flow burner

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1 Abstracts

Effects of vortices in a burnt gas on flames interaction are investigated experimentally by using the offsetting counter-flow burner. The flow and the flames structures are measured with two particle image velocimetry and time series laser tomography. The burner system consists from twin symmetrical counter-flow burners having 10mm nozzle exit diameter and 20mm nozzles separation. Lean methane air mixtures, up to 1.0 equivalence ratio (φ) issue with 1.0m/s mean velocity ($\bar{U}_0$). Making the offsetting counter-flow, one of the burner, the lower burner in here is sliding in the horizontal direction, then the stagnating front is leaning with the burner sliding rate. The leaning stagnating front generates the shear stress. The shear stress increases with increasing the offsetting rate (r_{off}) defined as $r_{off} = \triangle r/D$, where $\triangle r$ is the offsetting distance from the origin axis and D is nozzle exit diameter. The offsetting rate exceeds around 0.4, the single or twin vortices formed behind flames.
The flame structures and extinction characteristics can be divided into three distinct regimes, slant flames, hyperbolic flames and hyperbolic oscillating flames depending on the offsetting rate. In the regimes Ⅰ (r_{off} <0.4), the slant flames are formed with no vortices. The extinction mechanisms are similar with ordinary counter flow twin flames and the flame stretch may become the extinction trigger. The flames distance for the upper flame and the lower flame is constant in this regime while the local maximum burning velocity increases with increasing the offsetting rate. In the regime Ⅱ ($0.40<r_{off}<0.85$), the hyperbolic stationary flames are formed with single or twin vortices, then the vortices scales and structures are strongly influenced by U_0 and φ. The extinction stretch rate become half of the slant flames and the extinction starts from the edge of the hyperbolic flame. In regime Ⅲ($0.85<r_{off}<1.00$), the hyperbolic oscillating flames are formed with single vortex. The oscillating mechanisms would be the results of the local quenching induced by the interactions of the flame and the vortex. The flame length scale and local propagation speed probably changes with the flame oscillating motion.