Dynamics of Laminar Premixed Flame under Equivalence Ratio Oscillations

Thesis by

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Thesis Abstract

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Thesis Summary

Dynamics of laminar-premixed flames of CH_4/air mixture under equivalence ratio oscillations were experimentally and numerically investigated for stagnation flame and conical flame by focusing on the oscillation wavelength is larger than the nominal flame thickness. In an experimental work, lean region is focused because flame moves monotonically in equivalence ratio variations. It was observed that the flame moves periodically following the variation of the equivalence ratio. This movement is primarily due to the equivalence ratio oscillations, since the velocity perturbation is significantly suppressed. Furthermore, it was observed that the flame dynamics is influenced by the characteristic of the piston type oscillator at the quasi-steady regime (St < 1.0) by an increase in amplitude of the flame motion with an increase in the frequency of the equivalence ratio variation. On the other hand, an increase in the oscillation frequency of the equivalence ratio variation decreases the flame motion amplitude as it was influenced by the oscillation frequency at the unsteady regime (St > 1.0). The numerical work for the stagnation flame was focused at St > 1.0 in the lean, rich and lean rich crossover cases and the results are agreed with the experimental works. Moreover, numerical work demonstrated that, the back support effect influences the dynamic response of the flame movement, in that, the direction of the cycles of the dynamic response in the lean and the rich conditions are different. In addition, hysteresis of the flame movement is seen in the numerical and experimental works. An explanation of this hysteresis was done by introduces concept of the non-uniform scalar value profile and was clarified by development of simplified qualitative mathematical model. For conical flame, the quasi-steady manner of the flame tip movement was observed at St < 1.0. At St > 1.0, we found that the attenuation of the flame tip motion is affected by the wrinkling of the flame surface in addition to the attenuation of the equivalence ratio oscillation amplitude. Overall, a ratio between the characteristics time of the flow and the characteristics time of the oscillation called *Strouhal* number is an important parameter to categories the dynamics of the laminar premixed flame in quasi-steady (St < 1.0) or unsteady (St > 1.0) manner either the stagnation or conical flame configurations.