

Acoustically Excited Premixed Hydrogen-Air Slit Flames

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Combustion noise is an important issue in lean burn gas turbines, which often generate highly unsteady flames. Acoustic waves are directly coupled to fluctuations in the flow field, where heat release fluctuations result in a direct noise source term related to perturbations of the flame surface, which can be damped or amplified by intrinsic flow and combustion stability phenomena.

In this study, the noise generation in two-dimensional lean premixed hydrogen–air slit flames is systematically investigated and the fuel–air equivalence ratio is varied to investigate its impact on flame dynamics. Under nonexcited conditions, inherent instabilities give rise to pronounced cellular structures along the flame front, resulting in continuous pocket shedding and significant pressure fluctuations at the flame tip. These exhibit a distinct shedding frequency, particularly in richer hydrogen–air mixtures [1]. Subsequently, acoustic excitation is applied and the flame response to the perturbations is analyzed and compared with the baseline cases. CAA (Computational Aeroacoustics) simulations solving the APE (Acoustic Perturbation Equations) provide further insight into the distribution and relevance of individual noise source terms.

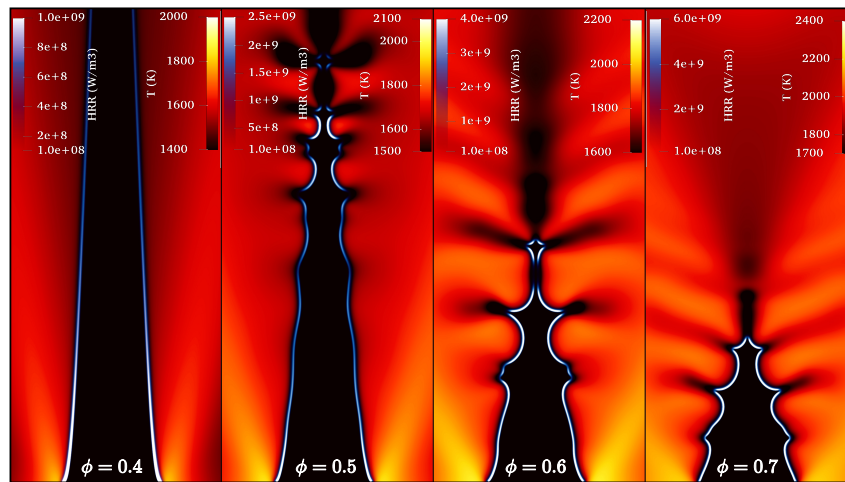


Figure 1: Heat Release Rate (HRR) at the flame front and contours of the temperature field for four distinct reference cases at different fuel–air equivalence ratios (ϕ): $\phi = 0.4$ (left) to $\phi = 0.7$ (right).

References

- [1] Pedro-Beltran B, Meinke M, Schröder W. Acoustic Emission of Thermodiffusive Unstable Premixed Lean Hydrogen-Air Slit Flames. *American Institute of Aeronautics and Astronautics*. 2024.