Numerical study of vaporization-controlled instability in afterburner combustion using Large Eddy Simulation

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In this work, the combustion instability observed by Cross et al. [1] in the Georgia Tech post-combustion bench is studied using Large Eddy Simulation (LES) for various fuel injection conditions. In the continuity of the auto-ignition and fuel injection simulation activities performed by Mocquard [2] and Vincze et al. [3], further detailed liquid jet in crossflow injection and secondary atomization models are included in the AVBP solver [4] to better represent the fuel dispersion in steady and dynamic conditions. A preliminary non-reactive simulation of the academic reheat chamber described in Lubarsky et al. [5] shows a satisfying comparison with experimental measurements. It highlights the fuel input modulation induced by the Von-Karman (VK) vortex trail behind the bluff flame-holder. This coupling leads to a strong sinuous combustion instability in reactive conditions at the VK frequency, as experimentally evidenced by Cross et al. [1]. The amplitude of the oscillations for increasing global equivalence ratios is hence investigated and compared with the experiments. Overall, this work shows an example of a vaporization-controlled instability mechanism in liquid-fueled combustion chambers as theorized by Abramzon and Sirignano [6] and highlights the capacity of the Lagrangian two-phase LES framework to predict such phenomena.

References

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