ANALYSIS OF STANDING AND TRAVELING TANGENTIAL WAVE IN A LOX/KEROSENE LIQUID ROCKET ENGINE BASED ON OpenFOAM

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Keywords: *combustion instability, standing and traveling 1T wave, thermo-acoustic coupling, LOX/Kerosene liquid rocket engine, sprayFOAM.*

Self-excited first-order tangential (1T) high frequency combustion instability is captured in a high-staged combustion LOX/Kerosene liquid rocket engine based on sprayFOAM solver. The 1T mode combustion instability behaves two different patterns: standing wave and traveling wave. In the design operation condition, the value of oxygen-fuel ratio (O/F) is 2.5, all injectors share the same propellant mass flow, and there is no oscillatory combustion in the numerical calculation results. The chamber pressure between numerical calculation and experiment shows a good agreement, which validate the numerical model. When the fuel mass flow of two injectors which are along the same diameter and locate at the edge of injector face is changed, severe unstable combustion occurs and nodal diameter remains consistent, which is a standing 1T wave mode. When the value of O/F increases to 4.4 and the propellant distribution is completely uniform, there is also a high frequency combustion instability whose nodal diameter is spinning, demonstrating a traveling 1T wave mode. Once the combustion instability occurs, no matter what kind of wave modes, thermo-acoustic coupling forms, and the pressure and heat release oscillate totally in phase temporally and couples spatially. It is the coupling process between heat release and combustion that results in the combustion instability.