Effects of the Combustor Structure on Propagation Characteristics of Rotating Detonation Waves Utilizing Liquid Kerosene

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Abstract： To investigate the effects of different combustor structures on propagation characteristics of rotating detonation waves, this experimental study has been performed in a laboratory-scale rotating detonation combustor. Four cases, including a hollow combustor, a cavity combustor, and two annular combustors with combustor widths of 20 mm and 32 mm, have been considered in this study, and a fixed outer diameter of 100 mm and the same injection scheme have been employed for different cases. Kerosene and oxygen-enriched air with an oxygen volume fraction of 40% have been used as fuel and oxidizer respectively. Four modes, i.e., the fast deflagration mode, the dual-wave collision mode, the quasi-stable detonation mode, and the stable detonation mode, have been observed and their propagation characteristics have been discussed. In the hollow combustor, three propagating modes, including the fast deflagration mode, the quasi-stable detonation mode, and the stable detonation mode have been obtained at different mass flow rates. In the annular and cavity combustors, the quasi-stable detonation mode cannot be observed and the dual-wave collision mode occurs at a higher mass flow rate. Besides, an obvious tendency could be found that the operating range of the stable detonation mode is narrowed for the annular combustor, as the combustor width decreasing from 32 mm to 20 mm. The average propagation velocity of rotating detonation waves is around 1750 m/s in the hollow combustor, which is evidently faster than both of the annular and cavity cases. Moreover, the average propagation is around 1360 m/s in the cavity combustor, which is smaller than the value around 1460 m/s in the annular one with a combustor width of 32 mm. As a result, the hollow combustor is considered as a more favorable choice to obtain stable rotating detonation waves than the other structures in this study. Stable detonation waves are difficult to be maintained as the combustor width is decreased to 20 mm and the cavity combustor is regarded as an alternative structure.

Key words： Rotating detonation; liquid kerosene; Combustor structure; Propagation mode; Propagation velocity