Experimental Study of Perforated-Wall Rotating Detonation Combustors

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Abstract

The combustion stability regulation and thermal protection are two critical issues on the application of rotating detonation engines. We believe the perforated walls are potentially applied in RDCs to stabilize combustion and perform transpiration cooling. In this study, the effects of perforated wall on the acoustics and combustion characteristics of the RDC are investigated by examining five types of perforated walls with different hole sizes and perforated area ratios (Fig.1).

The stable and unstable rotating detonation are both observed in the experiments, and the unstable phenomena mainly correspond to the counter two-wave rotating detonation that co-exists with the acoustic modes of the combustor. It is found that a perforated wall with proper geometric parameters can effectively suppress acoustic modes over the full range of flow rate, and this is mainly due to the function of perforated holes to dissipate pressure waves that excite acoustic modes in the RDC. When acoustic modes attenuate or disappear, the rotating detonation becomes more stable, and the fluctuation in pressure peak and wave velocity is significantly reduced (Fig.2). It is inferred that the acoustic modes are excited by local high-pressure spots generated by the collision of two detonation waves, and they induce the fluctuating pressure peaks and wave velocity by affecting the H_2 injection. The perforated holes dissipate high-pressure spots, and thereby suppress the acoustic modes.

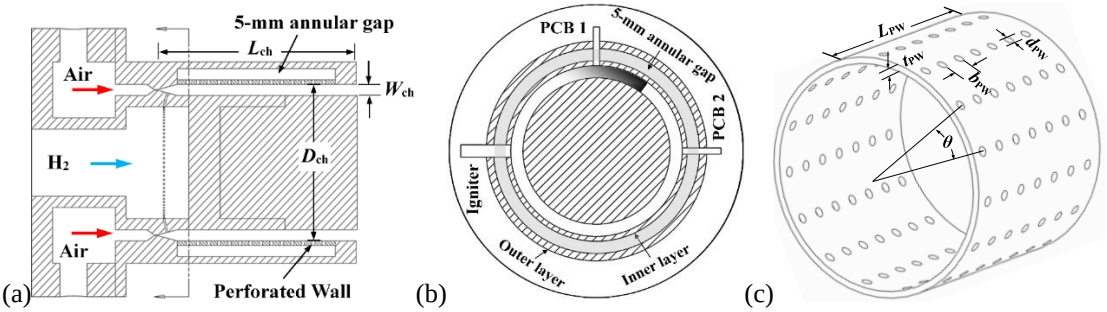

Figure. 1 Schematic of (a) the rotating detonation combustor, (b) the configuration of instruments and (c) the perforated wall.

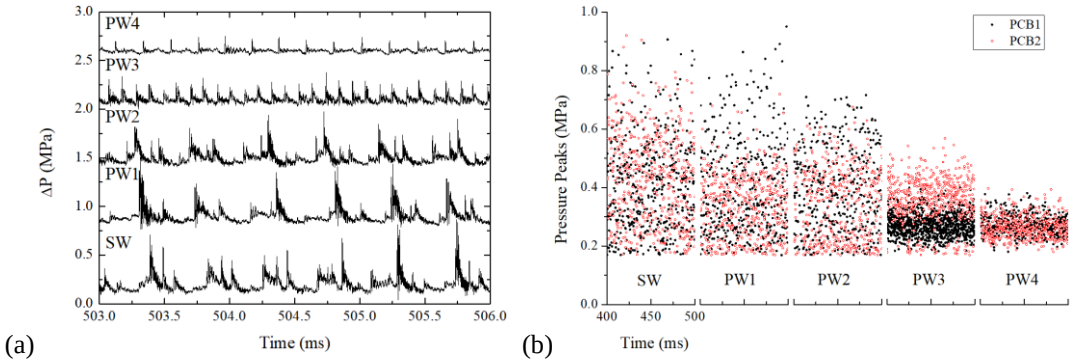

Figure. 2 Comparison of the (a)pressure profiles and (b) pressure peaks distribution for different walls, $\dot{m}_{air}$=165 g/s.