

# Propagation behavior of rotating detonation in an obround combustor

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## Abstract

The rotating detonation engine is a potential pressure-gain combustion engine. The engineering application of RDE requires a comprehensive understanding of the propagation behaviors and instabilities of rotating detonation, which are influenced by a wide-range of factors. In this study, the geometric factor is investigated in an obround slit-channel combustor (Fig. 1) with a  $H_2$ - $O_2$ - $N_2$  mixture under different oxygen volume fractions ( $\alpha=21\%$ ,  $30\%$ ,  $35\%$  and  $40\%$ ) and equivalence ratios ( $ER=0.8\sim 1.1$ ).

Based on the velocity fluctuation ratio, the experimental data is divided into stable and unstable regions based on the velocity fluctuation ratio. The stable rotating detonation is obtained within wide-range ERs for  $\alpha=40\%$  and  $35\%$  in which the detonation velocity fluctuation ratio is approximately 1%. The pressure histories indicate that the instability of the detonation front is induced by the curvature transition for  $\alpha=30\%$  and  $21\%$ . Complicated unstable phenomena associated with the detonation propagation are observed in which the acoustic modes can be identified, namely acoustics-detonation coexisting mode, acoustic-dominant mode and detonation quenching (Fig. 2).

Finally, a mechanism of the unstable propagation of rotating detonation in the obround combustor is proposed. The curvature transition induces instability in the detonation front and generates non-detonative combustion, thereby exciting acoustic modes of the combustor. Furthermore, the acoustic modes affect the rebuilding process of the detonation front. The coupling of the instability of detonation front and acoustic modes leads to and aggravates the unstable propagation of rotating detonation.

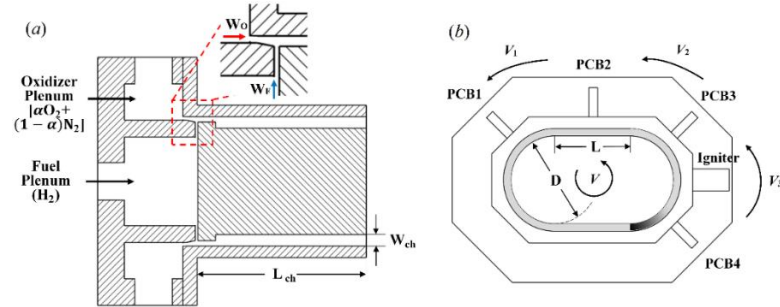


Figure. 1 Schematic of the obround combustor and instruments.

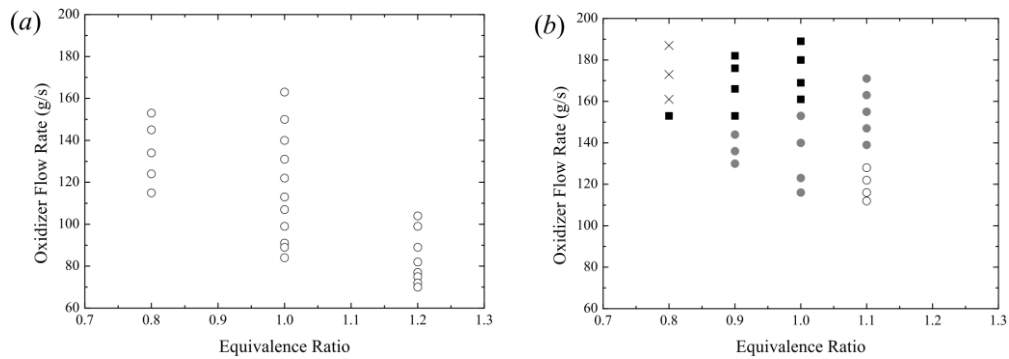


Figure. 2 Operating maps showing the types of unstable propagation phenomena in the unstable region: (a)  $\alpha=30\%$ ; (b)  $\alpha=21\%$ . (○:acoustics-detonation coexisting mode, ●:acoustic-dominant mode, ■:detonation quenching, ×: failure)