Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Effects of the geometrical parameters of the injection nozzle on ethylene-air continuous rotating detonation

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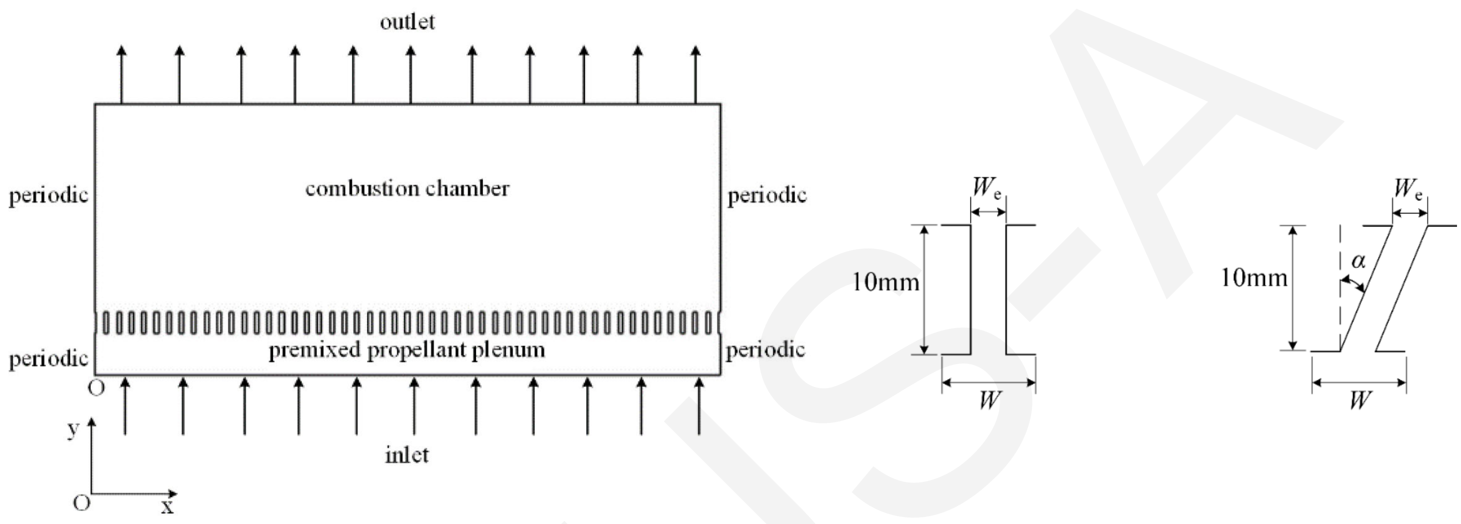
Cite this as: Wei-jie Fan, Jin Zhou, Shi-jie Liu, Hao-yang Peng, 2021. Effects of the geometrical parameters of the injection nozzle on ethylene-air continuous rotating detonation. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 22(7):547-563. https://doi.org/10.1631/jzus.A2000314

Physical model and numerical method



(a) whole computational domain
(b) vertical injection nozzle
(c) slant injection nozzle

Fig. 1 Computation domain and nozzle geometry.

- A stoichiometric ethylene-air mixture is stored in the plenum and is injected into the combustion chamber through a uniformly distributed array of nozzles.
- Two-dimensional Euler controlling equations are solved by the density-based solver of ANSYS FLUENT.

Results and discussion

- **Effects of the distance between two neighboring nozzle centers**

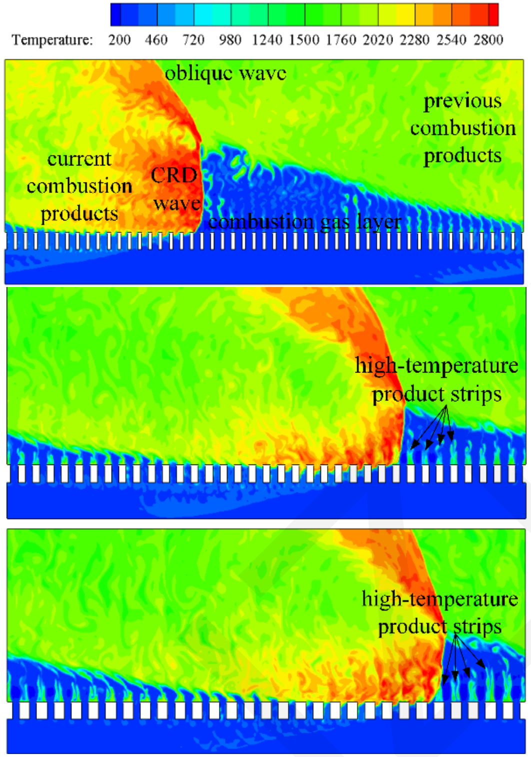


Fig. 2 Temperature contours of Case A0-A2. Unit: K

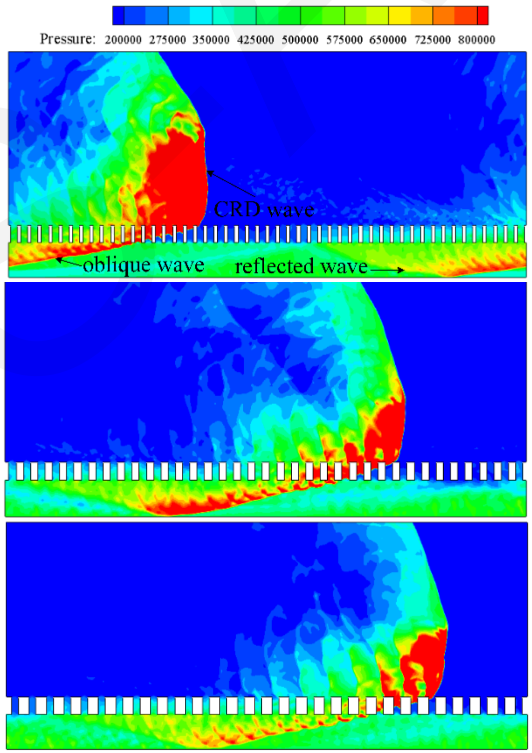


Fig. 3 Pressure contours of Case A0-A2. Unit: Pa

Results and discussion

Effects of the nozzle exit width

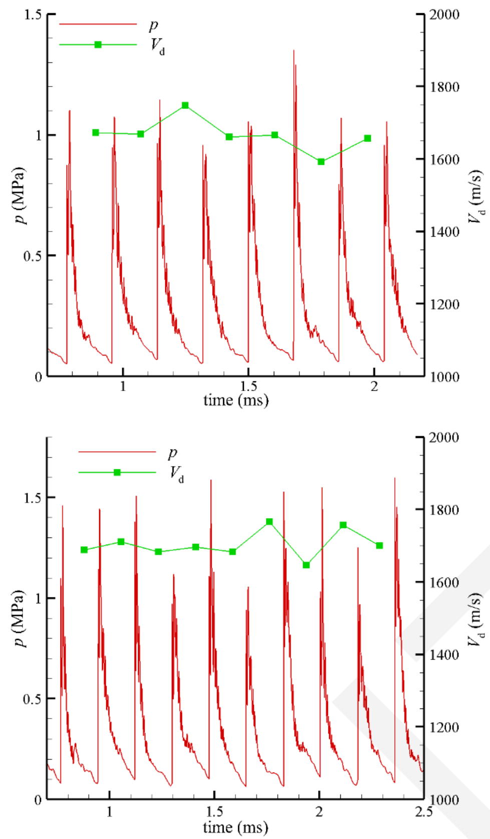


Fig. 4 Pressure record curves of P2 in the chamber

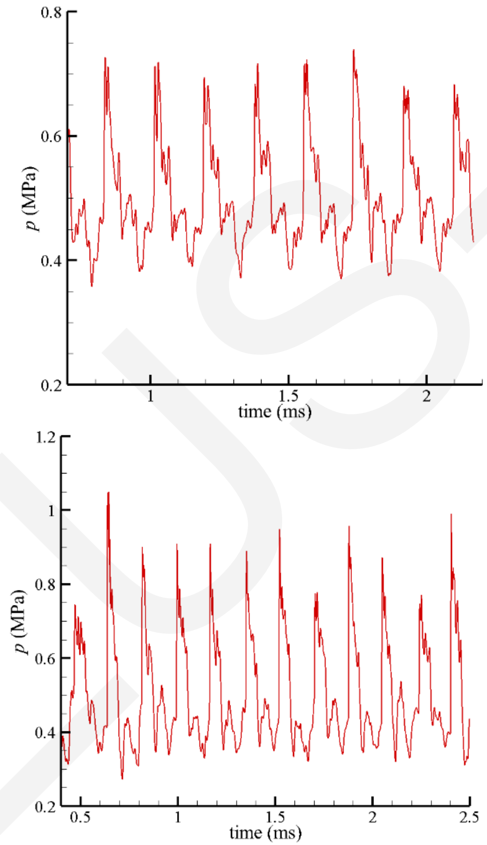


Fig. 5 Pressure record curves of P1 in the plenum.

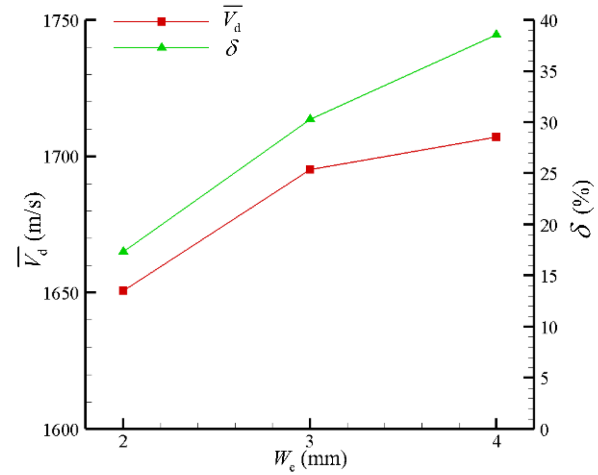


Fig. 6 $\overline{V}_d$ and δ VS W_e

Results and discussion

☐ Effects of the slant angle of nozzle

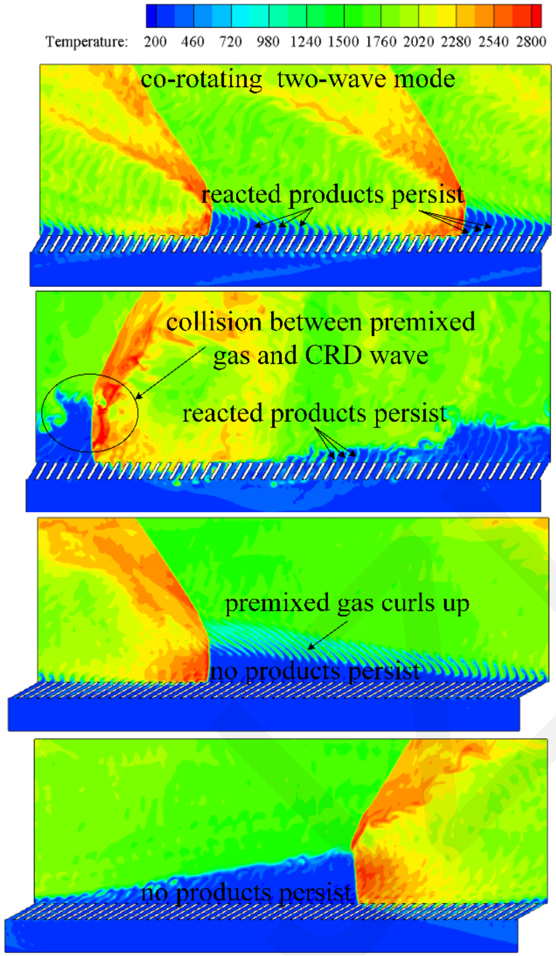


Fig. 7 Temperature contours of Case C1-C4.

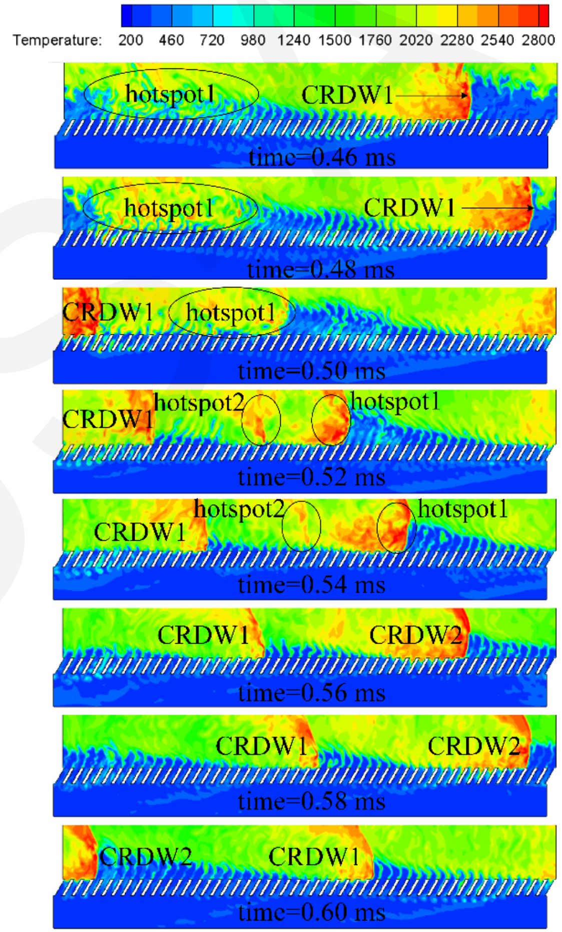


Fig. 8 Transition process from one-wave mode to two-wave mode.

Conclusions

- Small distance between two neighboring nozzle centers helps to improve the strength of the CRD wave and leads to great feedback pressure into the plenum.
- The strength of the CRD wave is improved and the feedback pressure into the plenum gets higher as the nozzle exit width increases.
- The visible velocity of the CRD wave is greatly improved when the nozzles slant in the propagation direction of the CRD wave. And slant injection conduces to inhibiting the feedback pressure into the plenum.
- Injection with a slant angle can change the propagation mode of the CRD wave. The parasitic combustion induces a hotspot and the azimuthal velocity of the premixed gas in the propagation direction of the CRD wave contributes to the formation of a new CRD wave.