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Effect of nozzle geometry features on the nozzle internal flow and cavitation characteristics based on X-ray dynamic imaging

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Nozzle geometry features directly impact the nozzle internal flow which significantly affects the spray atomization, as well as in-cylinder combustion and fuel economy. In this study, the nozzle internal transient flow was visualized through X-ray phase-contrast imaging technology. The experimental results indicated that the sac-orifice relative positions and the structural asymmetry of the nozzle orifice prominently influence the in-nozzle cavitation strength and distribution. Some nozzle geometry features with general applicability such as inlet normal inclination angle, orifice inlet included angle and orifice conicity angle are defined to better elaborate their effects on the internal flow characteristics. A 3D simulation of the nozzle internal flow demonstrated the relevance between the nozzle geometry and the cavitation characteristics. It is found that the cavitation phenomenon is intensified when the wall inclination angle is positive and will be inhibited when it is negative. The cavitation development is facilitated with smaller orifice inlet included angle. The nozzle orifice conicity, which obviously alters the pressure distribution in the orifice, also has a significant influence on the cavitation characteristics.

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