Numerical Study of Non-Premixed Combustion of Pulsed Swirling Co-axial Jets

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Abstract

This study presents cold flow and combustion characteristics of a non-premixed swirling co-axial jets pulsed at certain Strouhal number. The cold flow characteristics was studied experimentally using flow visualization, hot-wire anemometer and concentration measurement. The combustion characteristics was studied numerically. The cold flow study shows that jet pulsation improved the mixing characteristics and jet spreading significantly. It was shown that jet pulsation can be used to control mixing thereby manipulate the flame characteristics to control heat release and pollutant emission. When the jet pulsation was tuned to a certain Strouhal number, the cold flow study shows that mixing is significantly improvement near the nozzle exit. Such improvement in mixing enhances the combustion characteristics. The flame length become shorter, heat release was increased and pollutant emission was reduced. At certain pulsation conditions, high temperature region appears further downstream from the burner tip. As such, flame impingement on the burner tip is reduced, which improves equipment life and reduce maintenance needs. Cold flow study infers that when the jet was excited at large pulsation intensity and low Strouhal number, the large momentum flux may blow out the fire and it becomes difficult to sustain combustion. The results of the cold flow and combustion study show that by tuning the jet pulsation to some Strouhal numbers, the heat release, flame length and emission characteristics of a swirling co-axial jets combustion can be improved compared to naturally evolving flows.

Keywords
Non-premixed combustion; Pulsed jet; Mixing; Co-axial jet; Swirling jet