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OPERATIONAL SENSITIVITIES OF AN INTEGRATED AERODYNAMIC-RAMP-INJECTOR/ GAS-PORTFIRE FLAMEHOLDER IN A SUPERSONIC COMBUSTOR

Abstract

Results are presented of experiments conducted in a supersonic wind tunnel on an integrated fuel injection/ignition system, consisting of an aeroramp injector and a gas-portfire igniter. The main goals of the work were to determine how the lifting effect of the gas-portfire affected the fuel from aeroramp jet, to ascertain how the injection of gas through the gas-portfire influenced the combustion in the combustor model, and to investigate any synergistic effects from the combination. The gas-portfire igniter/flameholder was placed downstream of the injector on the centerline at three different locations in order to find the best suitable gas-portfire injector geometrical configurations. The aeroramp was observed to generate a pair of streamwise vortex and gas-portfire had a strong lifting effect on this vortex. Experiments achieve a stable combustion while ethylene equivalence ratio above 0.1.As increasing the gas-portfire momentum flux ratio from 0.64 1.43, the delay time of ignition has been shortened obviously, but was not observed to influence the combustion efficiency. 3-D numerical study was conducted to investigate the details of combustion flow structures. The distribution of pressure obtained by experiments and simulation is according well (average error<5%). The numerical results show that the distance of gas-portfire apart from aeroramp injector is a critical parameter which influenced the combustion efficiency. The results demonstrate that the gas-portfire play an important part in combustion enhancing. The ignition delay time is sensitive to momentum flux ratio of gas-portfire. When momentum flux ratio is lower than 1.0, the delay time will reach nearly 0.3s. On the other side, lower momentum flux ratio bring about a lower total pressure loss without drop of combustion efficiency, thus achieve a higher thrust.

Keywords: Aerodynamic-Ramp-Injector/Gas-portfire, Scramjet, Supersonic combustion.