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Author: Mr. Wang Jianchen
Beihang University, China, rechard_1982@sina.com

Prof. Lin Yuzhen
China, 18600369549@163.com
Mr. zhang yan
Beihang University, China, rechard_1982@sina.com

SUPERSONIC COMBUSTION OF LIQUID KEROSENE WITH AN INTEGRATED STRUT-INJECTOR/CAVITY FLAMEHOLDER

Abstract

Experimental and numerical results from liquid kerosene combustion in a direct-connect supersonic combustor facility were presented. Successful ignition and sustained combustion were achieved using an integrated strut-injector/cavity flameholder configuration. High enthalpy clean air was heated to a total temperature ranges of 1100K by clean air storage heater, and entered the isolator entrance at a Mach number of 2.0. The inflow total pressure was held constant to 0.87MPa. The strut had a sweep angle and a compression angle at the leading edge, and the cavity with a rear ramp was just installed downstream of the strut. The liquid kerosene was injected into the combustor through the side walls of the strut. A dependent gas generator, normally located at the bottom of the cavity, acted as the igniter at the start of experiment. The successful combustion was demonstrated by observing wall-static pressure rises in the combustor. Both subsonic and supersonic combustion modes can be achieved at equivalence ratios between 0.45 and 0.85. High speed camera was utilized to obtain the flame structure, illustrating that the combustion mainly occurred in the wake of the strut. Schlieren images in the fuel-off case were obtained to describe the coupling mechanism between the strut and cavity. Furthermore, off-design flight conditions were also tested by varying the inflow air total temperature. Supersonic combustion was achieved at total temperatures as low as 750 K. Non-reacting and reacting simulations were also conducted and the numerical results agreed well with the experimental results. The non-reacting results showed that the oblique shock induced by the leading edge of the strut increased the static temperature and decreased the velocities around the injector, resulting in the improvement on the fuel ignition. Some important parameters, such as mixing efficiency, penetration depth and maximum concentration decay, were investigated through the non-reacting simulation flow field. The CO2 mass fraction contours also showed that the combustion mainly occurred in the wake of the strut, and few fuel was entrained into the cavity, illustrating a bad coupling between the strut and cavity. The combustion efficiency and total pressure loss of this configuration were approximately 70