63rd International Astronautical Congress 2012

Paper ID: 16244
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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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EXPERIMENTS OF SUPERSONIC COMBUSTION USING DISTRIBUTED INJECTION IN A MODEL SCRAMJET ENGINE

Abstract

Supersonic combustion with distributed injection of ethylene in a model scramjet engine was experimentally investigated in Mach 2.92 facility with the stagnation temperatures of approximately 1430K. The model combustor shown in Fig. 1 had a total length of 1890 mm and consisted of one nearly constant area section of 300 mm and three divergent sections with the expansion angles of 2.5, 3.5, and 4 degrees, respectively. The entry cross section of the combustor was 54.5 mm in height and 75 mm in width. Static pressure distribution in the axial direction was determined using pressure transducers installed along the centerline of the model combustor top walls. The entire test rig including air heater and the model scramjet engine was mounted upright on a platform. A weight sensor mounted on the forehead of the air heater was used to measure the rig thrust changes during the experiments. The thrust increment from only air heater working status to scramjet engine working status plus air heater could be used as one target parameter for the combustor performance assessment. High speed imaging camera was used to capture flame luminosity and combustion region distribution and the obtained images were used to explain combustion results. In the experiments, combustor performances with different fuel injection locations, injection stages, and cavity flamehoder locations and number of cavities were investigated systematically and discussed based on the measured static pressure distributions, the specific thrust increments due to combustion and the images obtained by high-speed camera. Injector locations combined with cavity locations have obvious effects on combustor performance. As the injection combined with cavity moves to downstream locations where the combustor divergent angle increases, the overall pressure level decreases, however the pressure around the downstream cavity increases. Under this condition the thrust increment is not obviously affected. Adding injection stages on the opposite wall upstream of the cavity location could improve the combustion performance, but adding injection stages downstream of the cavity location has little effect. The obtained images demonstrate that the downstream injection has a lower penetration height which could not provide an enhanced combustion effect. Two cavity flameholders in tandem shows that the pressure level and the thrust increment are both increased, and the images obtained by high-speed camera shows that the flame region is enlarged, which means the secondary cavity enhances the downstream injection combustion and has positive effects for the concentrated heat release.