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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (9)

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COWL AND CAVITY EFFECTS ON SCRAMJET FUEL MIXING AND COMBUSTION

Abstract

Scramjet is a promising air-breathing engine for the access to space which typically consists of an inlet, an isolator, a combustor, and a nozzle. With the scramjet, supersonic fuel-air mixing and combustion must be maintained within the combustor. To enhance the combustion, a recessed-type cavity flame-holder, which is known to reduce ignition delay time and also provide a continuous source of auto-ignition, is often used. A cowl further assists the combustion by shock impingement. This method affects mixing and combustion characteristics and thereby the cavity flow. Furthermore, it affects jet trajectories by reducing jet's unstable periodical motion. In this work, the supersonic fuel-air mixing and combustion were experimentally investigated using a scramjet model in a short-duration facility shock tunnel. Ethylene, which is known as a surrogate model of a hydrocarbon fuel, was used. Recently, the present authors found that, at flow total temperature of 2080 K which is equivalent to flight Mach number of 6.7, the combustion was maintained inside the cavity and this condition provided a continuous ignition downstream of the cavity indicating that flame-holding is achieved. At 1860K, a strong level of combustion signal was observed inside the cavity but gradual quenching of hydrocarbon radical (CH*) during steady flow was found and flame-holding was not maintained. In light of the above, the present work conducted a series of experiments with a cavity flame-holder and different cowl locations to investigate the enhancement of fuel mixing and combustion. Five different cowl locations were considered. Different cowl position changed the reflected shock impingement location from upstream of injection orifice to cavity rear wall. Mixing and combustion characterizations were visualized using shadowgraph flow visualization and CH* chemiluminescence techniques. Further details of the experimental results and discussion are included in a full paper.