Paper ID: 23410
student

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

Author: Mr. Won Keun Chang
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, ericwkchang@kaist.ac.kr

Prof. Gisu Park
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, gisu82@kaist.ac.kr
Prof. Duck Joo Lee
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, djlee@kaist.ac.kr

EFFECTS OF COWL AND CAVITY 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. The 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 investigated using a scramjet model in a short duration facility shock tunnel. The model consists of a contoured wedge followed by a main body with the cavity and the cowl. A fuel injection module was mounted inside the main body. Ethylene was used as the fuel. According to the literature, it is found that, at flow total temperature of 2080 K, 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 temperatures lower than this, a strong level of combustion signal was observed inside the cavity but eventually quenching of hydrocarbon radical (CH*) during steady flow was found and flame-holding was not maintained. Therefore, one flow condition at 1860 K with different cowl locations was used herein to investigate effects of the cowl and the cavity on the mixing and the combustion. Three different cowl locations were considered. One was having a reflected cowl shock wave that impinges at upstream of a fuel injection orifice. The others were located at downstream and the middle of the orifice. Mixing and combustion characterizations were carried out using wall static pressure data, shadowgraph flow visualization images, as well as CH* chemiluminescence images. Numerical simulation was performed using a CFD code to analyze the cavity flow.