Paper ID: 16210
oral

SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

Author: Dr. Antonella Ingenito
University of Rome "La Sapienza", Italy, antonella.ingenito@uniroma1.it

3D LES OF THE HYSHOT COMBUSTOR USING OPENFOAM

Abstract

With the overall goal to clarify the physics of compressible (supersonic) combustion, a 3D LES of the HyShot supersonic combustor has been performed with the OPENFOAM code and is reported in this paper. HyShot is an (originally) Australian program to assess feasibility of supersonic combustion by means of a ballistic test flight. The HyShot combustion chamber is shaped as a box 75x9.8 mm in cross section and 300 mm long. Hydrogen is injected at 90 degrees with respect to the supersonic airstream 40 mm downstream from the combustor inlet by means of four 2 mm diameter choked orifices. Air enters the channel at a Mach number that, in the actual test, depended on the flight trajectory; in this simulation, the trajectory point is that at height = 28 km, where the Mach number was 2.79, P=82.11 kPa and T = 1229 K. Hydrogen-air combustion is treated by means of the Jachimowski chemical kinetics model. Numerical results indicate that hydrogen penetrates in the air stream generating 3D bow shock structures upstream of the injection orifices as seen in experiments. In these regions recirculation zones upstream and downstream of the fuel injection orifices are observed as expected; the OH predicted by LES indicates that a flame starts already in the upstream recirculation zone. Interactions among the essentially 1D airstream entering the combustor, the heat released and the 3D jets produce large vorticity rates and therefore enhance and accelerate turbulent mixing. Combustion is predicted very fast and efficient.