Paper ID: 73638
oral

IAF SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic Air-breathing and Combined Cycle Propulsion, and Hypersonic Vehicle (7)

Author: Mr. Naresh Relangi
Scuola di Ingegneria Aerospaziale "La Sapienza", Italy

Dr. Antonella Ingenito
Sapienza University of Rome, Italy
Prof. Jeyakumar S
India

LES INVESTIGATION OF A CAVITY-BASED AXSYMMERIC SCRAMJET

Abstract

Three dimensional LES of a H2/air cavity-based axisymmetric scramjet were performed. Different injection angles and positions were numerically investigatesd. Large Eddies Simulation showed to be a promising tool to investigate the fundamental physical phenomena involved in the flame/ turbulence/shock waves interaction. The present LES of a cavity-based axisymmetric scramjet showed that the interactions between the airstream entering the combustor and the H2 sonic jet produce a high turbulence intensity. The interaction between the hydrogen transverse jets, the supersonic air flow and the cavity angle leaded to the bow shock formation and, accordingly, a spanwise recirculation vortices created by the baroclinic effect. These vortices are the key structures responsible for the observed fast fuel air mixing.Simulations have shown that the cavity-based injection impacts the periodic shedding of lateral vortices and drastically boosts the mixing rate and the combustion efficiency. For the axisymmetric cavity-based scramjet, the thermal choking is observed when the fuel equivalence ratio is increased above 0.5. To avoid thermal choking, the effect of a divergent combustion chamber is also investigated and a minimum angle of divergence has been found. Computational results showed that 30 degrees upstream injection and 30-degree back wall injection into the cavity provides acceptable results in terms of temperature distribution throughout the cavity and also in the core flow regime. Greater combustion efficiency has also been found for these two cases. In this context, an analysis of the flame structure was conducted to propose a appropriate kinetic and chemical/turbulence model.