Performance Evaluation of Hypersonic Intake for Scramjet Engine

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Abstract

Hypersonic intake performance is governed by complex flow physics, shock-boundary layer interactions and flow separation phenomena, which strongly influence key performance parameters such as total pressure recovery, mass capture and overall propulsion efficiency. Accurate numerical simulation supported by experimental investigations are therefore essential for reliable analysis and optimization of the intake designs for scramjet operations. In the present study, a reference intake geometry reported by Idrish et al. is investigated using OpenFOAM v2506. The simulations are carried out using the density -based solver rhoCentralFoam, coupled with the SST $k - \omega$ turbulence model, to accurately capture shock structures and viscous effects. The Computational setup is designed to closely recreate the simulation and experimentally analysed intake configuration, while using the flexibility of OpenFOAM solver and discretization schemes options. The study also incorporates the analysis of the intake with off-design condition along with the comparative analysis of Ansys Mesh and the OpenFOAM - BlockMesh utility. The numerical results show good agreement with the reference data, with deviation of 12%, demonstrating the capability of the chosen solver-model framework for hypersonic intake flow prediction and performance assessment.

Keywords: BlockMesh, OpenFOAM, rhoCentralFoam, Boundary Layer .