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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

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RANS ANALYSIS OF THE TPS PROTUSIONS ON THE ESA IXV VEHICLE

Abstract

The ESA project IXV (Intermediate Experimental Vehicle) is being developed. In this framework ESA is coordinating a series of technical assistance activities aimed at verifying and supporting the IXV design and development process. As for all the ESA project this technical support is provided both by ESA TEC directorates and by National Organizations, with the supervision and coordination of the ESA IXV project. Namely, for IXV the Italian Space Agency (ASI) is operating this assistance activity by means of the technical support of the Italian Aerospace Research Center (CIRA). Among the topics object of the technical assistance activities carried out by CIRA this paper deals with the numerical simulations performed to evaluate the effects of the protusions of the thermal protection system (TPS) of the ESA IXV vehicle independently from the analysis addressed by the industrial team, and to be used by ESA for cross checking and verification purposes. A vehicle entering the Earth atmosphere being subject to high surface thermal fluxes requires a thermal protection system. This system is assembled on the body with some tollerances and steps and gaps between the different layers of TPS material can arise. The thermal fluxes need be carefully evaluated in these zones because local and distributed over-heating can occur. The solver used for the numerical simulations is the in-house developed code H3NS solving the Reynolds Averaged Navier Stokes (RANS) equations in a density-based finite volume approach. The air can be modelled as an ideal gas or in both thermo-chemical non equilibrium and equilibrium. Several turbulence models are available for turbulent computations with the transition that can be imposed across surface lines. A RNG - model with compressibility effects correction for high speed flows is employed in the simulations discussed in the paper. The solver makes use of structured multi-block meshes, and the computational grids have been generated by the commercial ANSYS sofware ICEM-CFD. The configurations discussed in the paper presents eight layers of steps and gaps on the windward side of the vehicle. Each layer starts with a step of finite thickness and ends with a step of zero thickness. The results presented in the full paper will focus mainly on the heat thermal fluxes and will be discussed with reference to the “clean” IXV configuration and to available experimental data.