MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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AEROTHERMODYNAMIC DESIGN OF SCIROCCO PLASMA WIND TUNNEL TESTS FOR IXV TPS INTERFACES

Abstract

In the frame of the ESA Intermediate eXperimental Vehicle (IXV) project, leaded by TAS-I (Thales Alenia Space-Italy) as prime contractor, CIRA is in charge of designing and executing qualification tests on different Thermal Protection System interfaces of the vehicle. The tests will be executed in the CIRA SCIROCCO Plasma Wind Tunnel. The study carried out during the phase C2/D of the IXV project, object of this work, has concerned with the definition of test article configurations and test conditions for two IXV adjacent TPS assemblies in real scale, characterized by the presence of different TPS materials, both ceramic and ablative ones. The tests will be aimed at reproducing the total heat load foreseen on the TPS junctions during the IXV re-entry trajectory, and possibly the maximum heat flux which the junctions will be submitted to. Test conditions have been preliminarily defined and verified by means of two dimensional simulations, performed with the CIRA CFD code. The possibility to include both the material interfaces in the same test article and reach both the heat flux requirements in a single test has been evaluated, this solution having the advantage to reproduce the flight configuration with the two interfaces assembled. In order to take into account the actual materials characteristics in the evaluation of wall heat flux, finite rate catalytic behaviour of materials has been considered for the definition of the test conditions. In particular, numerical models based on experimental results collected for the silica-based parts of the vehicle have been introduced in the CFD code. Results show that, by adopting the catalysis model based on experimental findings, both the IXV silica-based materials show a very low catalytic behavior. Therefore, this modeling could reduce the safety factor assumed in the design of the PWT tests, introducing the risk to submit the test article to extremely high heat fluxes in case of an actual material more catalytic than the modeled one. In addition, finite rate catalysis heat fluxes have been also computed with the kinetic model developed for silica surfaces.