Paper ID: 39569
oral
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Environmental Effects and Spacecraft Protection (6)

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NUMERICAL SIMULATIONS OF RADIATIVE HEAT EFFECTS AT A PLASMA WIND-TUNNEL FLOW UNDER MARS ENTRY CONDITIONS

Abstract

Mars, whose atmosphere consists mainly of CO_2, with a few percent of N_2 and other trace gases, is the aim of future space projects. Therefore the entry into its gaseous shell is of high research interest.

For this purpose, an arc jet driven plasma wind tunnel, which is a part of HELM (High Enthalpy Laboratory Munich), is available to simulate relevant entry conditions for the neighbor planet. The recently improvements and qualification of the test facility, enables the testing on earth of high enthalpy flows with CO2 rich composition.

In order to complement the experimental analysis, numerical simulations of the test facility running at relevant ambient pressures of some 600 - 1000 Pa, corresponding to low altitudes, are run.

The simulations are done with a density-based Navier Stokes solver called NSMB. The code copes with non-equilibrium chemical and thermal effects which are characteristic of these type of high enthalpy flows. Special interest is given to the radiative heat transfer mechanism. Under these high temperature conditions, radiative effects become more relevant and advanced radiation models have to be used. The coupling between the Navier Stokes and Radiative Transfer equations favors the understanding of plasma wind tunnel flows. NSMB estimates the radiative heat using the k-distribution spectral model, which is appropriate for non-homogeneous radiating media.

The numerical results and measurements are compared in order to improve the analysis methods for Mars entry flows.