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Author: Dr. Xiaoyan Li
CALT,CASC, China, 13911002471@163.com

AEROHEATING ANALYSIS OF RCS JET INTERACTION EFFECTS ON THE RLV

Abstract

The reaction control system (RCS) jets of the reusable launch vehicle (RLV) can have a significant impact on the magnitude and distribution of the surface heat flux in the interference region during reentry the atmosphere. For a reusable thermal protection system design requirement, it is urgent to construct the jet interference heating database accurately. In this paper, the heating enhancement is evaluated in terms of augmentation factor over the smooth surface heating both for RCS non-fired and fired conditions along the entire reentry trajectory. Firstly, Numerical computations governed by the Navier-Stoke equation are performed to obtain the RCS induced heat flux distribution at typical flight conditions for a simplified RLV windward side. Different grid scales are studied to achieve a convergent solution, which is based on a cold jet model. The heating magnitudes and distribution features are analyzed, which are correlated with the separation and reattachment flow field characteristics from the supersonic jet interaction with a high enthalpy base-flow field. And the heating enhancement and some important factors on peak heating amplification factor are correlated and discussed. Furthermore, the interaction flow field from a real gas inflow coupled with the hot multi-species jet is simulated to research the high temperature jet heating effects. Finally, for the purposes of thermal protection design, heating augmentation factor models coupled with the RCS work plan have been developed, which is used to construct the RCS heating database for regional TPS optimization.