

LOCAL HEAT TRANSFER SIMULATION OF AIR AND CO₂

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In order to develop reusable thermal protection for the next generation of space vehicles, the Institute of Problems in Mechanics (IPM) has developed a methodology that allows the determination of chemical surface properties. This method is based on Local Heat Transfer Simulation. It uses a combination of experimental and numerical results as input for detailed boundary layer simulation around a potential thermal protection material.

In this project, the Local Heat Transfer Simulation (LHTS) is applied to air and CO₂. First, a reliable procedure to extract the necessary data from the Navier-Stokes-Calculation has been implemented into the code. A database of solution for both air and CO₂ flow has been created and the influence of different operating conditions on the flow field has been studied.

A detailed sensitivity analysis has been undertaken for an air gas mixture. It compares the potential uncertainty coming from the numerical side of the methodology to the uncertainty coming from the experimental side.

It was found that the influence of uncertainty coming from the experiment dominates the overall uncertainty. Therefore special care should be taken in future in the accuracy of the experimental measurements. The uncertainty in terms of heat flux is not striking.

For CO₂ flow a closer look has been taken to the boundary layer calculation since CO₂ exhibits special chemical features. The influence of the outer elemental composition was studied. Furthermore, it was found that the assumption of equal catalycity for the two wall reactions taken into account is conservative but does not hold for all outer elemental fraction.

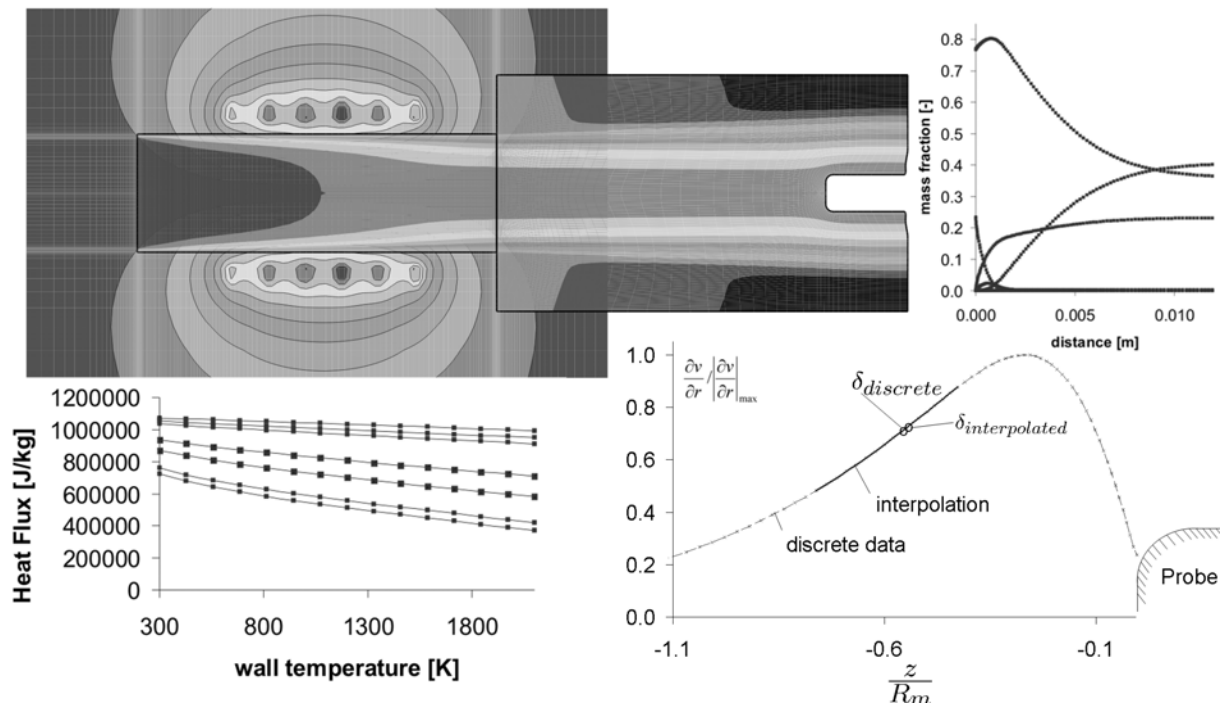


Figure 1: Computational domain for the simulation of the plasma flow (top left), distribution of air mixture species (top right), heat flux abacus example (below left) and velocity gradient at stagnation point (below right).