SIMULATION OF ENTRY IN THE TRUE MARTIAN ATMOSPHERE

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Up to now, the Martian atmosphere has been modeled by a pure carbon dioxide mixture. A more comprehensive approach employs the addition of argon and nitrogen compounds. The real composition of the mixture in the aerobreaking altitude is estimated to be the same as on the ground level.

The transport properties depend on collision integrals for every possible encounter of two particles. The integrals were computed from intermolecular potential and added to Mutation, a library that can be interfaced with a CFD code. To compute the collision integrals with a FORTRAN code, for the low temperatures the (m,6) potential was used while the Born-Mayer potential was reserved for the higher ones. Transport properties of Mutation with this more comprehensive mixture show marginally higher values.

The parameters of the potentials are taken from the literature. To that aim, an extensive literature survey was accomplished, in which the Tang-Toennies potential was found. This is a single, semi-empirical potential for the short and long range. The program for solving the collision integrals was rewritten in a general way to make it possible to use the Tang-Toennies potential. This is a novel approach. The use of the Tang-Toennies potential gives promising results for the whole temperature range.

Computations for the Pathfinder model were performed to check the influence of argon and nitrogen. For the design of a space vehicle an important quantity is the heat load. Non-catalytic and chemical equilibrium boundary conditions were applied at the wall. The heatflux and wall temperature were slightly higher, if argon and nitrogen were added (Fig.1).

In the Plasmatron heatflux experiments were carried out with pure carbon dioxide and with additional nitrogen and argon to simulate a more Martian-like gas. The heatflux measured shows small differences, but they are in the range of the errorbars (Fig. 2).

Overall the differences between pure carbon dioxide and the more Martian-like atmosphere are small. Compared to the uncertainties in boundary conditions and experimental parameters the addition of argon and nitrogen is not needed to get more accurate results.

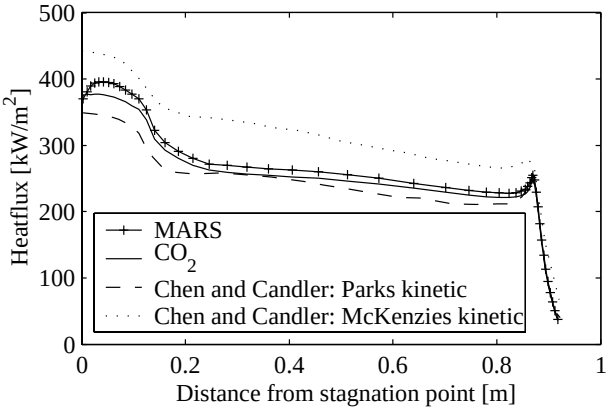

Figure 1: CFD for Pathfinder with non-catalytic wall

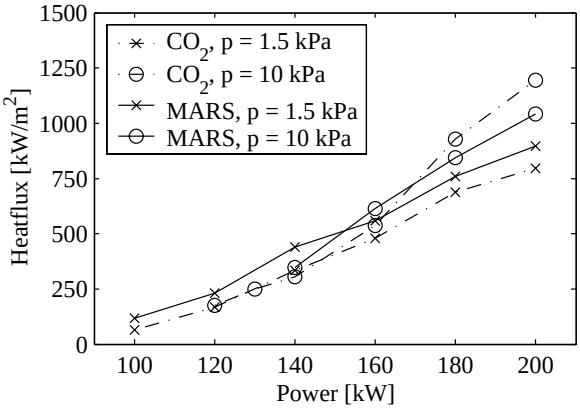

Figure 2: Plasmatron experiments