Thermal Modeling of a Honeycomb Reformer including Radiative Heat Transfer

J. Schöne[1], A. Körnig[1], W. Beckert[1] and A. Michaelis[1]
[1] Fraunhofer IKTS, Winterbergstraße 28, 01277 Dresden, Germany

Introduction: Catalytic reformers are common components in fuel cell systems, crucial for efficient preparation of fuel gases. Modeling has been proved as a valuable tool in the design and optimization process. Of major interest is the temperature distribution in the honeycomb. Due to temperatures between 300° C and 900° C radiation is an important heat transport mechanism and should be considered.

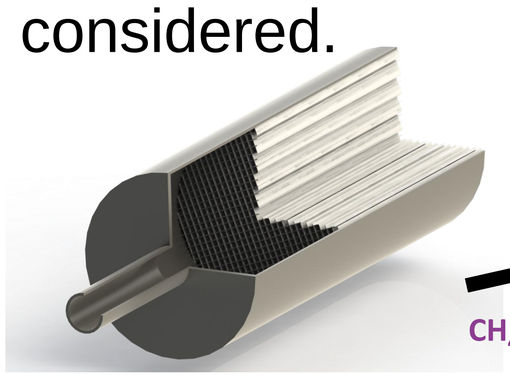

Figure 1. Reforming unit

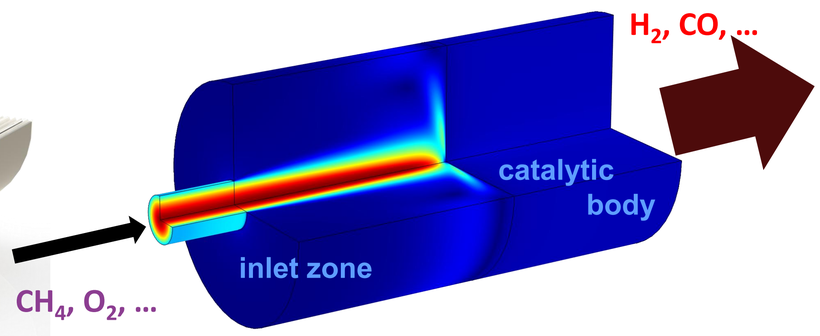

Figure 2. Velocity magnitude

Computational Methods:

- porous media approach for the honeycomb
- anisotropic properties for honeycomb
- 2D axis-symmetric geometry
- free (turbulent) flow and laminar flow zones
- simplified chemical reactions
- conv. + cond. + radiative heat transfer
- boundary coupling of the S2S to a radiation in participating media approach
- sub models for parameter estimation

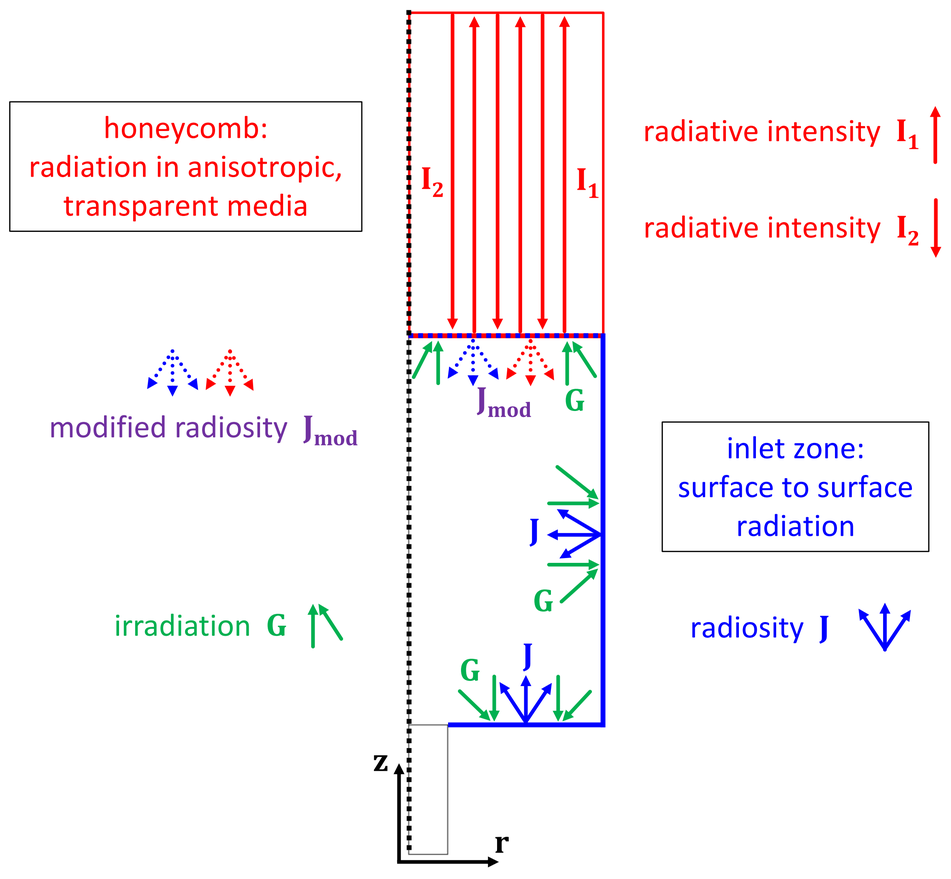

Figure 3. Interaction between Surface-to-Surface radiation in inlet zone and user defined radiation model in honeycomb

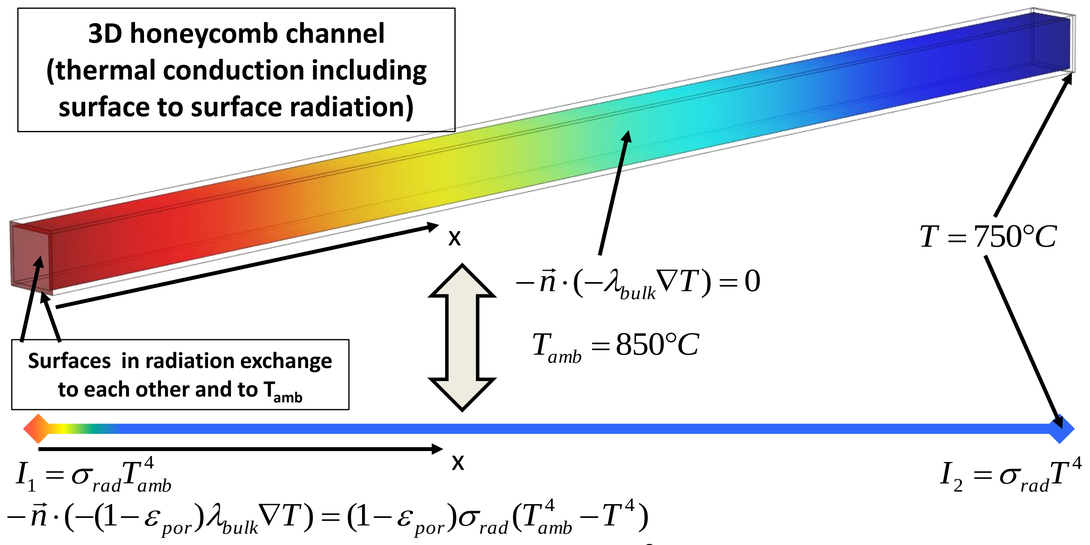

Figure 4. Detailed 3D channel model with conduction and Surface-to-Surface radiation (top) for parameter adaption of a 1D model with heat conduction and radiation in participating media (bottom).

Results:

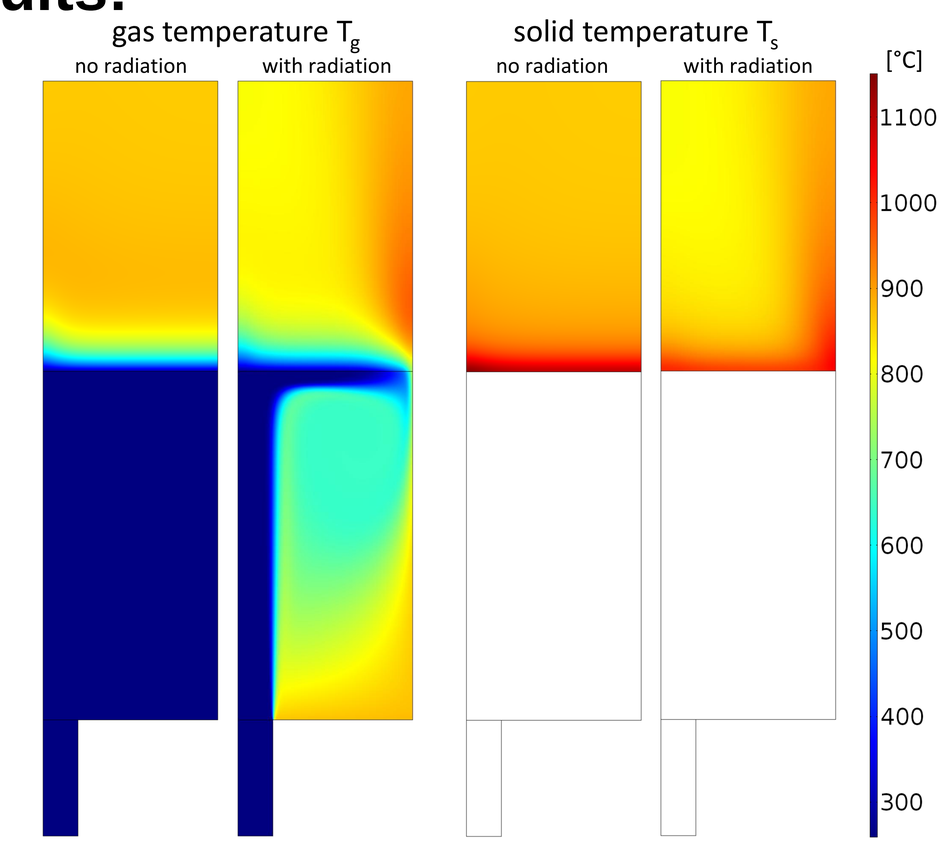

Figure 5. Contours of gas and solid temperature

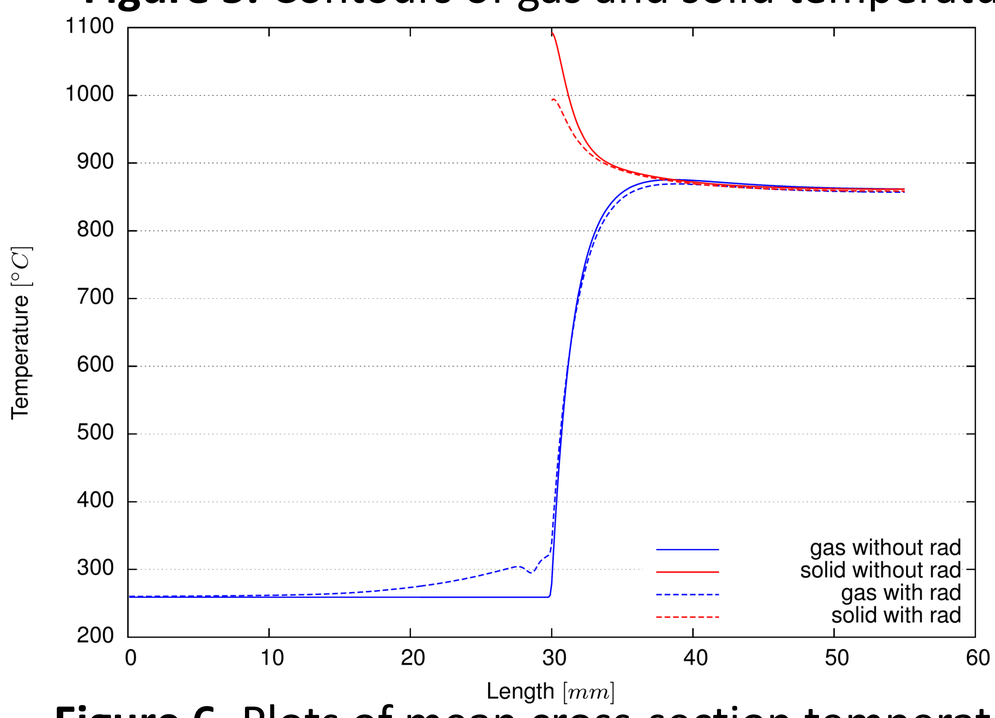

Figure 6. Plots of mean cross-section temperatures

Conclusions:

- S2S and radiation in participating media model coupling is feasible with COMSOL
- Radiation reduces maximal reformer temperatures significantly

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