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Direct pore-level simulation of ammonia combustion in multi-zone porous media burners

Rishabh Puri[1]*, Thorsten Zirwes[2], Oliver T. Stein[1]
*Lead presenter: rishabh.puri@kit.edu
[1] KIT-Karlsruhe Institute of Technology, Engler-Bunte-Institute, Simulation of Reacting Thermo-Fluid Systems, Karlsruhe, Germany
[2] University of Stuttgart, Institute for Reactive Flows, Stuttgart, Germany

Ammonia is a promising fuel for decarbonization of the energy infrastructure. However, NH_3 exhibits poor combustion characteristics [1]. Blending with reactive fuels like H_2 can improve the flame stability of NH_3 at the expense of higher NO_x emissions [2]. Another approach is porous media combustion (PMC), where the gaseous mixture is burned in a solid matrix [3]. Heat recirculation between the upstream fuel/air and the reaction zone can improve the flame stability of NH_3 flames and enable burner operation with lower NO_x emissions. In this work, a multi-zone porous media burner is considered. The porous zones are comprised of triply-periodic minimal surface (TPMS) gydroid and diamond structures. Comprehensive sub-models for conjugate heat transfer (CHT) and radiation are integrated in an in-house 3D solver. The effects of porosity, topology and material properties of the porous structures on flame stabilisation and pollutant emissions are investigated through direct pore-level simulations (DPLS). The inlet boundary conditions are set to obtain a flame that stabilises in the TPMS-diamond structures and NH_3/air is preheated in the gyroidal section. A snapshot of the flame inside the porous structure is shown in Fig. 1.

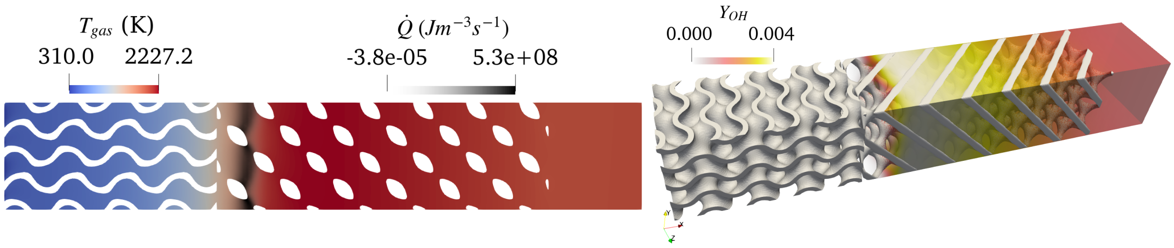

Figure 1: DPLS of ammonia/air combustion in a multi-zone porous burner. Lengthwise cut of the temperature distribution and the heat release rate in the gas phase (left), flame position visualised through the OH mass fraction (right).

References

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