Institut für Technische Verbrennung

RWTH AACHEN UNIVERSITY

Bachelor or Master thesis

Understanding Ammonia and Hydrogen Combustion: Analysis of NO_X Formation in Laminar Premixed Flames

The topic is suitable for

- ✓ Bachelor thesis
- ✓ Master thesis

Field of activity

Reacting flows physics
Numerical simulations
Flame instabilities
Pollutant formation

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Ammonia (NH_3) is a widely discussed carbon-free fuel candidate for industrial and heavy-duty applications due to its high hydrogen (H_2) content. While the combustion properties of pure NH_3 are characterized by low burning velocities and high ignition energies, they significantly improve when mixed with H_2. However, these fuel mixtures exhibit intrinsic flame instabilities driven by thermo-diffusive processes. For pure H_2, it is known that these instabilities can cause a tremendous increase in the global fuel consumption rate. Further, they lead to local temperature overshoots and increased nitrogen oxides (NO_X) production. However, the influence of these instabilities on NO_X formation in NH_3/H_2 blends, where mainly NO_X from the fuel-bound N-atoms instead of thermal NO_X becomes important, has yet to be evaluated. Understanding these phenomena can help to reduce emissions in future combustion systems.

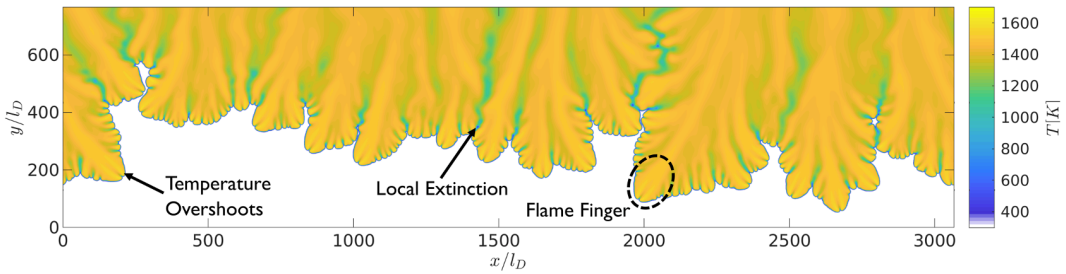

Figure 1. Characteristic cellular small- and large-scale structures of laminar thermos-diffusively unstable hydrogen flame. *Berger et al. Proc. Combust. Inst. 37, pp. 1879-1886, 2019.*

This study will investigate the NO_X formation pathways based on high-quality data from direct numerical simulations of laminar premixed NH_3/H_2 flames. More specifically, the differences in the formation and destruction processes between simplified one-dimensional configurations and more complex two-dimensional configurations with thermo-diffusively stable and unstable flames will be analyzed.

Your tasks

- ◊ Analysis of NO_X formation pathways based on one- and two-dimensional simulation data
- ◊ Analysis of the influence of thermo-diffusive mechanisms on NO_X formation in 2D ammonia/hydrogen flames

About you

This thesis might be suitable for you if you:

- ◊ Are interested in programming and numerical modeling
- ◊ Are curious about developing next-generation combustion systems
- ◊ Are willing to advance your knowledge and skills

This thesis does not quite fit your ideas? Feel free to contact me to customize this topic or to find an alternative thesis.