Technische Universität Braunschweig

IFAS Institut für Flugantriebe und Strömungsmaschinen

From High-Quality Meshes to Predictive CFD: Numerical Investigation of a Research Burner for Sustainable Fuels

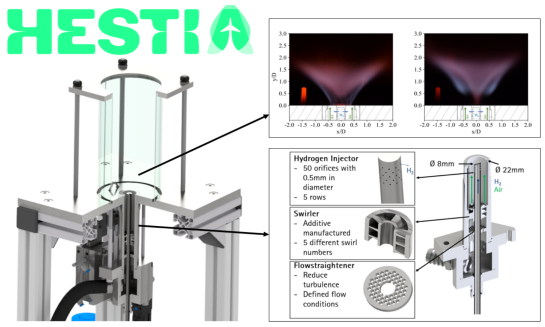
Studienarbeit/Master Thesis (Duration: 3/6 Months)

The transition toward climate-neutral energy and aviation requires combustion systems that can operate safely and efficiently with hydrogen, hydrogen carriers, renewable alcohols, and synthetic fuels. Because these fuels differ strongly from conventional hydrocarbons, their mixing behaviour, flame stability, thermal loads and emissions cannot be predicted from existing burner experience alone.

Computational fluid dynamics can accelerate the development of research burners for sustainable fuels by revealing flow structures that are difficult to access experimentally. Reliable predictions begin with mesh generation: the grid must resolve small fuel and air passages, shear layers, near-wall flow, recirculation and mixing while keeping the computational cost manageable. The resulting mesh then provides the foundation for robust, traceable simulations.

What you'll work on

Starting from the available burner fluid domain, you will develop a reproducible mesh-generation strategy using suitable OpenFOAM meshing tools. Mesh-independence studies will identify the best balance between numerical accuracy and computational cost. Building on this mesh, you will first set up non-reacting steady or transient simulations, select appropriate turbulence models and boundary conditions, and assess convergence. The validated model will then be extended to reacting flow for a selected sustainable fuel or fuel blend. The reacting-flow results will be evaluated in terms of flame structure, temperature distributions, stabilization behaviour and flame-stability indicators, including lift-off, flashback or blow-off tendencies, and compared with available experimental data.



Setup of the test bench with exemplary hydrogen flames

Burner geometry source: **Leibniz University Hannover - HESTIA single-burner test rig**

Requirements:

- Interest in fluid mechanics, CFD and sustainable combustion
- Interest in mesh generation, numerical methods and high-performance computing
- OpenFOAM/Linux, Python or ParaView experience is advantageous

This project contributes to the EFZN Lower Saxony Graduate School 'Hydrogen and the Hydrogen Derivative Ammonia'. At IFAS, you will work in an international research team and contribute to advanced CFD studies.

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Start: By arrangement