Numerical simulation of direct injection hydrogen engine

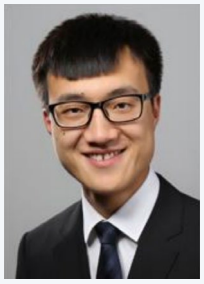
Topic is suitable for

- ✓ Master thesis
- ✓ Bachelor thesis

Field of activity

Turbulent reacting flows

Contact Person



Dr. -Ing. Hongchao Chu

Group Leader

Reacting Flow Applications

h.chu@itv.rwth-aachen.de

Room 208.2
Templergraben 64
52056 Aachen

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Hydrogen, which is carbon-free, flexible, and can be produced using renewable energy, is a promising energy carrier of future energy systems. The use of hydrogen as a fuel in thermochemical energy conversion processes is particularly crucial for reducing greenhouse gas emissions in hard-to-decarbonize sectors, such as heavy industry (steel manufacturing, chemical production, etc.), and long-distance transport. However, challenges arise from the specific molecular transport and combustion properties of hydrogen, which differ significantly from conventional fuels. For lean hydrogen flames, the combustion process is prone to thermodiffusive instabilities that significantly affect flame dynamics, heat release rates, NO_x formation, and safety. Predictive simulations of hydrogen combustion in practical devices are essential for designing and optimizing modern combustion devices and thus for the decarbonization of combustion processes.

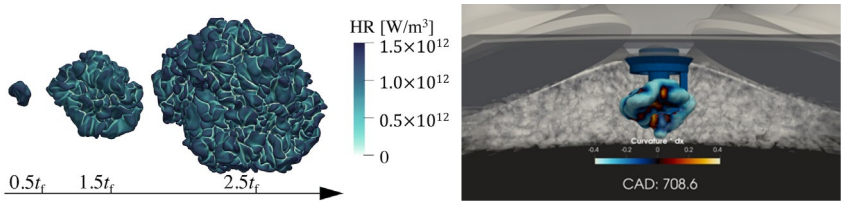

Figure 1. DNS of hydrogen flame kernel (left) and LES of engine combustion (right).

In this project a new G-equation model for the simulation of hydrogen engines with direct injection will be developed. The model development will be based on existing DNS data of hydrogen flames and will be performed in the commercial software CONVERGE by user-defined functions. This study is part of a BMBF project, a collaboration between industry and universities, which includes numerical and experimental investigations.

Tasks:

- Getting familiarized with the topic and simulation software
- Carrying out RANS/LES without and with combustion
- Development of the new G-equation model for hydrogen combustion
- Sensitivity analysis and validation of the simulations with measurement data

Our Offer:

- Close supervision with integration into the research group
- A relevant, state-of-the-art research topic that can be adjusted to your interests

Requirements:

- Enthusiasm about programming and numerical modeling
- Interest in fluid dynamics and thermodynamics