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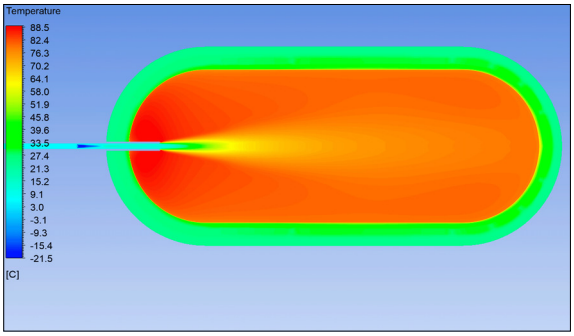
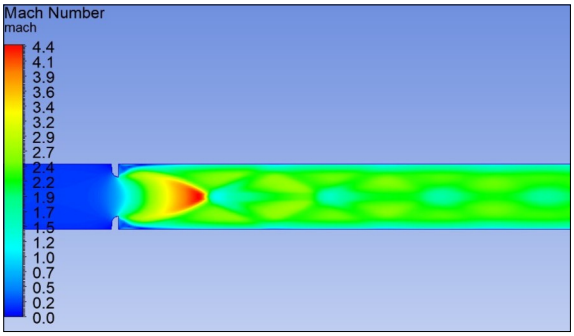
Subject Area	Thermo- and fluiddynamics
Project Partner	H2Energy, Zürich, ZH

A Parametrical Model for Hydrogen Filling Processes



The CFD Model shows the temperature distribution inside a tank and its walls during a filling process with hydrogen.
Own presentment

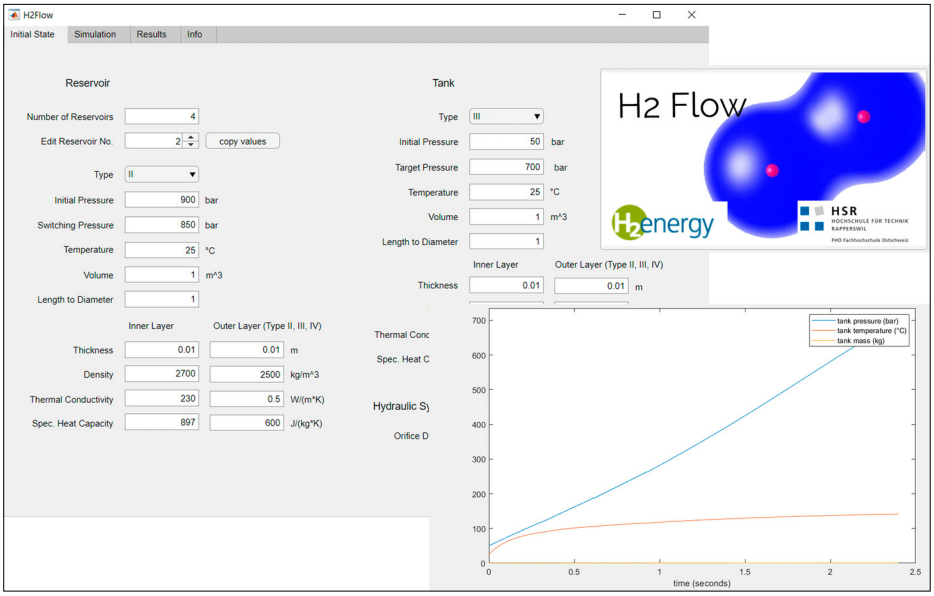


Flow velocity analysis of overcritical hydrogen tube flow through an orifice. Note Mach 1 at the smallest diameter.
Own presentment

Introduction: Hydrogen is widely considered as a feasible future energy carrier to replace fossil fuels in mobile and stationary applications. In the transition from a fossil to a renewable energy economy, hydrogen can be used to store excess energy production from renewable energy sources like solar and wind power. The Zurich-based industry partner of this thesis, H2 Energy, focusses on promoting hydrogen as a supporting pillar to the efforts of stopping climate change.
One of the challenges for the use of hydrogen as fuel is its storage and suitable tank filling technologies.

Approach: The main objective of this thesis is to offer a parametrical numerical simulation to enable a quick analysis of thermodynamic properties of hydrogen during filling processes.
In a first step, all the aspects of the fueling system, including temperature and pressure changes, heat flux over the tank walls, pre-cooling of the gas, flow speed and more, are modelled mathematically. Real gas equations for hydrogen are applied for all thermodynamic state calculations using the RefProp library. Based on these models, Microsoft Excel is used for rapid prototyping of model subsystems. The final implementation is realized in Matlab.
In parallel, a CFD model of the system is implemented in Ansys to enable plausibility checks of the Matlab simulation. Further validations are provided by comparison to literature values.

Result: A standalone application for Windows and MacOS named “H2Flow” has been programmed. It offers a user-friendly interface for parametrization and evaluation of results. The flexible parametrization options allow quick analysis of a broad variety of hydrogen fueling applications. The validations have shown good accordance with the CFD model and the literature values in all major aspects.



The 0D numerical simulation offers a graphical user interface for rich parametrization options and graphical results analysis.
Own presentment