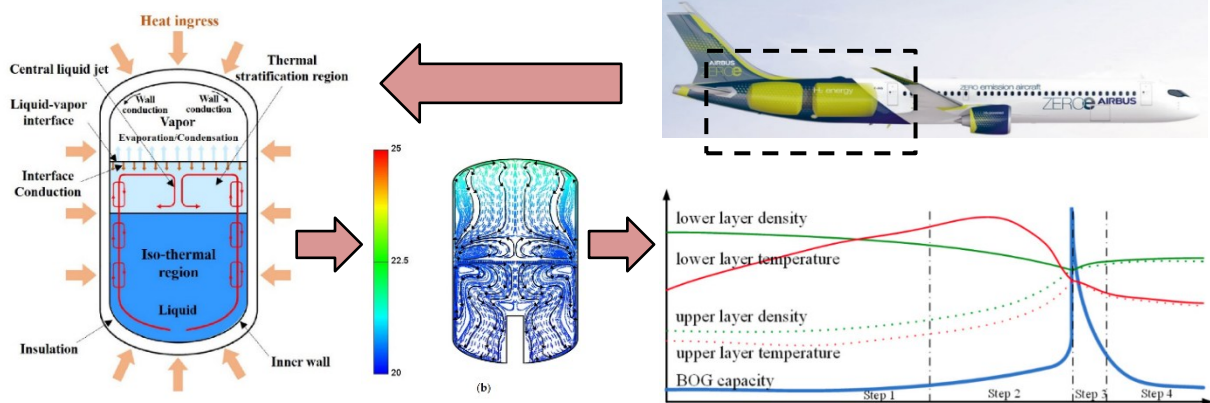


Bachelor's/Master's Thesis

Computational Fluid Dynamics (CFD) of Thermal Stratification and the Rollover Phenomenon in Cryogenic LH₂ Aircraft Tanks

Motivation

Achieving climate goals requires a drastic reduction in greenhouse gas emissions, including in the aviation sector. Liquid hydrogen (LH₂) offers a way to make flying emission-free and to replace fossil fuels. However, the safe storage of LH₂ at cryogenic temperatures (≈ 20 K, ≤ 3 bar) has a challenge: Unavoidable heat transfer from the environment through the tank insulation leads to thermal stratification of the liquid. If the density difference between the layers exceeds a critical value, a rapid mixing process (rollover) occurs, causing a high pressure increase due to boil-off losses and an excessive loss of hydrogen, which can potentially lead to tank failure.



Objective

The development of a realistic simulation model to provide a basis for the development of a innovative cryogenic tank system for aircraft applications. Such a model allows the optimization of operational strategies and system design across all phases of flight and serves as input for further comprehensive system-level simulations. The choice of CFD software used for this purpose is flexible and may include, for example, OpenFOAM, ANSYS Fluent, STAR-CCM+, or comparable software.

Tasks

- Research and study of thermal stratification and the rollover phenomenon in cryogenic LH₂ tanks
- Quantification of H₂ storage losses and dynamic rollover behavior in relevant operating phases (filling, standing time, phases of flight, discharge, fill level, etc.)
- Scaling possibilities through the use of non-dimensional flow parameters
- Plausibility check, validation, and documentation of the results

Requirements

- Interest in hydrogen technologies and in working on innovative technologies
- Knowledge of thermodynamics, fluid mechanics, and heat transfer
- Ideally, first experience in computational fluid dynamics (any software is acceptable)



German
Version



Student works
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Start: Now/by agreement

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