



Call for Applications – Thesis or Project

Simulation of Local Effects in Fuel Cells under Aviation-Relevant Operating Conditions

Motivation and Objectives:

Achieving climate goals requires a significant reduction in CO₂ emissions, including in the mobility sector. In aviation, hydrogen-powered fuel cells represent a promising technology for enabling emission-free flight and a sustainable alternative to fossil fuels. Flight operations pose a unique challenge for fuel cell systems, as they operate at high altitudes—and thus at low ambient pressures.

This alters the conditions within the fuel cell. Low pressures result in lower open-circuit voltage and increased activation and diffusion losses. Pressure-dependent changes in the dew point, which affects the water balance and, consequently, the ohmic resistance within a PEM fuel cell. Lower operating pressures also alter flow velocities along the cell, influencing transport processes. Cell behavior at flight-relevant operating pressures below one bar has not yet been sufficiently investigated.

The project involves extending an existing open-access 1D model (implemented in MATLAB)—which currently maps processes across the cell cross-section but not along the cell length—into a 2D model capable of representing processes along the cell as well. The model's results can be verified by comparing them with the institute's own measurements of fuel cells operating under low-pressure conditions. Subsequently, parameter variations will be performed using the model to analyze the influence of operating pressure (between 200 mbar and 1 bar), humidity, stoichiometry, and mass flow, with the aim of identifying optimal operating conditions for low-pressure operation.

Tasks:

- Familiarization with fuel cell modeling
- Model expansion
- Comparison with experimental measurements (under vacuum conditions) and theory
- Parameter variation to analyze the influence of pressure, humidity, stoichiometry, and mass flow
- Analysis of the effects of individual operating parameters on fuel cell performance
- Documentation

Requirements:

- Interest in fuel cells
- Proficiency in MATLAB
- Ability to work independently

Start date: To be agreed upon

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