Process Simulation and Integration of PEM Fuel Cell Systems for Maritime Application

Master Project (30 ECTS)/Semester Project (10 ECTS)

Administrative

Supervision: Riddhi Chakraborty, Prof. J. Van Herle
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Location: Sion or remotely (travel allowance offered)
Remarks: If interested, please send your CV, with a short motivation letter, to Riddhi.
The scope and depth of the tasks may be adapted depending on whether the work is carried out as a master's or semester project.

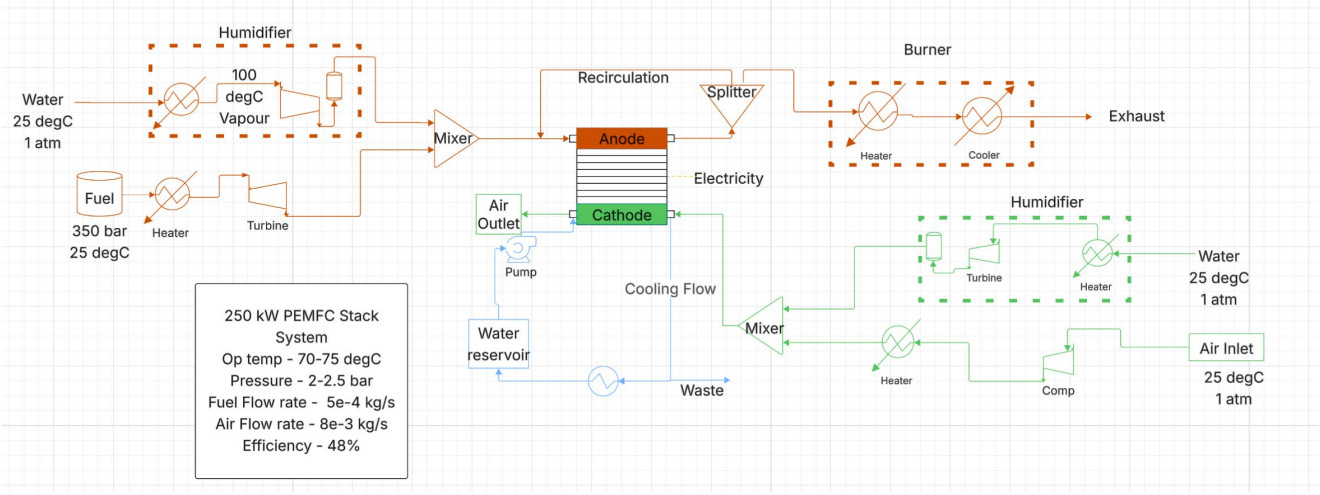
Project description:

The increasing need for sustainable power sources in the marine sector has led to growing interest in Proton Exchange Membrane Fuel Cells (PEMFCs) as an alternative to traditional combustion engines. The long-term goal of this research is to develop a 250 kW PEMFC stack module that can be scaled up to multi-megawatt (up to 10 MW) systems through a modular architecture — pushing the current state of the art in marine fuel cell technologies. This project focuses on modeling, analyzing, and optimizing PEMFC performance to support future marine integration.

This student project focuses on **system-level modeling** of a Proton Exchange Membrane Fuel Cell (PEMFC) system for marine applications. The work can be carried out in **two directions**, depending on the student's interest and background:

- **Aspen Plus:** for **steady-state process simulation and system integration**.
- **Modelica:** for **dynamic modeling and transient system analysis**.

The overall goal is to design and simulate a complete PEMFC-based marine power system, integrating key components such as compressors, humidifiers, heat exchangers, and cooling loops. Different system configurations will be investigated to evaluate their performance, efficiency, and scalability for maritime applications.



Your tasks:

For Aspen Plus (Steady-State Simulation):

- Understand the fundamental operation of PEMFC systems and learn to use Aspen Plus for process modeling.
- Develop process flow simulations and integrate the PEMFC stack with balance-of-plant components (compressor, humidifier, heat exchanger, etc.).
- Collect technical and economic data from state-of-the-art research for system design and performance evaluation.
- Prepare a techno-economic report comparing alternative system configurations in terms of efficiency, cost, and scalability.

For Modelica (Dynamic Simulation):

- Learn to use OpenModelica for dynamic system modeling of PEMFC-based power systems.
- Create 1D dynamic models for key components such as the PEMFC stack, air compressor, burner, and heat exchanger, and couple them to form a dynamic model of the complete system.
- Assess system behavior under load variations, start-up, and shutdown conditions relevant to marine operations.
- Perform a sensitivity analysis by varying key parameters to evaluate their impact on efficiency, stability, and safety.

Skill: Knowledge of Coding is required for Modelica