Process Simulation and Dynamic Modelling of AEM Water Electrolyzer Systems

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

Administrative

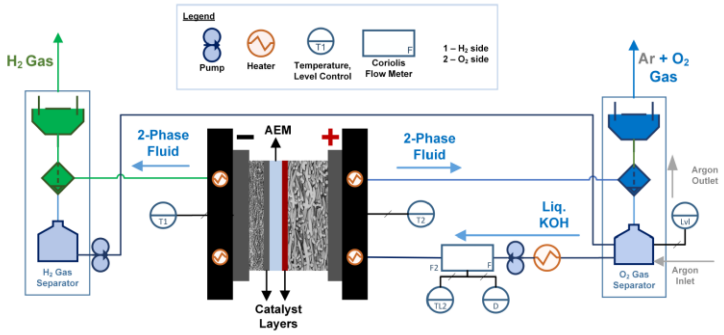
Supervision: Simon Dorthe, Prof. J. Van Herle
Contact: simon.dorthe@epfl.ch
Location: Sion or remotely (travel allowance offered)
Remarks: If interested, please send your CV, with a short motivation letter, to Simon.
The scope and depth of the tasks may be adapted depending on whether the work is carried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

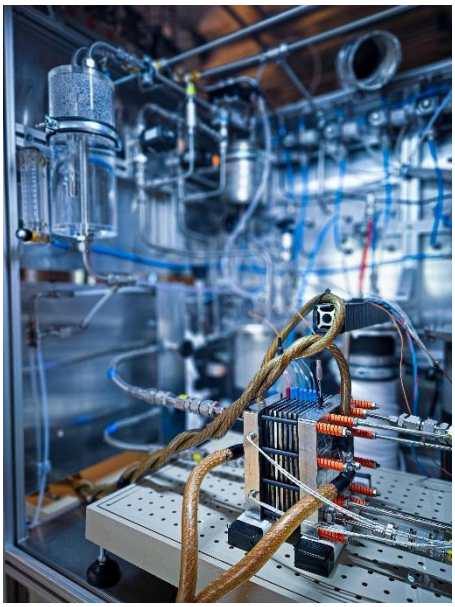
Project description:

This student project focuses on system-level modelling of Anion Exchange Membrane (AEM) water electrolyzer systems for green hydrogen production. As for our PEM fuel cell maritime project, the work can be carried out in two complementary directions, depending on the student's interest and background:

- **Aspen Plus or Simulink** for steady-state process simulation and system integration
- **Modelica or Simulink** for dynamic modelling and transient system analysis

The overall goal is to design and simulate a complete AEM-based hydrogen production system, integrating key components such as the electrolyzer stack, water treatment, gas–liquid separation, compression, heat exchangers, and cooling loops. Different system configurations will be investigated to evaluate their performance, efficiency, and scalability for various applications (e.g. grid-connected or renewable-powered systems).





Your tasks:

For Aspen Plus/Simulink (Steady-State Simulation)

- Understand the fundamental operation of AEM water electrolysis systems and learn to use Aspen Plus for process modelling.

- Develop process flow simulations and integrate the AEM stack with balance-of-plant components (water treatment, separator, compressor, heat exchanger, etc.).
- Collect technical and economic data from state-of-the-art research for system design and performance evaluation.
- Analyse and compare alternative system configurations in terms of efficiency, energy consumption, heat integration and hydrogen production cost.
- Prepare a concise techno-economic report summarizing assumptions, models, and key results.

For Modelica/Simulink (Dynamic Simulation)

- Learn to use OpenModelica (or similar) for dynamic system modelling of AEM-based hydrogen production systems.
- Create 1D dynamic models for key components such as the AEM stack, power supply, hydrogen buffer/compressor, cooling loop and heat exchanger, and couple them into a full system model.
- Assess system behaviour under realistic operating scenarios: start-up, shutdown, load ramps, and coupling to intermittent renewable power.
- Perform sensitivity analyses by varying key parameters (temperature, pressure, current density, control settings) to evaluate their impact on efficiency, stability, and safety.
- Propose control and operating strategies to improve dynamic performance and component lifetime.

Skills

- For Aspen Plus: background in thermodynamics / chemical or energy engineering is an asset.
- For Modelica/Simulink: coding skills are required (e.g. experience with MATLAB, Python or similar and interest in equation-based modelling).