Modeling, Optimization, and Control of PEM electrolysis systems

Marius Fredriksen

Norwegian University of Science and Technology (NTNU)

Related projects: FME HYDROGENi

Ph.D. candidate in the Process Systems Engineering group at the Department of Chemical Engineering, NTNU. Master's degree in chemical engineering from NTNU.

Introduction:

The successful transition to a hydrogen-based energy economy relies on the development of efficient and sustainable hydrogen production methods. Proton Exchange Membrane (PEM) water electrolysis is a promising technology due to its high energy efficiency and operational flexibility [1]. However, the intermittent nature of renewable energy sources, such as wind and solar, makes proper control essential to optimize stack performance and lifespan [1].

Primary Objective:

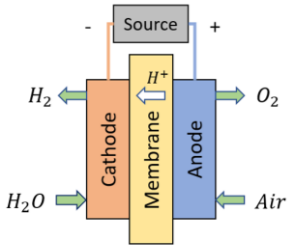
- Develop control strategies for PEM electrolysis systems

Secondary Objectives:

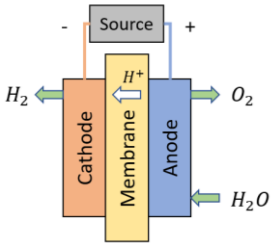
- Develop dynamic models for PEM systems
- Study optimal operating conditions

Current activities:

- Modelling the electrolyzer stack and Balance of Plant units, such as heat exchangers, separators, and pipes, for both conventional and Hystar PEM system layouts.
- Implementing Advanced Regulatory Control (ARC) techniques, such as active constraint control and constraint switching.
- Evaluating the feasibility of Model Predictive Control (MPC) as an alternative to the ARC-based strategies.



Hystar layout [2]



Conventional layout [1]

Estimated progress of the PhD project:

Just started ...	< 50 %	> 50 %	Almost done ☺

References:

[1] Majumdar, A., Haas, M., Elliot, I., & Nazari, S. (2023). Control and control-oriented modeling of PEM water electrolyzers: A review. International Journal of Hydrogen Energy.

[2] https://hystar.com/patented-technology/

Norwegian Research School on Hydrogen and Hydrogen-Based Fuels

Department of Chemical Engineering
Norwegian University of Science and Technology