Two-Phase Flow Simulation for AEMWE

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

Administrative

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Project description:

Anion exchange membrane water electrolyzers (AEMWE) are considered an emerging and promising technology for hydrogen production. Contrary to currently used proton exchange membrane water electrolyzers (PEMWE), which use rare and expensive materials such as Ir and Pt, AEMWE use cheaper non-noble catalyst materials such as Ni and Fe-based catalysts.

The student project will be part of the HyPrAEM European project which is one of the Horizon Europe initiative projects [1]. One of the goals of the HyPrAEM project is to build a 100-kW 100 bar AEMWE demonstrator stack and build an equivalent multi-physics model for it. To validate the virtual model, the output generated needs to match the experimental results taken from the real stack. Once validated, the virtual model will be run for different operating parameters to train a math-based surrogate model, which will serve to construct a digital twin for the real AEMWE system, for real-time control, testing, monitoring and maintenance.

The AEMWE cell voltage can be written as $E_{cell} = E_{OCV} + \eta_{ohm} + \eta_{act} + \eta_{mt}$

where E_{OCV} is the open-circuit voltage, η_{ohm} is the ohmic overpotential, η_{act} is the activation overpotential and η_{mt} is the mass transport overpotential. The current model does not consider the concentration overpotentials (part of mass transport) and some of the water flows in the AEMWE are not considered. These concentration overpotentials and the water flows do not only affect the cell voltage and the polarization curve (figure 1), but they also affect the heat transfer in the cell as well as the results observed from the electrochemical impedance spectroscopy (EIS). Therefore, the student's role is to add the concentration overpotentials and all the water flows to the current model.

Your tasks:

1) Simulate water flows in the AEMWE
2) Simulate concentration losses in the AEMWE
3) Improve current EIS model

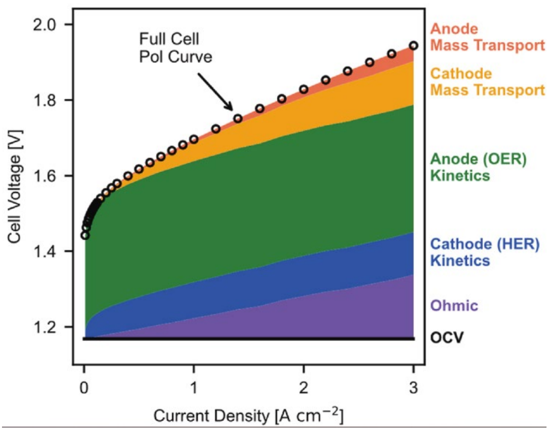

Figure 1: AEMWE cell voltage breakdown [2]

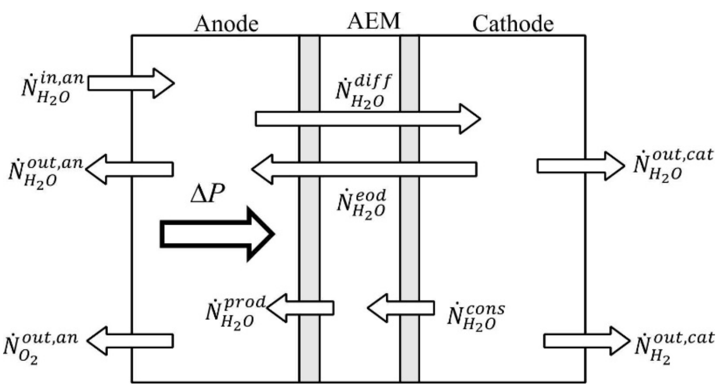

Figure 2: AEMWE water flows [3]

References

[1] cordis.europa.eu CORDIS, “High-pressure anion exchange membrane electrolyzers for large-scale applications,” *CORDIS | European Commission*, Dec. 20, 2024. https://cordis.europa.eu/project/id/101192442 (accessed Jun. 20, 2025).

[2] A. W. Tricker, J. K. Lee, J. R. Shin, N. Danilovic, A. Z. Weber, and X. Peng, “Design and operating principles for high-performing anion exchange membrane water electrolyzers,” *Journal of Power Sources*, vol. 567, p. 232967, May 2023, doi: https://doi.org/10.1016/j.jpowsour.2023.232967.

[3] A. G. Vidales, N. C. Millan, and C. Bock, “Modeling of Anion Exchange Membrane Water Electrolyzers: The Influence of Operating Parameters,” *Chemical Engineering Research and Design*, May 2023, doi: https://doi.org/10.1016/j.cherd.2023.05.004