Unravelling anion exchange membrane electrolysis cells through a multiscale approach

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Anion exchange membrane electrolysis cells are emerging as a promising solution for the green energy transition, coupling the main benefits of other low-temperature cells: Ni-based electrocatalysts, membranes as separators, low-concentration alkaline electrolytes, quite high applicable currents and fast system response. Showing currently a low technological readiness level, an engineering optimization of used materials and cell design, as well as detailed studies on electrochemical kinetics and operation management, are key points to promote the application of these electrolysers.

A multiscale modelling approach permits facing these issues by combining a plant-level analysis with a phenomenological local description (Figure 1). Moreover, the synergy between academic and industrial worlds leads to the validation and the optimization of developed models by considering cell current performance and market requirements.

Starting from a microscale level, modelling allows for evaluating the chemical-physical properties of each layer in terms of used materials and their microstructure, followed by reaction kinetics and species material transport understanding. Moving to the full cell study at the mesoscale level, the electrochemical operation is predicted at variable working conditions, plotting the characteristic curves and distinguishing the polarization losses. Finally, the macroscale simulation of the overall plant can provide a preliminary sizing of different unit operations to estimate attended electric consumption, heat exchanges and system net efficiency.

Figure 1: A multiscale approach to study AEMEC technology.

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