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Investigation of water transport in anion-exchange membrane electrolyzers via neutron imaging

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In anion-exchange membrane (AEM) electrolysis, the hydrophilic nature of hydrocarbon ionomers and membranes poses a major challenge. Although reinforcements and modified polymer chemistry have improved stability, the operation mode and water management within the membrane-electrode-assembly (MEA) still strongly influence durability and performance.

Dry cathode operation in AEM water electrolysis, where only the anode side is supplied with liquid electrolyte (KOH), minimizes the contamination of the generated hydrogen. However, this introduces unique challenges for non-fluorinated anion-exchange polymers, whose conductivity and mechanical properties are strongly influenced by water content. High-
resolution in situ neutron imaging (~6 µm effective resolution) was utilized to show that varying the anion-exchange capacity of the cathode binder ionomer can help retain membrane humidification, which improves efficiency, by lowering the overpotential and decreasing the high-frequency resistance(1).

Secondly, electrochemical reduction of CO_2 is a crucial technology for the defossilization of the chemical industry, but salt precipitation and water management remain major challenges. High-resolution neutron imaging of a zero-gap CO_2 electrolyzer operating at $200\,mA\,cm^{-2}$ and $2.8\,V$ reveals salt precipitation penetrating the cathode gas diffusion layer, which blocks CO_2 gas transport and causes the commonly observed decay in Faraday efficiency. Salt accumulation is observed to be higher under the cathode channel of the flow field than the land. The findings suggest that resolving the water management and salt precipitation issues is crucial for advancing the commercialization of CO_2 electrolysis technology(2).

References
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