Transport Mechanisms of Ions and Water in Ion Exchange Membranes during Alkaline Electrolysis

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Ion exchange membranes (IEMs) are key components in energy conversion and storage technologies such as electrolyzers and fuel cells. Primarily, IEMs act as both product separators and electrolytes, enabling a minimal distance between the cathode and anode to reduce ohmic losses. In alkaline media, cation exchange membranes (CEMs) predominantly transport alkali cations and water from the circulating electrolyte (catholyte and anolyte). In contrast, anion exchange membranes (AEMs) allow the transport of both alkali cations and hydroxide ions, along with water, resulting in a more complex ionic conduction pathway. Herein, we present the performance of alkaline water electrolyzers constructed with either AEMs or CEMs, and investigate the impact of ionic and water transport on long-term electrolysis. In this study, Nafion® 212 is employed as the CEM, while Fumasep FAA-50, Sustainion X37-FA, and PiperIon® Gen 2 are used as AEMs. A 1 M KOH solution is used as electrolyte in both the cathode and anode flow fields. The cathode and anode are composed of Pt/Ti and Ni/Ti, respectively. The results are discussed in terms of water crossover, potassium ion transport, and overall electrolyzer performance, providing insights into the actual capacity of each membrane configuration to sustain efficient and stable operation under alkaline conditions.

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