

# Water Transport in Anion and Proton Exchange Membranes\*

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## Abstract

Water balance in anion exchange membrane fuel cells (AEMFCs) is crucial because water not only is produced in the anode but also functions as a reactant in the cathode. Therefore, accurate measurement of AEM water transport properties is important for AEM design to improve AEMFCs performance and durability. Very few studies report water transport properties of AEMs; even in those limited studies, interfacial transport rates were either not considered in data analysis or not given as a function of water activity. In this work, the liquid-vapor permeation method was used to determine the water flux across the Aemion<sup>®</sup> AH1-HNN8-50-X, Fumapem<sup>®</sup> FAA-3-30/50, and Versogen<sup>™</sup> PiperION-A40. Using three numerical models, the results were analyzed to understand whether diffusion or interfacial transport resistances were limiting, and the values were estimated. Our results indicate that interfacial transport is limiting; therefore, the interfacial exchange rate and its activation energy were determined. Water desorption rate of AH1-HNN8-50-X is similar to Nafion<sup>®</sup> N115 and N117 ( $10^{-5}$ – $10^{-4}$  cm/s), and the activation energy for this process is also similar at 53.4 kJ/mol. On the other hand, FAA-3-30/50 and PiperION-A40 exhibit two to three times faster desorption and a lower activation energy: 46.0, 41.8, and 46.8 kJ/mol, respectively.

**Keywords:** anion exchange membrane, proton exchange membrane, interfacial transport rate, desorption, activation energy

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## 1. Introduction

Hydrogen anion exchange membrane water electrolyzers (AEMWEs) and fuel cells (AEMFCs) are promising technologies to achieve a net zero-emission energy system [1, 2]. However, water management in these devices is critical for achieving high performance. To reduce ohmic resistance, the anion exchange membrane and the ionomer phase in the catalyst layers must be hydrated [1, 3]. Therefore, in AEMFCs, humidified hydrogen and oxygen (or air) are provided to the anode and cathode, respectively. Cathode dehydration might occur because water within the humidified reactant supplied to the cathode not only is consumed in the oxygen reduction reaction but also is transported to the anode through the electro-osmotic drag. In the meantime, anode flooding might occur because water is produced as a by-product of the hydrogen oxidation reaction and electro-osmotic drag moves water from

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# Anion And Proton Transport

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