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Water transport through short side chain perfluorosulfonic acid ionomer membranes

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Abstract

Liquid and water vapour transport through short side chain (SSC) perfluorosulfonic acid (PFSA) ionomer membranes are measured as a function of membrane thickness (24- 96 μm) and temperature (25- 85 °C). Three types of water permeation techniques are used in this work and are based on applied chemical potential gradients across a membrane. These are: liquid-liquid permeation (LLP) in which both sides of membrane are in contact with liquid water; liquid-vapor permeation (LVP) where one side of the membrane is exposed to liquid and the other is exposed to vapor; and vapor-vapor permeation (VVP) where both sides of the membrane are exposed to water vapor. Within the SSC series, the increase in permeance for VVP upon decreasing membrane thickness is not as significant as compared to LLP due to the larger interfacial water transport resistance ($R_{interfacial}$) observed for membranes exposed to vapor. The study of LVP and VVP transport resistances indicates that $R_{interfacial}$ plays dominate role in determining the overall membrane resistance, even for a thick SSC membrane. It is speculated that $R_{interfacial}$ is the result of water depletion layer caused by membrane dehydration at the membrane interface. The LVP interfacial resistance for SSC membranes is similar to that found for long side chain PFSA ionomer membranes such as, Nafion®, even though SSC membranes possess significant lower internal LVP permeation resistance. Water permeance determined by LLP, LVP and VVP measurements are all found to increase with temperature, due to the increased water volume fraction (Xv) and an increase in the