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Functionalized Nano porous Ceramic Membranes for Electrodialysis Treatment of Harsh Wastewater

Authors : Emily Rabe, Stephanie Candelaria, Rachel Malone, Olivia Lenz, Greg Newbloom

Abstract : Electrodialysis (ED) is a well-developed technology for ion removal in a variety of applications. However, many industries generate harsh wastewater streams that are incompatible with traditional ion exchange membranes. Membrion® has developed novel ceramic-based ion exchange membranes (IEMs) offering several advantages over traditional polymer membranes: high performance in low pH, chemical resistance to oxidizers, and a rigid structure that minimizes swelling. These membranes are synthesized with our patented silane-based sol-gel techniques. The pore size, shape, and network structure are engineered through a molecular self-assembly process where thermodynamic driving forces are used to direct where and how pores form. Either cationic or anionic groups can be added within the membrane nanopore structure to create cation- and anion-exchange membranes. The ceramic IEMs are produced on a roll-to-roll manufacturing line with low-temperature processing. Membrane performance testing is conducted using in-house permselectivity, area-specific resistance, and ED stack testing setups. Ceramic-based IEMs show comparable performance to traditional IEMs and offer some unique advantages. Long exposure to highly acidic solutions has a negligible impact on ED performance. Additionally, we have observed stable performance in the presence of strong oxidizing agents such as hydrogen peroxide. This stability is expected, as the ceramic backbone of these materials is already in a fully oxidized state. This data suggests ceramic membranes, made using sol-gel chemistry, could be an ideal solution for acidic and/or oxidizing wastewater streams from processes such as semiconductor manufacturing and mining.

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