Selective lithium extraction from brines using MOF-based membrane capacitive deionization

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Abstract:

The increasing demand for lithium appeals to explore efficient and environmental-friendly methods to extract lithium from multi-ion brines. Capacitive deionization (CDI) as an emerging technology is of interest in lithium extraction because of its rapid adsorption rate, low cost, low environmental impact, and high energy efficiency, yet lithium selectivity is one of the challenges. Herein, CDI is integrated with ion-selective membranes to separate lithium from multi-cation solutions. As ZIF-8-type metal-organic framework (MOF) with subnanometer-size pores has shown lithium selectivity and mussel-inspired polydopamine (PDA) has been reported as a potential adhesive to enhance the stability of the membrane, ZIF-8 is employed as fillers in PDA matrix to form a ZIF-8/PDA mixed matrix membrane (MMM). Membrane CDI performances, including lithium adsorption capacity and lithium selectivity, are tested using six groups of lithium-containing solutions (mixed with Na^+, K^+, Mg^{2+}, Ca^{2+}). Compared to CDI and ion-exchange membrane CDI processes, this work shows the high Li selectivity from multi-monovalent ion solutions. Also, PDA enhanced the ZIF-8 membrane stability. The cation adsorption order is $K^+ < Na^+ < Li^+ < Ca^{2+} < Mg^{2+}$, indicating that the effects of competition ions on the selective Li selectivity are primarily charge extent and ionic radii. This study will promote insight into the membrane material and process of lithium extraction to improve the Li selectivity.

Keywords: Lithium extraction; Membrane capacitive deionization; ZIF-8; Ion-selective membrane; Electrochemical adsorption