Freeman Lab – Direct Production of LiOH via Selective Bipolar Electrodialysis

Lithium demand has sharply risen as demand for lithium ion batteries has increased. However, current methods to extract lithium from brines use ponds for successive solar evaporation and chemical precipitation, and can take up to 18 months while losing up to 50% of the present Li^+. Thus, economical, environmentally friendly, and domestic sources of lithium are desired. The largest and highest-quality Li^+ resource in the US is geothermal brine from the Salton Sea.

An emerging direct lithium extraction technique to significantly reduce process time and improve yield is bipolar membrane electrodialysis (BPED). Here, cells consisting of a cation exchange membrane (CEM), an anion exchange membrane (AEM), and a bipolar membrane (BPM) are repeated between two electrodes. A BPM consists of a CEM laminated onto an AEM to form a bipolar junction that, under an applied voltage, will dissociate water into H^+ and OH^-. The H^+ and OH^- ions combine with Li^+ and Cl^- from the feed to form LiOH and HCl products, respectively. However, conventional CEMs are not selective for Li^+ ions over other feed contaminants (e.g., divalent cations) and will allow permeation of such contaminants. Divalent ions that transport across the CEM form $Ca(OH)_2$ and $Mg(OH)_2$ which precipitate and foul the CEM. These precipitates prevent a conventional BPED process from being utilized unless the brine is rigorously, extensively cleaned to remove all contaminants. Our team has synthesized a selective CEM (sCEM) with a cation-selective coating that prevents the transport of ions of higher charge (e.g., Ca^{2+} and Mg^{2+}). Our selective CEM prevents the formation of $Ca(OH)_2$ and $Mg(OH)_2$ precipitates in the base product, which enables the selective BPED process (**Fig. 1**) to purify and concentrate the LiOH product, without requiring the numerous purification steps in a conventional BPED Li^+ production process. In addition to enabling the simultaneous concentration, purification, and electrochemical production of LiOH from brines, our sBPED process reduces overall water consumption and allows the Li^+-depleted brine to be reinjected back into the source, minimizing environmental impact of the brine.

This proposal demonstrates the Freeman Lab team's systematic advances in sBPED technology for direct production of LiOH. We have demonstrated bench-scale synthesis of our selective membranes and testing of our sBPED technology on brines. In our proposed work, we will continue to validate and improve the effectiveness of our membranes while systematically exploring and optimizing the operating conditions for our sBPED process. We will transition to pilot-scale manufacturing of our membranes and pilot-scale testing of our sBPED process in conjunction with economic modelling to prove the viability of our technology for extracting lithium from Salton Sea geothermal brines.

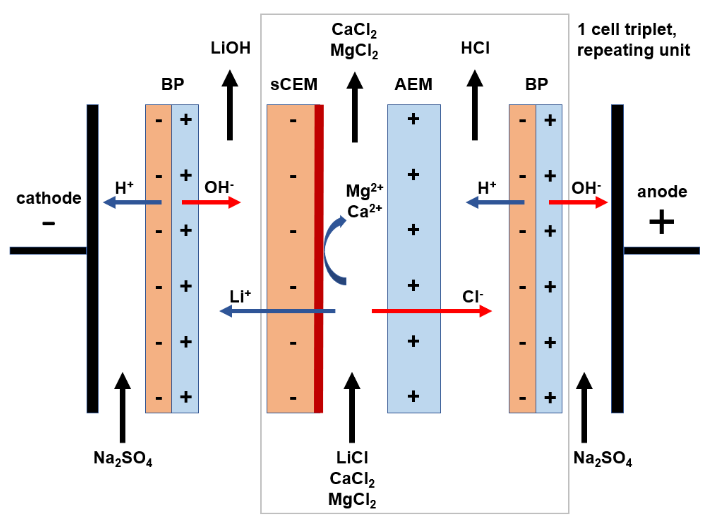

Fig. 1. *Selective BPED system demonstrating how the selective coating on the sCEM (dark red) repels divalent cations and only allows transport of Li^+ through the membrane to create a high purity LiOH base product.*