Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.32009

Optimization of ion-exchange sorbents to recover lithium from brines

DANIEL S. ALESSI[1,2], FANGSHUAI WU[1] AND KARTHIK RAMACHANDRAN SHIVAKUMAR[1]

[1]University of Alberta
[2]University of Texas at Austin

Critical minerals demand is projected to increase, driven by their use in the manufacture of batteries and electronics essential to a low-carbon economy. Among the most important, lithium (Li) use is expected to increase ten-fold by 2040, a rise that traditional Li resources such as salars or hard rock mines, or battery recycling efforts, will not be able to meet. Thus, lower-concentration resources like sedimentary brines produced as a byproduct of oil and gas extraction or in geothermal plants have attracted attention[1]. Extracting Li from such unconventional sources requires a rapid, efficient, and highly selective process, and Direct Lithium Extraction (DLE) technologies show potential in addressing this need. This presentation focuses on efforts to stabilize synthetic spinel lithium manganese oxide (LMO) nanoparticles, among the most promising ion-exchange materials for DLE[2], for Li recovery from produced sedimentary brines containing sub-100 parts-per-million Li. Two primary mechanisms cause the degradation of LMOs: (1) reductive dissolution of structural Mn(IV) in LMO due to the presence of organic compounds and/or aqueous sulfide species that are found in many Li-bearing sedimentary brines, and (2) the Jahn-Teller effect, or the induction of structural distortions during the intercalation of Li that leads to Mn reduction, loss and LMO degradation. To overcome these issues and ensure that the sorbent is economically viable, we modified LMO through several approaches: applying thin, porous ceramic coatings on LMO particles, doping LMO with divalent cations to stabilize its structure, and depositing LMO nanoparticles onto a polymeric membrane. These modified materials were tested for Li extraction from low-Li bearing sedimentary brines collected from oil and gas wells in the Western Canadian Sedimentary Basin. Our results demonstrate that these novel materials have markedly lower Mn loss, offering a flexible range of DLE technologies that are effective for Li recovery in field operating conditions.

[1] Zolfaghari, A., Gehman, J., Kondash, A. J., Konhauser, K. O., Ok, Y. S., Vengosh, A., Alessi, D. S. (2024) *Nature Water* 2(8): 749-757.

[2] Seip, A., Safari, S., Pickup, D. M., Chadwick, A. V., Ramos, S., Velasco, C. A., Cerrato, J. M., Alessi, D. S. (2021) *Chemical Engineering Journal* 426: 130713.