Evaluating Energy Consumption in the Electrodialytic Recovery of Lithium from Mineral Sources

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Raw materials are essential for both industrial development and societal needs, facilitating the transition toward a climate-neutral economy through innovations in digitalization, decarbonization, and other advanced concepts (Pires et al., 2022). However, technological advancements and rapid economic growth have exacerbated the challenges associated with secure access to raw materials and fluctuations in their costs (Almeida et al., 2025).

Lithium (Li), due to its exceptional properties enhancing battery performance, is extensively utilized in the production of electric vehicles (EV). As the EV market continues to expand, the demand for Li has surged, heightening supply risks and emphasizing its economic significance. Lithium is now recognized as one of the 34 critical raw materials (CRM) identified by the European Union (European Commission, 2023).

To reduce the European Union's dependency on imported battery chemicals and raw materials while simultaneously enhancing competitiveness within the battery storage value chain, research into eco-friendly alternatives has intensified. Electrochemical technologies have shown promise in recovering CRM from various environmental matrices, such as mine tailings (Almeida et al., 2020), sewage sludge (Guedes et al., 2016), soils (Pires et al., 2023) and fly ash (Kirkelund et al., 2015). Among these, the electrodialytic (ED) process employs low-level current densities between two electrodes to mobilize species in the presence of ion-exchange membranes (Almeida et al., 2020).

The energy consumption associated with the ED process is a critical consideration, largely determined by electrolysis reactions, stirring mechanisms, ohmic losses, and the energy required for species transport through porous samples (Magro et al., 2021). Alternative potential and current applications are being explored to improve the energy efficiency of ED processes. The potentiostatic technique involves applying a constant electric potential across the electrodes for a defined duration, whereas the galvanostatic technique applies a constant current (Wan et al., 2021).

This study investigates electrochemical technologies for recovering Li from Li-bearing minerals using a two-compartment (2C) ED reactor equipped with a cation-exchange membrane. An organic acid was employed as part of the process, and both galvanostatic and potentiostatic ED techniques were tested. Additionally, the energy consumption of these experimental approaches was evaluated.

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