Membrane crystallization with ion-exchange hollow fibers for Li_2CO_3 recovery

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Introduction

The high demand for lithium led to a dramatic price increase in lithium, which rose by nearly 300% between 2020 and 2021 [1]. To meet this demand, significant quantities of lithium salts, which account for roughly 65% of global lithium consumption, are required. Lithium carbonate (Li_2CO_3), one of the most commercially important lithium salts, is widely used not only in Li-ion batteries but also in the pharmaceutical industry. Satisfying this demand would necessitate an extensive increase in the mining and processing of lithium ores, which, however, poses serious environmental challenges. As a result, research is increasingly focused on recovering lithium from secondary sources such as electronic waste, spent batteries, wastewater, and brines. Several technologies, including evaporation, precipitation, electrodialysis-metathesis, nanofiltration, forward osmosis, and others, have been proposed and investigated. However, these methods often face limitations, including low efficiency, high energy and chemical demands, environmental concerns, costly materials, and difficulties in scaling up for industrial applications.

Experimental/Methodology

This study explores the membrane crystallization of lithium carbonate using a module equipped with anion-exchange hollow fibers. The process combines Donnan dialysis with crystallization. Model solutions simulating real-world lithium solutions were used as feed. The effects of various parameters on mass transfer, product purity, and crystal size were examined.

Results and Discussion

Membrane crystallization utilizing ion-exchange hollow fibers shows promise as a technique for recovering lithium salts, particularly lithium carbonate (Li_2CO_3), from diverse solutions. This approach benefits from selective ion transport through membranes, operates under low pressure and has low energy consumption. For Li_2CO_3 precipitation, the salt's high solubility allows for a more even distribution of supersaturation within the solution, not only near the membrane surface. Higher temperatures enhanced mass transfer across the membranes and facilitated the crystallization of Li_2CO_3. By increasing temperature, both crystallization speed and ion transport through the membranes were improved.Loss of lithium during the process was small, between 5 to 8 %. In comparison to electrodialysis in terms of economics and costs, this process currently presents a viable opportunity

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References

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