3rd Global Conference on Research in Chemistry and Chemical Engineering

Prague, Czech Republic 18 – 20 September 2025

Innovative Lithium Recovery: A Promising Pathway from Laboratory Optimization to Industrial Feasibility

Damir Zuljevic[1], Doreen Kaiser[1], Sandra Pavón[2], Sebastian Hippmann[2], Jana Pinka[3], Sebastian Braune[3], Martin Bertau[1,2]

[1]Institute of Chemical Technology, TU Bergakademie Freiberg, Freiberg, Saxony, 09599, Germany
[2]Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Fraunhofer Technology Center for High-Performance Materials THM, Freiberg, Saxony, 09599, Germany
[3]G.E.O.S. Ingenieurgesellschaft mbH, Halsbrücke, Saxony, 09633, Germany

ABSTRACT

The COOL+ Process is a method designed for lithium extraction from spodumene at moderate temperatures as well as valorization of the leaching residue, to achieve zero waste. It is an innovative and environmentally friendly process employing CO_2 in aqueous media, avoiding the use of strong acids to minimize environmental impact. The process was validated in a lab-scale where key variables, such as Na_2CO_3 dosage and mixing, calcination temperatures and duration, particle size, liquid-to-solid ratio, and reactor filling, were systematically optimized to maximize Li recovery. The challenges lie in the downstream of the process. Compared to the traditional acid leaching process, only a small amount of Al and Si is mobilized. The majority of Si was removed with the addition of MgO, and the main impurity, co-mobilised Na, is removed by washing. The solid residue, separated by filtration after supercritical CO_2 digestion, contains high amounts of nepheline, a precursor for the ceramic and cement industry. The residue can also be used as filler for geopolymer production. The optimized process recovers more than 90 % of Li from primary sources (spodumene and petalite), yielding battery-grade Li_2CO_3 as the final product. This study represents a comparison between lab-scale and pilot-scale, where partial pilot plant validation of key parameters serves as a precursor to full-scale implementation. The findings demonstrate that the COOL+ Process is technically viable and holds strong industrial potential, laying the foundation for a sustainable lithium production route from minerals.

Keywords: geopolymer; lithium carbonate; spodumene; scale-up; sustainable