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Sustainable LiOH Production by Bipolar Membrane Electrodialysis in a Closed-Loop Recycling Scheme

L. Sedlák[1], V. Kúdelová[2], E. Sedláková[1], J. Fehér[2], I. Červeňanský[1], L. Hlavatý[1], J. Markoš[1]
[1]*Institute of Chemical and Environmental Engineering, Slovak University of Technology in Bratislava, Radlinského 9, 812 37 Bratislava, Slovak Republic*
[2]*MemBrain s.r.o., Pod Vinicí 87, 471 27 Stráž pod Ralskem, Czech republic*
e-mail: lukas.sedlak@stuba.sk

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Global lithium demand has increased dramatically over the past two decades, driven mainly by Li-ion battery production. Despite the strategic importance of lithium, recycling rates of spent batteries remain very low, and no universal recycling route has been established. Hydrometallurgical recycling typically involves black mass production, acid leaching, purification of the leachate, and subsequent conversion of lithium into high-purity high-value products such as lithium hydroxide (LiOH).

This work focuses on valorization of a purified lithium stream by converting lithium sulfate (Li_2SO_4), commonly obtained after sulfuric acid leaching, into LiOH using electrodialysis with bipolar membranes (EDBM). Bipolar membranes enable in situ water dissociation, producing alkaline and acidic streams without the use of external chemical reagents. Produced LiOH can be subsequently crystallized and produced sulfuric acid can be directly recycled back to the leaching step, supporting a closed-loop concept. Because the conversion of the lithium salt leave purified water as the only remaining liquid phase, the process aligns well with Zero liquid discharge (ZLD) concept. Four different membrane types were investigated for LiOH production, evaluating specific energy consumption and the purity of the produced LiOH stream. Two membrane types enabled production of high-purity LiOH suitable for immediate crystallization while maintaining low energy demand. To intensify downstream processing, concentration steps were also investigated. Conventional electrodialysis was insufficient to reach saturation point, therefore membrane distillation was examined as an alternative, allowing additional concentration by utilizing waste heat.

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