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Use of multifiber membrane module for lithium recovery

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Lithium is considered a highly valuable substance not only because its extraction is challenging but also due to its limited availability on land. According to lithium consumption forecasts, by 2050, up to one-third of the lithium reserves that can be extracted from terrestrial sources are expected to be depleted. Up to 65% of the produced lithium is used in batteries, and this percentage is expected to increase in the coming years due to electrification. It will be necessary to expand recycling capacity of Li-ion batteries due to increasing electrification, considering only 5% of used batteries were recycled in 2022. This process generates several waste streams, which still contain enough lithium that can be separated. The experiments were carried out using a model solution composition that corresponds to the brine produced during battery recycling. This solution mainly contains lithium cations and chloride anions, which together form a highly soluble mixture. To reduce the solubility of lithium, the solution was converted into lithium bicarbonate using anion-exchange hollow fibers. Lithium bicarbonate is still well soluble, but by heating to temperatures up to 80°C, it transforms into poorly soluble and commercially most valued lithium carbonate. The resulting crystals were analyzed for crystal size distribution. The conversion of lithium chloride solution into lithium bicarbonate was performed in a multi-fiber module packed with anion-exchange fibers manufactured by MemBrain s.r.o. The experimental investigation was focused on the influence of different packing densities on Donnan dialysis, as well as on effect of hydrodynamic conditions on the rate of mass transfer. Since Donnan dialysis is a time-consuming process, it was necessary to examine lithium losses during the experiments. The results showed that lithium losses through the membrane cannot be significantly influenced by changes in operating parameters, as they primarily depend on the concentration of functional groups in the membrane. However, what could be influenced by changing the process conditions was the rate of anion exchange, which was strongly affected by temperature. Flow rates inside the fibers and in the shell of the module influenced the transmembrane pressure, which during longer experiments led to a significant amount of water passing through the membrane, which was an undesirable effect in our case.

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