Electrodialysis with bipolar membranes for acid and base production: a pilot scale investigation with real bitterns

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In the fields of desalination and minerals recovery from seawater, Electrodialysis with Bipolar Membranes (EDBM) is gaining significant attention as an innovative and sustainable way to valorise waste brines (Lopez et al., 2025). Indeed, EDBM is an electro-membrane process, which employs only saline streams and electricity to generate acid and base solutions, which are widely used in many industrial sectors. Recently, this technology was investigated mainly at the laboratory scale with only a few cases at the pilot scale, demonstrating its effectiveness in producing high purity acid and base streams with low energy consumption, using synthetic NaCl feeds. As part of the European SEArcularMINE project (https://searcularmine.eu/), a pilot scale EDBM system was integrated into a circular scheme for the valorization of real saltworks bitterns. The aim of this work was the investigation of the semi-industrial scale EDBM unit with real brines for the production of sodium hydroxide and hydrochloric acid. Particularly, in this work we aim to identify the best operating conditions to reach a target product concentration of 0.5 mol L^{-1} with the highest possible acid and base purities. The EDBM unit was provided by SUEZ and composed of 50 repeating units. Different experiments were conducted in a batch configuration (i.e., closed-loop), with a current density of 200 A m^{-2} and using different volumes of the acid and base solutions. The saline solution composition was mainly made up of sodium and chlorides, while sulphates, potassium and bromides were present in lower amounts. Titrations and Ionic Chromatography were the main analytic techniques used for the analysis of the samples. The experimental results were particularly promising, showing the best Key Performance Indicators reported in the previous literature for EDBM. Particularly, the Specific Energy Consumption (SEC) was below 1.35 kWh kg^{-1} of NaOH, and the Current Efficiency (CE) was up to 89%. Moreover, the purity of the base and the acid were 97% and 90%, respectively. These results confirmed the efficacy of the EDBM process in producing chemical reagents at a larger scale. Further studies are needed to optimize the process conditions, bringing the technology to the industrial level.

References

Lopez, J. *et al.* (2025) 'Electrodialysis with Bipolar Membranes to valorise saline waste streams: Analysing the fate of valuable minor elements', *Science of The Total Environment*, 958, p. 177934. Available at: https://doi.org/10.1016/j.scitotenv.2024.177934.

SEArcularMINE website, https://searcularmine.eu/.

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