

Continuous Ion-selective Separation by Shock Electrodialysis

by

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Technical Summary

Cleaning water remains a challenge across sectors and across the globe. Many go without access to clean drinking water simply because the technologies that exist are too expensive in capital or energy. Areas thought to have reliably safe water can be betrayed by aging water infrastructure and become exposed to hazardous contaminants. In addition to the need to purify drinking water, is the necessity to treat waste water produced by chemical or energy plants. For a long time, reverse osmosis has been used as a catch-all technology for the robust treatment of contaminated water. That robustness comes at the cost of high energy requirements and membranes that can foul quickly under harsh conditions. For low-salinity separations or separations that target specific ions in solution, there may be a better technological fit.

We demonstrate shock electrodialysis (SED) achieving highly selective continuous removal of magnesium ions from an aqueous mixture of NaCl and MgCl₂. To explore this phenomena, the SED device has all of its inputs and outputs characterized to determine internal flows of fluid and ions. This careful study provides valuable insight into the mechanisms that drive selectivity, current efficiency, and desalination, as well as potential methods to improve performance. The selectivity comes as a result of the deionization shock and associated depletion region in a negatively charged porous frit. For solutions initially rich in sodium and dilute in magnesium, high (> 98%) removal of magnesium can be achieved with only moderate (50-70%) removal of total salt.

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