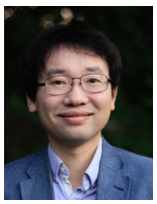
RESEARCH BRIEF
Start Date: Oct 1 2021 | Duration: 24 months

NAWI
National Alliance
for Water Innovation

A Novel Electro-Dialytic Crystallizer (EDC) for Energy Efficient Zero-liquid Discharge



Shihong Lin | Vanderbilt University
shihong.lin@vanderbilt.edu

Challenge

The last and often most costly and energy-intensive step in intensified brine management processes is crystallizing salts out from saturated brines. While disposal is often the preferred solution for brine management due to its low cost, in some cases zero liquid discharge (ZLD) is required.[1] Conventional reverse osmosis (RO) can only concentrate the brine to ~ 100 g/L before the osmotic pressure and scaling potential of the brine make further concentration unviable, and it is for these reasons that thermal processes are currently applied for brine concentration. However, thermal processes utilize high temperatures and require exotic metals to contain the hot and corrosive brine, which translates into high operational and capital costs.[2]

Research Approach

This project aims to develop a modular brine concentration/crystallization process that is substantially more energy efficient than the current state-of-the-art thermal processes. The team aims to investigate a new brine crystallization process called electro-dialytic crystallization (EDC), which integrates electrodialysis and crystallization into a single system to enable crystallization without evaporation or large temperature swings, thereby potentially improving the energy efficiency and reducing the cost of crystallization. The core innovation of EDC is the use of the electrodialysis phenomenon to maintain a saturated brine stream for continuous salt precipitation. The team will perform system-scale modeling to guide design and optimization of EDC, perform experiments to validate the concept and, conduct techno-economic analysis, life cycle assessment and market analysis to evaluate the potential of EDC for future practical adoption.

Impact

The proposed project will address major knowledge gap toward the future adoption of EDC. A fully successful project would not only provide experimental proof of EDC's technical capability but also pave the way towards making ZLD more widespread and potentially opening the door to recovering resources from concentrated brines.

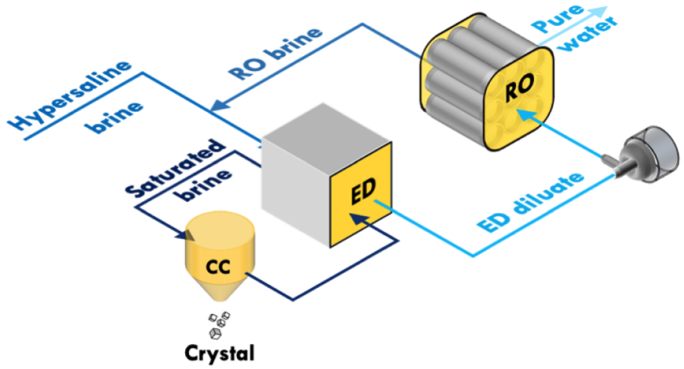


Figure 1. A simplified schematic of the EDC process coupled with reverse osmosis for ZLD without thermal evaporation.

RESEARCH PARTNERS

Black & Veatch: Gil Hurwitz, Srinivas Veerapaneni; Colorado State University: Jason Quinn, Todd Bandhauer, Tong Tiezheng; Vanderbilt University: Shihong Lin.

REFERENCES

1. Tong T. and Elimelech M., *Environ. Sci. Technol.* 2016, 50, p6846.
2. Yaqub, M. and Lee, W., *Science of the total environment*, 2019. 681, p551.

This work was supported by the National Alliance for Water Innovation (NAWI), funded by the U.S. Department of Energy, Energy Efficiency and Renewable Energy Office, Advanced Manufacturing Office.

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY