WATER-ENERGY RESILIENCE RESEARCH INSTITUTE

# Electrically Regenerated Ion-Exchange Technology

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## Motivation

Freshwater shortages have pushed communities around the world to increasingly rely on groundwater sources. At the same time, agricultural and industrial practices, as well as coastal saltwater intrusion have rendered many groundwater sources saline and unfit for use. In the United States, irrigated agriculture is a major water consumer in water stressed western states (e.g. California). Controlled growing conditions make irrigated agriculture highly productive and valuable, but given the recent droughts in California it is crucial to tap into new sources of water to sustain irrigated agriculture. One promising solution is the treatment and use of shallow, easy-to-recharge, brackish groundwater instead of energy intensive and unsustainable pumping of freshwater from deep wells.

## Technological Challenges

Existing technologies for brackish water treatment include: reverse osmosis (RO), electrodialysis (ED), memebranc CDI (mCDI) , and ion exchange (IX). The main shortcomings of RO, ED, and mCDI are that they rely on the use of membranes which results in higher capital and operating costs. Although IX is inexpensive, it requires the use of corrosive chemicals for regeneration and is therefore impractical for widespread use. For large volume applications such as agriculture, low capital cost and high water recovery are essential in treatment technologies.

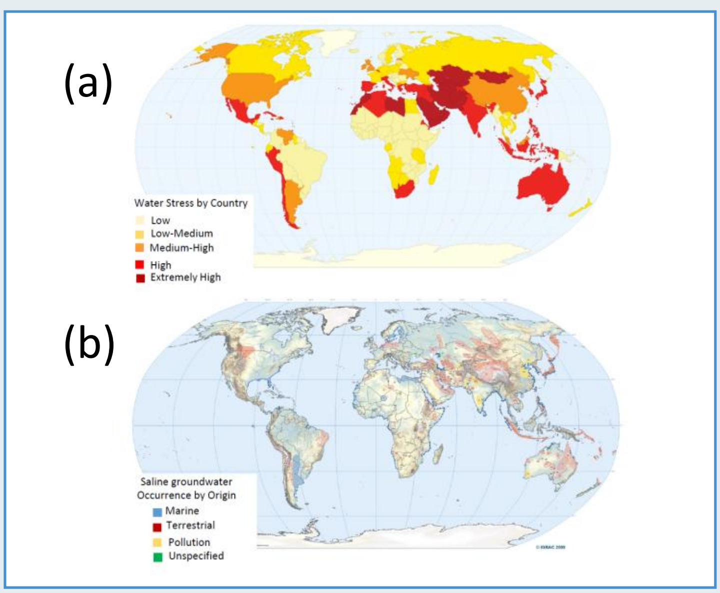


***Figure 1.*** *(a) Predicted global water stress in 2025 and (b) global distribution of brackish water sources.*

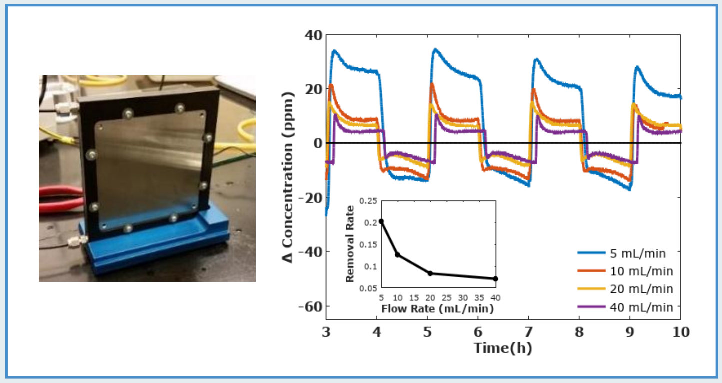


***Figure 2.*** *Photograph of ERI Prototype and data showing its performance as a function of variable flow rate of 100 ppm NaCl solution.*

## Research

To build an affordable solution for large volume, agricultural applications, we are developing a technology that relies on industrial-scale, inexpensive, and non-toxic materials known as ion-exchange resins (IERs). IERs are widely used for water softening and requires regular chemical regeneration using corrosive chemicals. Instead, in this innovation, the IER are embedded in conductive-composite electrodes and electrically regenerated--a method, free of chemical input. This new method is refered to as electrically regenerated ion-exchange (ERI) Technology. Besides the reduced cost, the composite electrodes used in ERI also allow for unique operational modes—salt capture without any energy input and salt rejection with minimal energy input. ERI technology has been successfully demonstrated in the lab using a prototype unit and is well positioned to treat a wide variety of influent water salinities and flow rates. The current ERI prototype has 100 $cm^2$ electrode area and an output flow rate of 10 mL/min for feedwater salinities for just 100 ppm NaCl. The ability of the system to treat higher salinity feedwaters, similar to those encountered in the field, and to have higher output flow rates are both tied to the electrode area--a modular design that allows for easy scalability.

## References

**Subban, C.V.**, et al. Devices and methods for removing dissolved ions from water using composite resin electrodes. *US patent application* serial no. 15/843,712, filed on December 15, 2017.

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