

Enabling Minimal Liquid Discharge Through a Modular, Flexible, and Electrified Pretreatment System

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Challenge

Desalination pretreatment is typically a multi-step process involving a combination of chemical dosing (coagulants, softening, anti-scalants) and a separation step (filtration, membranes) to remove particulate matter.^{1,2} However, this configuration is not ideal for small-scale, distributed applications due to the need for frequent chemical deliveries and the large physical footprint. Furthermore, small, neutral contaminants, such as NDMA and 1,4-dioxane, are not effectively removed by conventional methods and require additional, costly post-treatment.^{3,4}

Research Approach

To overcome these challenges and to develop technologies specifically suited for small-scale decentralized treatment, this project will develop an intensified pretreatment system that combines electrocoagulation (EC) and electrooxidation (EO) with an anti-fouling membrane separation into a single, modular, and electrified unit that is capable of generating a consistent pretreated water quality for reverse osmosis (RO), independent of the feedwater quality (Figure 1). To our knowledge, there has been no systematic investigation on how to integrate the EC and membrane processes.

Impact

If this project is successful, it may challenge the existing paradigm and question the need for multi-step treatment trains that are currently required to reach water quality and recovery goals. A TEA of the pretreatment system will also be developed to evaluate performance in terms of pipe-parity metrics, including:

1. **Reduced capital costs:** By combining all three processes together, the footprint, materials needed, construction, and land requirements are dramatically reduced.
2. **Reduced O&M costs:**
 - a. The team has demonstrated that EC can remove nearly 100% of silicates and >60% of hardness without impacting water quality, and at <50% of the cost of chemical coagulation, eliminating the need for chemical softening and reducing anti-scalant demand.
 - b. The group has also demonstrated an electroactive

method to protect ultrafiltration membranes from multiple forms of fouling,⁵ reducing downtime and cleaning intervals.

3. **Improved water quality:** The EO process can destroy small contaminants on-site with just electricity, obviating the need for exogenous chemicals or additional unit processes.

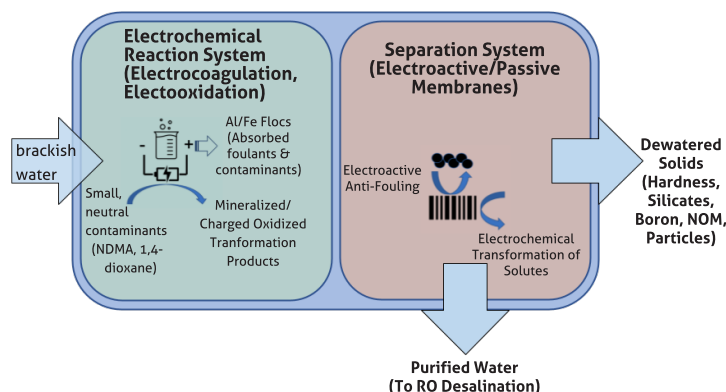


Figure 1. Process diagram of integrated, modular, EC pretreatment system combining an EC/EO reactor and an immersed, anti-fouling membrane system.

RESEARCH PARTNERS

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