RESEARCH BRIEF
Start Date: Apr 1 2022 | Duration: 24 months

NAWI National Alliance for Water Innovation

Electromagnetic Field for Membrane Scaling Control

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Challenge

Membrane scaling is a major impediment to the successful implementation of desalination technologies. The current state-of-the-art for scaling prevention is pH adjustment and dosing of anti-scalants, which are proprietary chemicals that allow sparingly soluble compounds, such as silica and calcium sulfate, to remain soluble even when supersaturated, which prevents them from precipitating on membrane surfaces. Unfortunately, anti-scalants are expensive consumables and need to be replenished, contribute to the waste stream, and are only effective to a certain point: operating above this threshold can still result in membrane scaling.

An alternative to using chemicals for scaling control is Electromagnetic Field (EMF) treatment, which as the name suggests, uses electricity and magnetism to alter the physicochemical characteristics of water and its constituents to prevent scaling. EMFs are energy-efficient, do not require exogenous chemicals, and do not produce any additional waste. Although PI Xu has demonstrated that EMF treatment was effective at preventing SiO2, CaSO4 and CaCO3 scaling during desalination of brackish and reclaimed water, to date, there are no systematic studies of the mechanisms by which EMF processes work. More importantly, the underlying complex physicochemical mechanisms involved in water treatment processes themselves are not well understood, which prevents the development of effective EMF devices for scaling control.

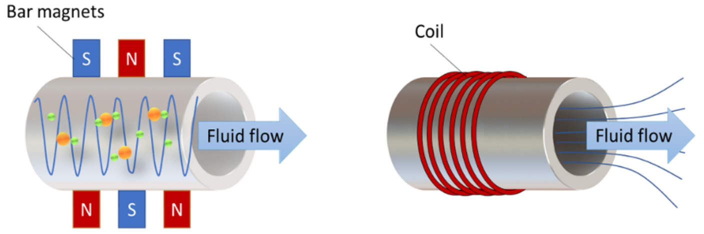

Figure 1. Illustration of EMF devices.

Research Approach

This project will focus on modeling, bench-scale experiments, and developing a suite of real-time, advanced characterization methods to elucidate the mechanisms and limitations of EMF for membrane scaling control. The main research objectives include:

1. Developing a better understanding of the factors affecting EMF efficiency for membrane scaling control under different operating conditions and water chemistries with generic and representative commercial EMF technologies;

2. Developing real-time monitoring, advanced characterization, and numerical simulation to elucidate the impact of EMF on water solutions, nucleation, crystallization, and precipitation in bulk solution and on membrane surface;

3. Performing a techno-economic analysis (TEA) and life cycle assessment (LCA) of EMF treatment in comparison with chemical pretreatment methods and;

4. Issuing guidance on how EMF can be applied for scaling control in water treatment processes and systems.

Impact

Successful completion of this project will lead to an improved understanding of how EMFs properties impact nucleation, crystallization, and precipitation of constituents in water at the atomic-, micro- and macro-scale. This new knowledge can serve as the basis for the development of next-generation technologies that can displace traditional anti-scalants help enable pipe parity by reducing or eliminating the cost of exogenous chemicals, their handling, and onsite storage.

RESEARCH PARTNERS

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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.

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