RESEARCH BRIEF
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NAWI National Alliance for Water Innovation

Porous Polymer Networks and Membranes for PFAS and Selenium Removal from Water

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Challenge

In many desalination and water treatment and reuse scenarios, it is commonly the case that there is a specific trace constituent or contaminant that drives the treatment design. Current treatment systems are often unable to selectively remove the problematic constituent, and many designs fall back on bulk removal or transformation (e.g., oxidation) processes that remove both problematic and benign constituents together. This both drives up capital and operating costs and can create a waste stream with the problematic and benign solutes mixed together.

Research Approach

Recent work in the Long Group at the University of California, Berkeley and Lawrence Berkeley National Laboratory has led to a new class of robust, tunable polymers, known as porous polymer networks (PPNs), that can be functionalized with various molecular binding groups to selectively remove a wide array of trace compounds from water.[1] Preliminary experiments have shown that PPNs can be designed to achieve among the highest selectivities, capacities, and uptake kinetics known for the adsorption of waterborne metals (e.g., copper and iron), even in complex water matrices.[2,3] Furthermore, the researchers have also shown that the PPNs can be fixed within electrodialysis membranes that capture target ions but not competing ions. In this approach, captured contaminants can then be desorbed into a concentrated, low-volume waste stream devoid of other constituents.[4]

The goal of this project is to design, synthesize, and test PPNs and electrodialysis membranes with embedded PPNs for the precise separation of two key contaminants from their respective wastewaters: per- and polyfluoroalkyl substances (PFAS) from municipal wastewater and selenium (Se) from power wastewater. Materials design, adsorption measurements, column prototype tests, electrodialysis prototype experiments, and techno-economic analyses will be performed in tandem, with the goal of maximizing overall value to enable pipe parity for these separations.

Impact

If successful, this work will demonstrate a flexible and regenerable platform technology for the precise removal of various problematic constituents from disparate non-traditional water sources, with selectivities and binding capacities orders of magnitude higher than those of established technologies. These attributes could lead to pipe parity by increasing removal efficiency, reducing capital and O&M costs, and minimizing waste volumes.

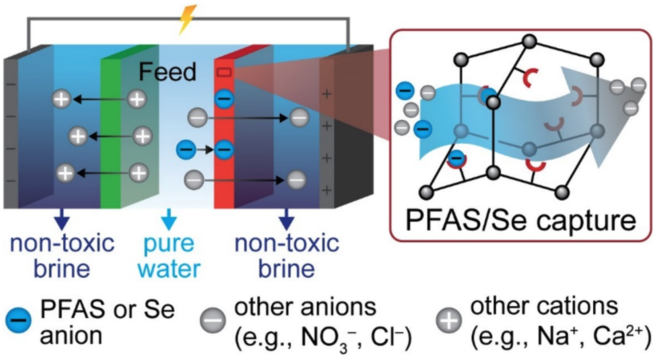

Figure 1. Simultaneous water desalination and selective PFAS or selenium capture by ion-capture electrodialysis, using anion-conductive membranes embedded with selective PPN adsorbents.

RESEARCH PARTNERS

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