Selective Ion Capture *via* Electrodialysis with Advanced Porous Materials

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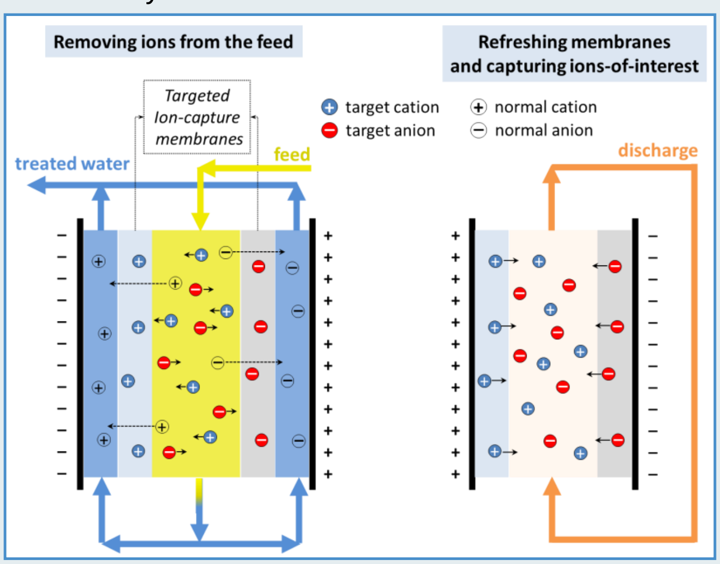
Motivation

Fresh drinking water is vital. The global scientific needs for water purification vary widely, depending on the specific ions present in local water supplies. For instance, in some regions, the level of arsenic, nitrate, borates, or radioactive elements is much higher than the World Health Organization's recommendations, and current water purification membranes struggle to capture these species. It is therefore necessary to develop materials with specific selectivity for these ions.

Technological Challenges

To either remove ionic contaminants from drinking water (e.g. heavy metals) or capture valuable ions from seawater, materials with respective selectivity are required. However, current state-of-the-art ion-capture materials seldom possess the high selectivity and capacity necessary to accomplish complete decontamination/capture, and as a result, this remains a scientific dream. As such, developing affordable ion capturing approaches for trace level to higher concentration level species is necessary.



Electrodialysis of water treatment in the ion capture (left) and ion discharge processes (right)

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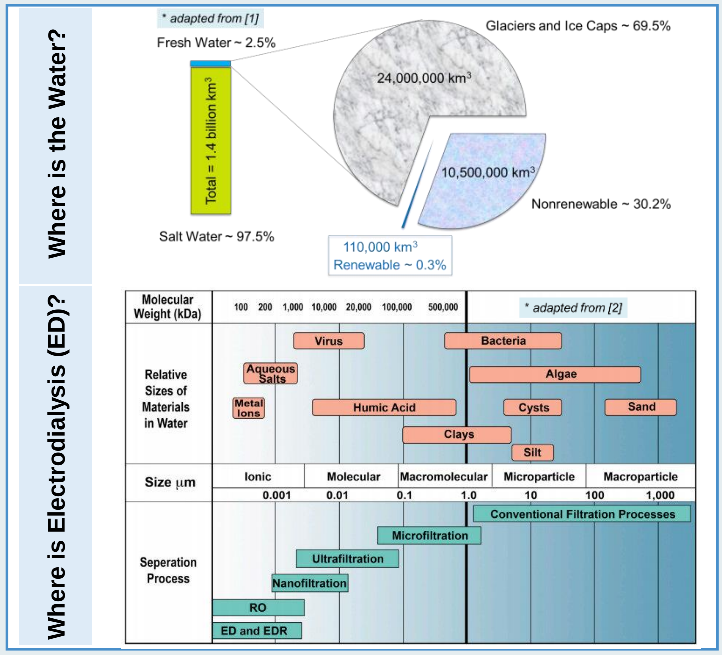

The world's water distribution (top); Relevant length scales and constituents in water and conventional treatment approaches for water treatment (base)

Research

In our approach, novel porous crystals will be developed and implemented into electrodialysis membranes for isolation of dilute ions in water by use of low-energy selective ion-exchange and subsequent electrodialysis. During this process, voltage will be applied to the electrodes to generate an electrical potential. The electric potential will drive the cations and anions in the feed toward in opposite directions. With both cation-capture and anion-capture membranes in between the two electrodes, the non-target ions would pass the membranes freely, but the target ions will be trapped in the membranes due to specific bonding to the porous active sites. Subsequently, a reverse voltage will be applied to the membrane, to drive the detachment of target ions from the pores to the discharge stream and facilitate the regeneration of the ion-capture membranes.

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