Fabrication of electrodes from recycled carbon fiber for water desalination and wastewater treatment via capacitive deionization

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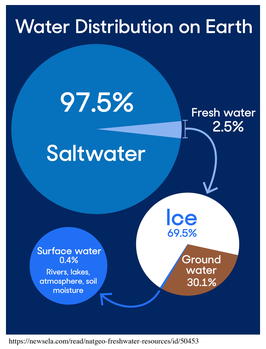
ABSTRACT

In less than a decade **50% of the world population will face water scarcity**. Nevertheless, most human activities that consume water produce wastewater; therefore, **identifying sustainable and efficient paths to safely treat saline water and reclaim wastewater is paramount.** Capacitive deionization (CDI) is an emerging eco-efficient process where water moves through a spacer channel with porous electrodes on each side. When the electrical field is applied, the electrodes capture the charged salt ions and results in a salt free stream. The aim of this research project is to fabricate porous electrodes using recovered carbon fiber from industrial solid waste. **The goal is to identify the most green and efficient method to fabricate electrodes from recycled carbon fibers for water desalination and wastewater treatment via CDI.**

INTRODUCTION



- Water scarcity is a national and international growing concern.[1]
- Desalination of saline water resources and wastewater reclamation are processing solutions to compensate the water shortage.
- A low-cost and eco-friendly technology, like CDI, can consume less energy than conventional desalination methods like reverse osmosis desalination. [2]


Getty Images


https://www.tehrantimes.com/news/439877/Iranian-product-cuts-agricultural-water-usage-by-half


https://www.aaracoolingtower.com/blog/cooling-tower.html

PROPOSED MATERIALS AND METHODS

Phase I: Fabricate electrodes from recycled carbon fiber

Recovered Carbon Fiber

- Produced by pyrolysis

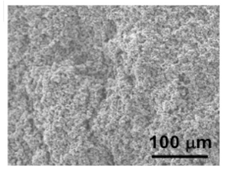
Improve Properties of Carbon Fiber

- An activation step might be necessary to enhance physical properties of the fibers

Electrode Formulation

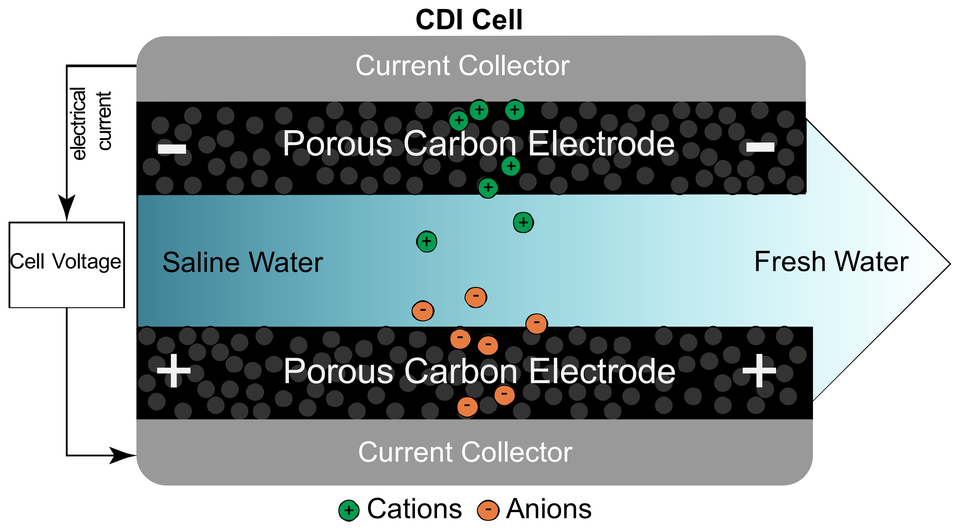
- Optimization of carbon to binder ratio and operating temperature

Porous Carbon Electrodes



- Measurement of electrode porosity, conductivity and adsorption capacity

Phase II: Testing the performance of the electrode in water desalination process



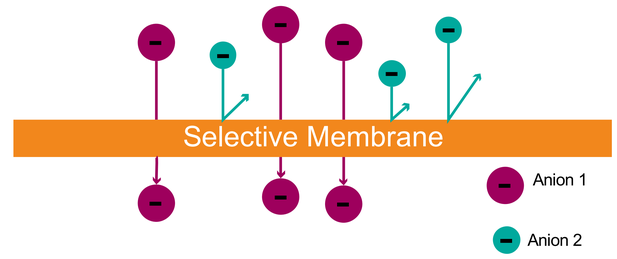
Operational Conditions
- Feed: Synthetic NaCl solution mimicking saltwater
- Room temperature
- Batch mode

Monitoring
- Temperature
- Conductivity
- pH

Measurements
- Electrodes' integrity and lifetime
- Calculation of degree of desalination
- Energy consumption

SCIENTIFIC CHALLENGES

- Making recycled carbon fiber suitable for fabrication of porous electrodes
- Electrodes are not ion selective, for the use wastewater treatment modifications to other electrochemical properties may be necessary, as shown below



FUTURE WORK

- Focus on CDI application in wastewater reclamation
- Possibility of using membrane CDI to save more energy due to more efficient charge adsorption

REFERENCES

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2. Paranthaman, M., Naskar, A.K., Tsouris, C., Ivancevic, M.R. "Carbon Electrodes Based Capacitive Deionization for the Desalination of Water." US2019/0225513A1. U.S. Patent Application Publication. Jul 25, 2019.
3. Pickering, S., Liu, Z., Turner, T., Wong, K., "*Applications for carbon fibre recovered from composites.*" 2016. 10.1088/1757-899X/139/1/012005.
4. Porada, S. *Preparation of Carbon Electrodes for Water Desalination Using Capacitive Deionization*. 2013. Wroclaw University of Technology, PhD dissertation.

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