Portable and Self-Cleaning Advanced Electro-Oxidation Systems for Distributed and Point-of-Use Water Treatment

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Abstract

Motivation: Water contamination poses a severe threat to human health. In underserved regions, such as Puerto Rico, water contamination necessitates the development of effective treatment technologies to ensure safe drinking water access for Puerto Rican citizens.

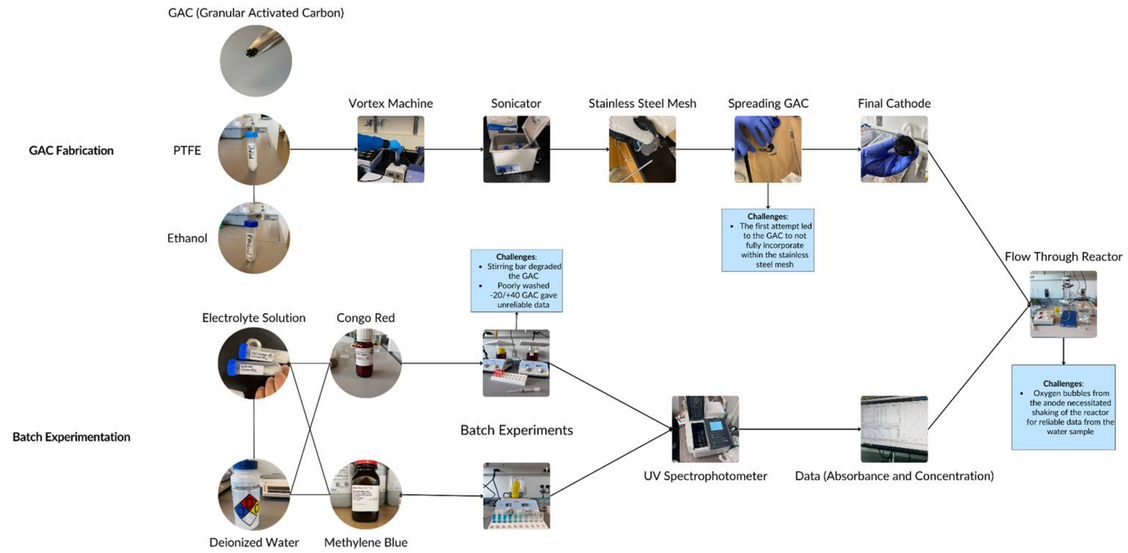
Objective: This research aims to optimize the parameter of pore size of Granular Activated Carbon (GAC) cathode in the reactor for better pollutant adsorption and removal.

Results: 3 g of -20/+40 mesh size GAC was found to be the best for adsorption or synthetic dyes.

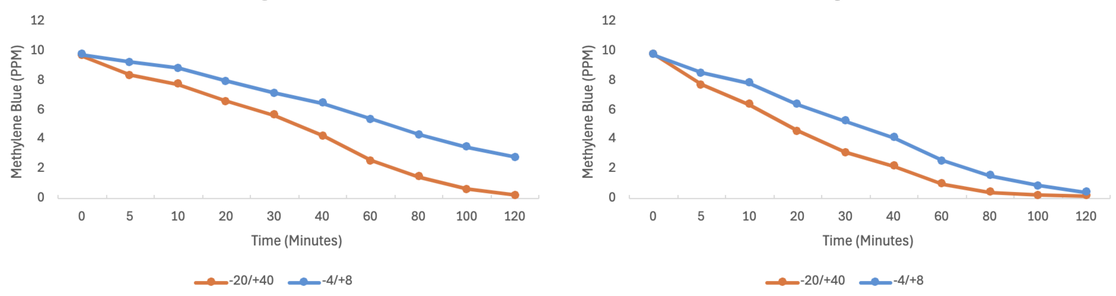
Background

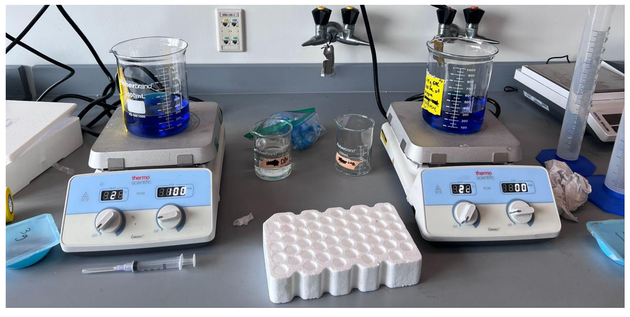
A flow-through reactor was developed in the PROTECT Project 4 lab for point-of-use (POU) water treatment. This system fundamentally consists of a voltaic cell, including a Ti/MMO anode and a carbon-based cathode. Initially, contaminated water enters the system from the bottom of the reactor and gets oxidized at the anode, generating oxygen. The oxygen gas continues to the GAC cathode, where it is reduced to produce hydrogen peroxide, followed by its catalytic decomposition into ●OH radicals. These radicals degrade organic pollutants adsorbed on the cathode surface to decontaminate the water. Here, we have preliminarily investigated the effect of pore size distribution in GAC on the adsorption of organic dyes, which primarily determines the decontamination mechanism. Additionally, we have also tested the H2O2 formation employing this flow-through system.

Experimental Methods

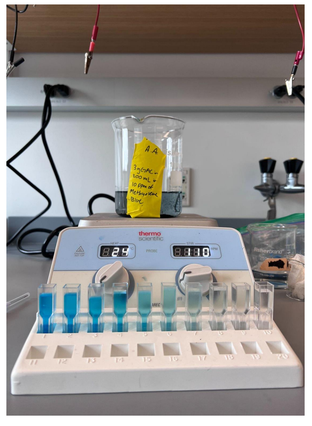


Results





Batch Reactor Setup



Batch Reactor with Samples Collected for Analysis

Conclusion and Future Steps

Conclusion:

Using 3 g of -20/+40 mesh GAC was the most efficient for methylene blue (MB) adsorption, achieving 97.79% removal. Similarly, at 1.5 g, -20/+40 mesh GAC achieved a 97.28% removal compared to 71.22% with -4/+8 mesh GAC. This indicates that smaller pore sizes, which increase surface area, are 26.06% more efficient for pollutant adsorption in the system.

Future Work:

To better understand the implications of GAC pore size distribution, different organic dyes with varying concentrations can be used to test its adsorption. Employing integrated (photo)electrochemical systems can also aid in degradation, which in turn can also enhance H_2O_2 production.

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