Preliminary Report - Task 1

Introduction

The presence of PFAS, specifically PFOA and PFOS, is a looming issue with intensifying consequences; this problem has created the need to find an affordable and efficient solution to destroy the PFAS on-site ex-situ once it is removed from water sources.

Methodology

Pretreatment and Setup

To prepare the test solutions, dissolve 5mg PFOA and 5mg PFOS into 1L DI water, to obtain a combined 10mg/L solution.

Experimental Procedure for First Trials:

1. Fill 4 flasks with 100ml (using a total of 400ml) of the 10mg/L PFAS solution. Set one flask aside as the control.
2. Using a batch reactor, dissolve 10g sodium percarbonate into each of the 3 remaining PFAS solutions.
3. Calibrate fluoride ion sensor using standardized fluoride solutions with known concentrations.
4. After 1 hour, use fluoride ion sensor to measure and record the amount of fluoride ions present in each of the 3 solutions and the control. The presence of fluoride ions in the solution is indicative of the PFOS and PFOA bonds being broken down over time.
5. Continue to record these measurements every 6-12 hours for the next 72 hours (timespan may vary in later trials).

Destruction of the PFAS - Chemistry

PFOS (Perfluorooctane sulfonate)

- $2Na_2CO_3.3H_2O_2 + C_8HF_{17}O_3S + H_2O \rightarrow$ Degradation Products + H_2O + CO_2 + F-

PFOA (Perfluorooctanoic acid)

- $2Na_2CO_3.3H_2O_2$ + C8HF15O2 + H2O → Degradation Products + H_2O + CO_2 + F-

Bench Scale Design

A batch reactor design will be used for destruction of PFAS by measuring a specified volume of the PFOA/PFOS solution and adding it into a 1L beaker. Sodium percarbonate will be added into the PFAS solution, and the beaker will be placed on a stir plate to ensure complete mixing. The operating parameters will be sodium percarbonate dosage, reaction time, the potential addition of heat, and the speed of the magnetic stir bar (rpm). Preliminary testing will be conducted to determine the optimum parameters of the reactor design to destroy the PFAS.

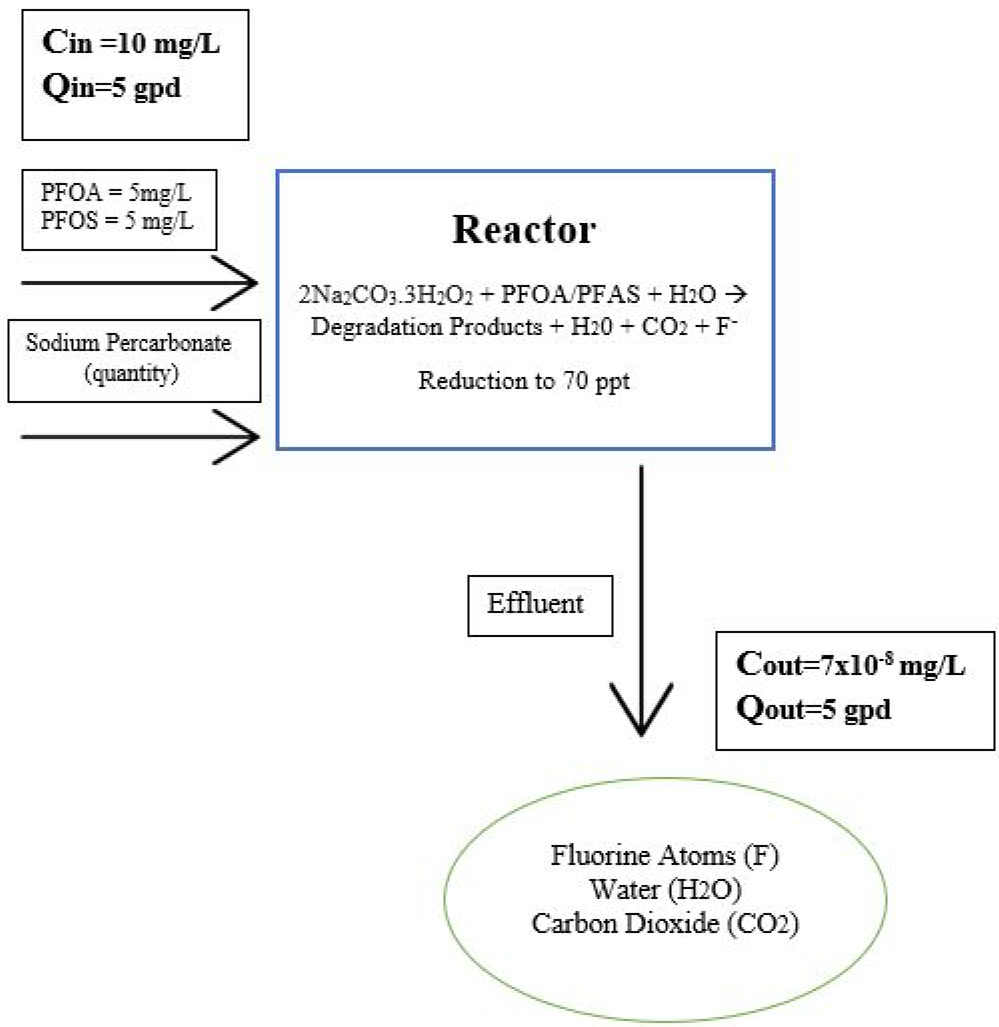

Figure 1.1: The process-flow diagram with expected inputs and outputs; Parts Per Trillion=ppt; Gallons Per Day=gpd; Q=discharge, C=concentrations. Degradation products will include various Carbon-Fluorine bonds, but these are not yet established.

Cost/Energy Requirements: Bench Scale Design

- The cost of materials, which includes the sodium percarbonate, fluoride sensor, stir plate (potentially a heated stir plate), yield a low overhead cost relative to other processes established.
- A standard 120 volt power outlet is required to run the stir plate; this yields a near negligible energy requirement for the overall destruction process.

Byproduct of Degradation

The only foreseeable byproduct of this destruction process is fluoride. This is a non-toxic, non-hazardous byproduct which yields no measurable negative impact on the environment or humans who are exposed to it. The amount of fluoride produced is directly related to the quantity of PFAS destroyed.