Fluorotelomer Alcohol Permeation through Landfill Covers and Liners

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Introduction

Background

- Per- and Polyfluoroalkyl substances(PFAS) are hazardous substances which are bio accumulative and potentially carcinogenic
- PFAS have been nicknamed "forever chemicals" because they are extremely difficult to break down
- Since these chemicals are used in a variety of consumer goods it is very common for them to end up in landfills where they end up in leachate which seeps through the bottom liners

Other Research

- There has been a lot of research into permeation of other chemicals through (HDPE) membranes
- Permeation of common PFAS such as PFOA and PFOS have been studied through linear low density polyethylene(LLDPE) membranes

The Gap

- There is a gap in the research for volatile PFAS permeation through HDPE membranes
- Our research aims to fill this gap by testing permeation of fluorotelomer alcohols(FTOHs), which are a type of volatile PFAS that are commonly found in landfills, through HDPE membranes

This Project

- We are testing the permeation of 4 FTOHs across a membrane under 4 temperatures over time
- Since FTOHs are volatile and convert to a gas state at room temperature, we will also do one experiment testing permeation of FTOHs in a gas phase
- We will use this experimental data to determine permeation, diffusion and partition coefficients, and breakthrough time using 2 mathematical models to deepen our understanding of PFAS and HDPE membranes and how we can prevent PFAS leaching from landfills

Methods

This research first evaluates the permeation of 4 fluorotelomer alcohols (4:2, 6:2, 8:2 and 10:2 FTOH) in water through a high density polyethylene membrane at 4 temperatures (40, 50, 60, 70 ºC).

- We will use two-chamber diffusion cells separated by the HDPE membrane and placed in a heated water bath
- We will test the source and receptor receptor by removing samples with a syringe and diluting them in water mixed with internal standard
- We then saturate a fiber with and place it in a gas chromatography- mass spectrometry(GCMS) machine to measure the concentration of the FTOH
- The data gathered from these experiments will eventually be used in the second stage of the project which is the mathematical modeling

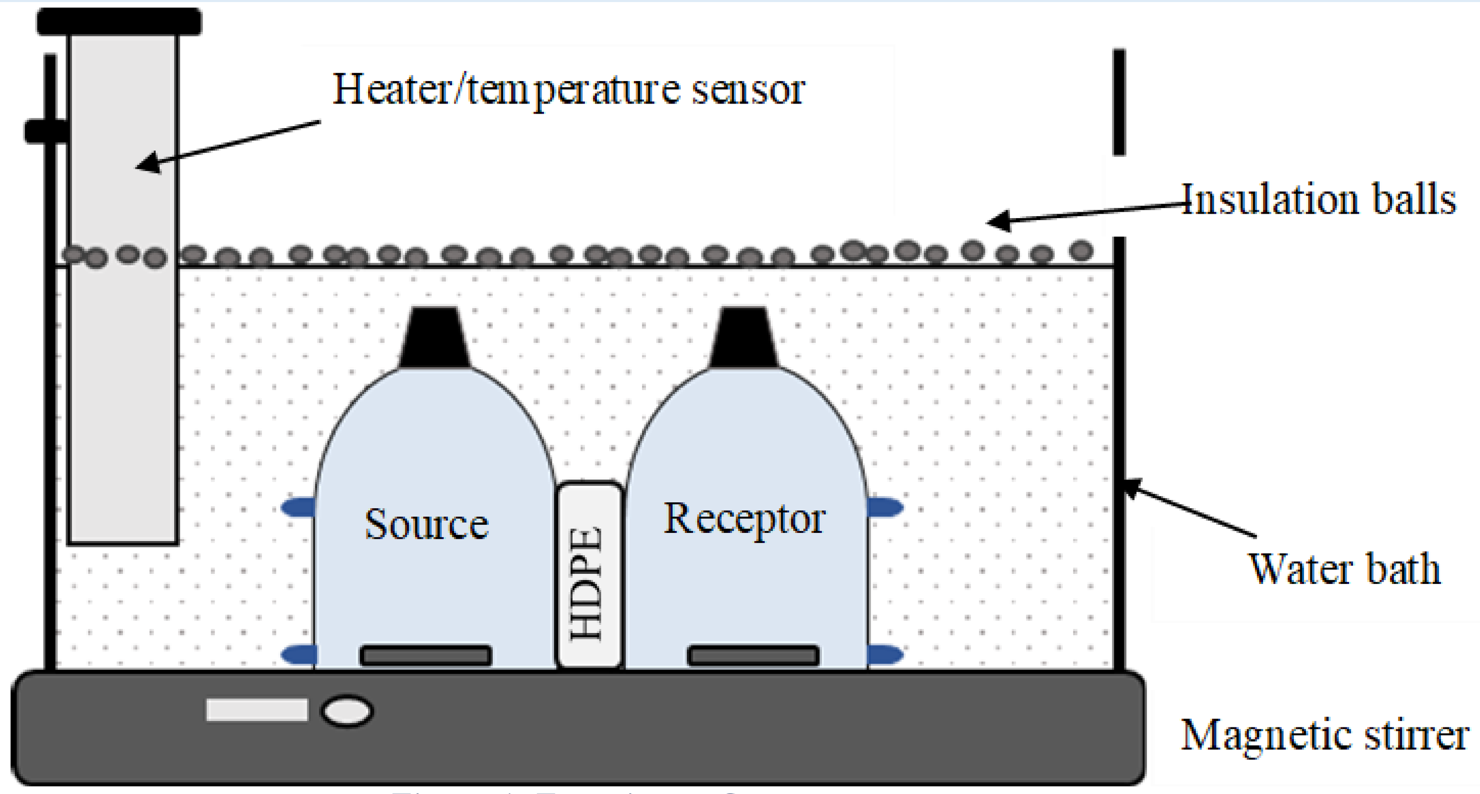

Figure 1. Experiment Set up

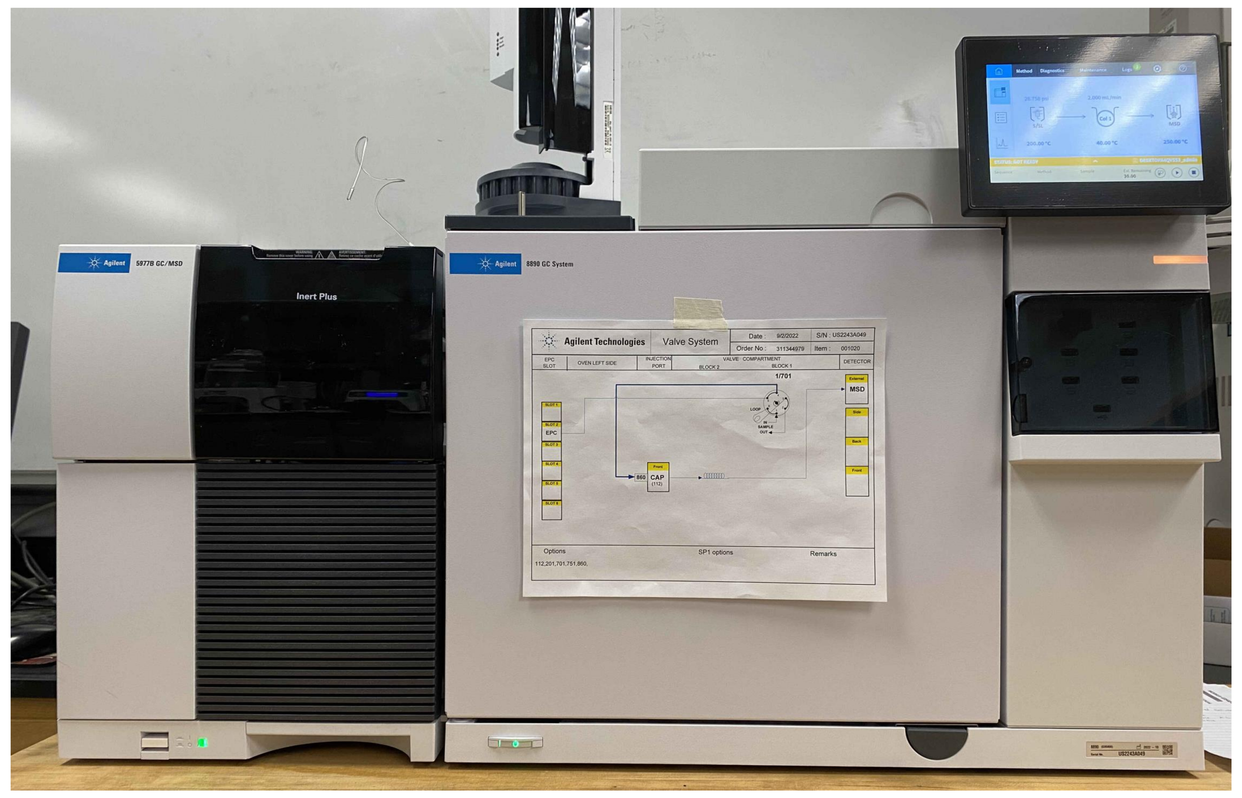

Figure 2. GCMS Machine

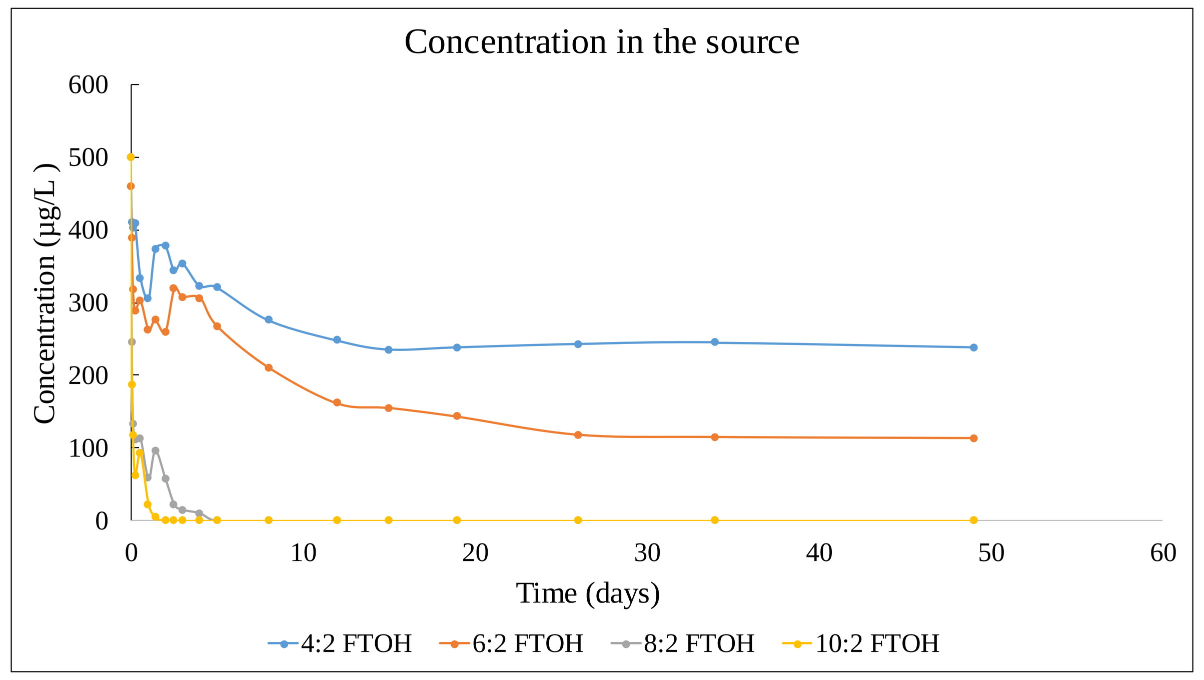

Figure 3. Source Concentration

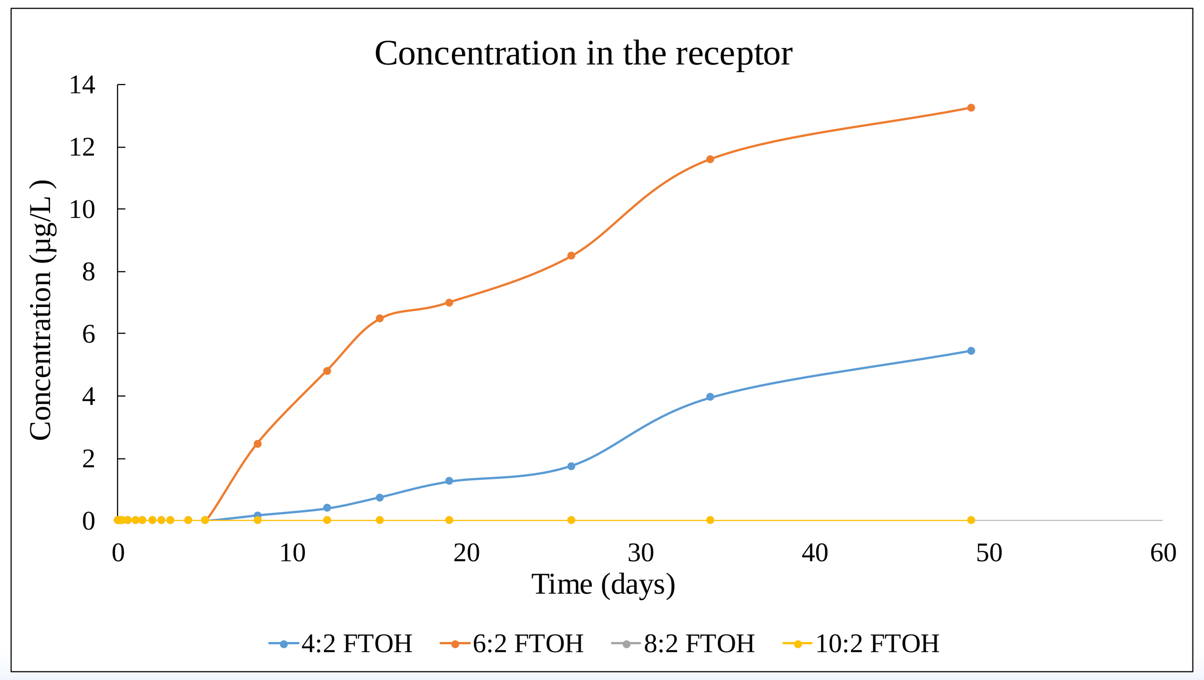

Figure 4. Receptor Concentration

Conclusions

- The findings of this research will deepen our understanding of the permeation of volatile PFAS as well as the effectiveness of HDPE as a landfill liner material
- Being able to understand and predict PFAS permeation is the first step to preventing it
- Future research could address FTOH permeation through LLDPE membranes or different geomembranes
- Future experiments could be done over longer time periods to gather more extensive and accurate data especially for long chain FTOHs which permeate much slower

Results

Preliminary results

- After 15 days, the FTOH concentrations in the source chamber decreased from approximately 500 μg/L to 235 and 155 μg/L for 4:2 FTOH and 6:2 FTOH, respectively.
- The concentrations of long chain FTOHs (8:2 FTOH and 10:2 FTOH) reached below the detection limit of 1 μg/L in the source after 5 days.
- The long chain FTOHs have remained under the detection limit in the receptor.
- After approximately 5 days concentrations of the short chain FTOHs (4:2 and 6:2 FTOH) started to increase with 6:2 FTOH increasing the most rapidly.

Once we complete our experiments and have collected all the data, we will be able to complete the modeling portion of this project and mathematically determine permeation, diffusion and partition coefficients, and breakthrough time.

Acknowledgements

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References