QUARTERLY PROGRESS REPORT

[October 01, 2024 – December 31, 2024]

PROJECT TITLE: Permeation of Fluorotelomer Alcohols through Landfill Covers and Liners

PRINCIPAL INVESTIGATOR:

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Project summary: The objective of this project is to determine the permeability of representative volatile per- and polyfluoroalkyl substances (PFAS) (*i.e.*, fluorotelomer alcohols (FTOHs)) through high-density polyethylene (HDPE) membrane, which is widely used in landfill liners and sometimes used in landfill covers. Task 1 (*i.e.*, Permeation experiments) of this project will experimentally study the permeation of four FTOHs in water (*i.e.*, 4:2, 6:2, 8:2, and 10:2 FTOH) through HDPE at four temperatures (*i.e.*, 40, 50, 60, and 70 °C). Task 2 (*i.e.*, Permeation modeling) of this project will mathematically determine the four permeation parameters by fitting the experimental data from Task 1 with two mathematical models. Four permeability parameters include permeation, diffusion and partition coefficients and breakthrough time. Task 3 (*i.e.*, Low FTOH concentration experiment) will evaluate the permeation of FTOHs through HDPE membrane at an environmentally relevant concentration. Task 4 (*i.e.*, Vapor-phase experiment) will evaluate the permeation of vapor-phase FTOHs.

Work Accomplished during this Reporting Period:

Project activities started as soon as the agreement was signed in late 2024. During this reporting period, we held the first technical awareness group (TAG) meeting and completed ~10% of Task 1.

Project Website: https://web1.eng.famu.fsu.edu/~ytang/FTOH_permeation.html

TAG 1: Technical Awareness Group Meeting #1

The first TAG meeting was held on December 6, 2024. The corresponding meeting minutes, TAG information, and recording can be found in the project website above.

Task 1: Permeation experiments

In Task 1, we will evaluate the permeation of four FTOHs (*i.e.*, 4:2, 6:2, 8:2, and 10:2 FTOH) in water through an HDPE membrane at four temperatures (*i.e.*, 40, 50, 60, and 70 °C). The permeation experiments will follow American Society for Testing and Materials (ASTM) Method F739-20 with modification for various temperatures and long testing periods. It will be conducted in two-chamber diffusion cells separated by an HDPE membrane. As shown in Figure 1, two cells are separated by the membrane and placed in a heated water bath. Table 1 shows the list of all experiments in Task 1.

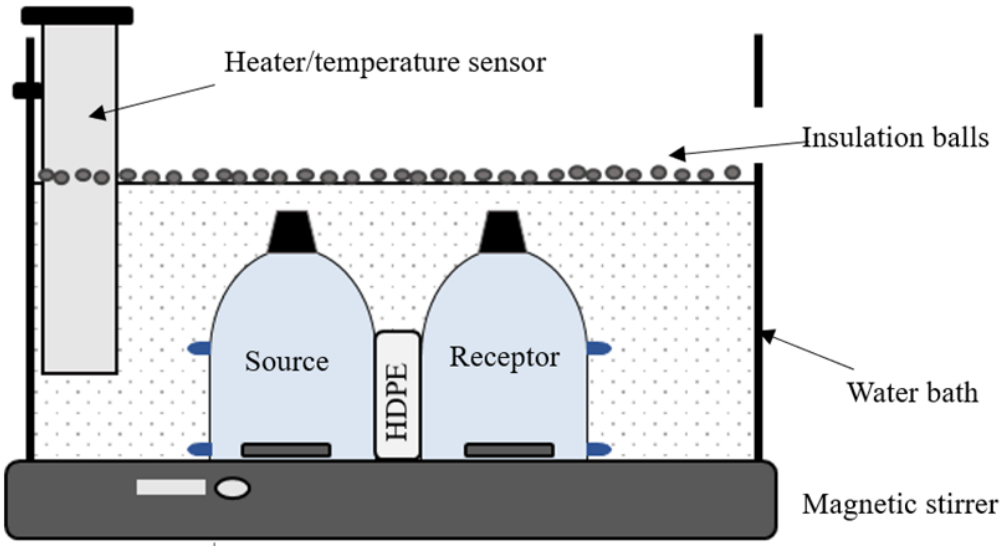

Figure 1. Permeation experiments in Task 1

Table 1. Permeation experiments in Task 1

Experiment #	Explanation
#1	Permeation of FTOHs at 500 µg/L in source at 40 °C through HDPE membrane.
#2	Permeation of FTOHs at 500 µg/L in source at 40 °C through metal membrane (control).
#3	Permeation of FTOHs at 500 µg/L in source at 50 °C through HDPE membrane.
#4	Permeation of FTOHs at 500 µg/L in source at 50 °C through metal membrane (control).
#5	Permeation of FTOHs at 500 µg/L in source at 60 °C through HDPE membrane.
#6	Permeation of FTOHs at 500 µg/L in source at 60 °C through metal membrane (control).
#7	Permeation of FTOHs at 500 µg/L in source at 70 °C through HDPE membrane.
#8	Permeation of FTOHs at 500 µg/L in source at 70 °C through metal membrane (control).

During this quarterly report, we did one experiment at 60 ˚C (experiment #5). 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 (See Figure 1). The concentrations of the long-chain FTOHs (i.e. 8:2 FTOH and 10:2 FTOH) reached below the detection limit of 1 µg/L after 5 days. Adsorption of FTOHs to the membrane was consistent with their octanol-water partition coefficients: Longer chain FTOH have higher octanol-water partition coefficients and adsorption rates (Carmosini and Linda 2008). Moreover, the concentrations of FTOHs were below the detection limit in the receptor during the first 15 days.

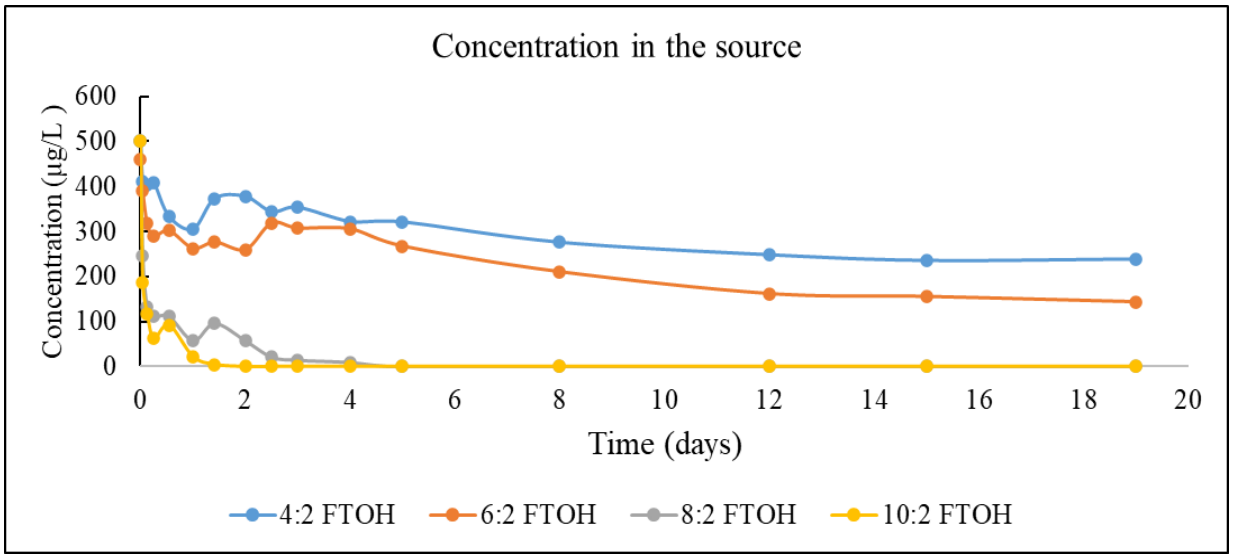

Figure 1. The concentrations of FTOHs in the source chamber at 60 ˚C.

References:

Carmosini, Nadia, and Linda S. Lee. "Partitioning of fluorotelomer alcohols to octanol and different sources of dissolved organic carbon." *Environmental science & technology* 42, no. 17 (2008): 6559-6565.

TAG MEETINGS:

• Date of the meeting.

The first TAG meeting was held on December 6th, 2024.

• Names/title/emails of all participants.

Mojtaba Nouri Goukeh (FAMU-FSU College of Engineering), Youneng Tang (FAMU-FSU College of Engineering), Joseph Dertien (Florida Department of Environmental Protection), Walsta Jean-Baptiste (Florida Department of Environmental Protection), Shanin Speas-Frost (Florida Department of Environmental Protection), Owete S. Owete (Florida Department of Environmental Protection), Chao Zhou (Geosyntec Consultants), Bruce Marvin (Geosyntec Consultants), Kevin M. Warner (Geosyntec Consultants), Terry Johnson (Waste Management Inc.), Xia Cao (GCP Applied Technologies Inc.), Mike Chase (Florida Rural Water Association), Peyton Piotrowski (Florida Rural Water Association), Paul E. Seaver (Palm Beach Springs Water Company Inc.), Natalia Soares Quinete (Florida International University), Timothy G. Townsend (Hinkley Center for Solid and Hazardous Waste Management), Hannah Sackles (Hinkley Center for Solid and Hazardous Waste Management), Sherry Carpenter, Dennis Ssekimpi (FAMU-FSU College of Engineering), Maeve Storm (FAMU-FSU College of Engineering), Sabrina Clark (FAMU-FSU College of Engineering)

• List of TAG members who were **unable** to attend this meeting.

Sterling Carroll (Florida Rural Water Association)

• Link to the video recording of the TAG meeting. The link to the TAG meeting recording should also be posted on the project website.

https://youtu.be/xbIC19xaHCg

Metrics:

1. Summarize input provided by the TAG during this period.

- *There is a question about the research team's plan for the three scheduled TAG meetings. Answer from the research team: The first meeting is an introduction, the second meeting will be to share experimental results, and the final meeting will be to share findings. The team will use feedback from TAG results; feedback is helpful because Task 3 and Task 4 were added based on previous suggestions.*
- *There is a question about the reasoning for the selected source concentration. Answer from the research team: A high concentration allows the research team to more easily view results, but the concentration cannot be raised because of low solubility of FTOH.*
- *There is a suggestion to compile the findings of all PFAS research projects. A statewide meeting or conference are discussed as possibilities.*
- *There is a question about the reason for selecting FTOH specifically. Answer from the research team: soluble PFAS have already been researched; volatile PFAS have different properties from previously researched PFAS. Research has not been done on volatile PFAS permeation through membrane, and FTOH is a dominant group of volatile PFAS.*
- *There is a question about Task 3 (low FTOH concentration experiment) and the measurement method that will be used. With GC/MS, there are often difficulties with volatile substances and trap. Answer from the research team: The team is using SPME, which uses fibers to adsorb and does not need to adsorb all target compounds. The internal standard is added to increase data quality, so both the internal standard and target compounds are measured and the results come from the ratio between them.*
- *There is a question about if the modeling results will inform of the timescale for Task 3, the low concentration experiment. Answer from the research team: Yes; the modeling will be used for the low concentration experiment.*
- *There is a comment that the Task 4 results may have relevance for vapor intrusion into existing or new structures, and there is an interest in FTOH in indoor air.*

2. List research publications resulting from THIS Hinkley Center project.

None in this reporting period.

3. List research presentations resulting from (or about) THIS Hinkley Center project.

Permeation of Fluorotelomer Alcohols through Landfill Covers and Liners. Presented by Mojtaba Nouri Goukeh at the first Technical Awareness Group Meeting. December 6th, 2024, Tallahassee, FL

4. List who has referenced or cited your publications from this project.

None in this reporting period.

5. How have the research results from THIS Hinkley Center project been leveraged to secure additional research funding? What additional sources of funding are you seeking or have you sought?

None in this reporting period.

6. What new collaborations were initiated based on THIS Hinkley Center project?

None in this reporting period.

7. How have the results from THIS Hinkley Center funded project been used (not will be used) by the FDEP or other stakeholders?

None in this reporting period.

PICTURES:

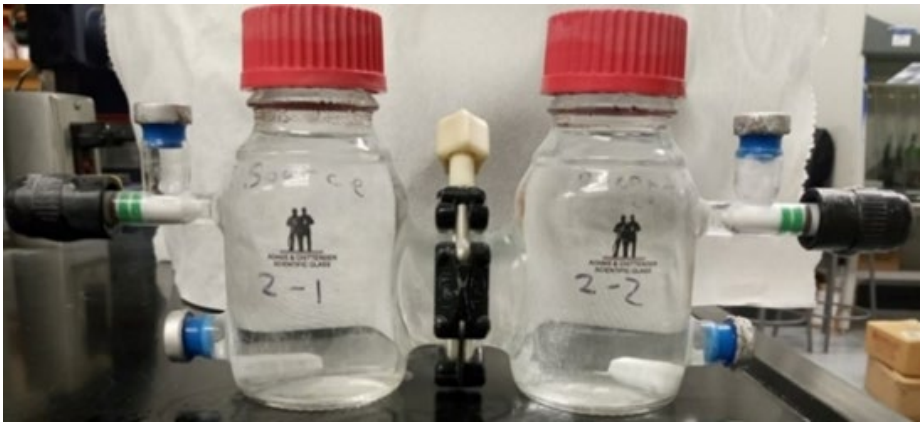

Figure 1. A two-chamber permeation cell used in the preliminary experiment