QUARTERLY PROGRESS REPORT

[October 01, 2023 – December 31, 2023]

PROJECT TITLE: Fate and Transport of Volatile PFAS in Bench-Scale Municipal Solid Waste Landfills

PRINCIPAL INVESTIGATOR:

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Project summary: While there have been tremendous knowledge advances in PFAS in municipal solid waste (MSW) landfilling, the following three research questions regarding the volatile PFAS fate and transport have not been answered: 1) Which types of MSW produce volatile PFAS in gas emission? 2) How do volatile PFAS concentrations in leachate and gas emission change with time during landfilling? 3) Are volatile PFAS leached to leachate and released to gas emission mainly through reaction of precursors? The following three tasks are proposed to address the above three questions, respectively. Task 1 (*i.e.*, Volatile PFAS source characterization) of this project is to characterize the MSW sources that contain volatile PFAS or precursors of these PFAS. It focuses on experimental determination of representative volatile PFAS (*i.e.*, fluorotelomer alcohols (FTOHs)) in representative municipal solid waste (*i.e.*, various consumer products). Task 2 (*i.e.*, Volatile PFAS leached to leachate and released to gas emission) is to determine the change of volatile PFAS concentrations in leachate and gas emission in bench-scale landfills for six types of representative municipal solid waste: one type of waste in each landfill. Task 3 (*i.e.*, Volatile PFAS release mechanisms) is to estimate the percentage of volatile PFAS leaching and release due to reaction of the PFAS precursors.

Work Accomplished during this Reporting Period:

Project activities started as soon as the subcontract was signed in early December 2023. During this reporting period, the research team developed a project website, held the first technical awareness group (TAG) meeting, and completed ~25% of Task 1.

Project Website:

https://web1.eng.famu.fsu.edu/~ytang/PFAS_in_landfill.html

TAG 1: Technical Awareness Group Meeting #1

The first TAG meeting was held on January 9th, 2024. The corresponding meeting minutes, TAG information, and recording can be found in the project website above.

Task 1: Volatile PFAS source characterization

This task focuses on experimental determination of representative volatile PFAS (*i.e.*, fluorotelomer alcohols (FTOHs)) in representative municipal solid waste -- various consumer products.

Based on an extensive literature review, we conclude that at least 90 materials have been evaluated for FTOHs concentrations in previous studies. Figure 1 shows the concentration ranges, concentration averages, and detection percentages for 6:2 fluorotelomer alcohol (6:2 FTOH) in various materials reported in the literature. We divide the materials into three categories, including category 1 (textiles, apparel, and carpets), category 2 (paper and food packaging products), and category 3 (liquid and semi-liquid products). Based on the literature review, we select 24 materials that likely contain FTOHs for further study (see Table 1). We will use methanol to extract FTOHs and then measure them using solid phase microextraction (SPME) combined with gas chromatography - mass spectrometry (GC-MS). During this reporting period, we placed purchase orders for materials and lab supplies needed for carrying out the three tasks. We expect to receive them soon.

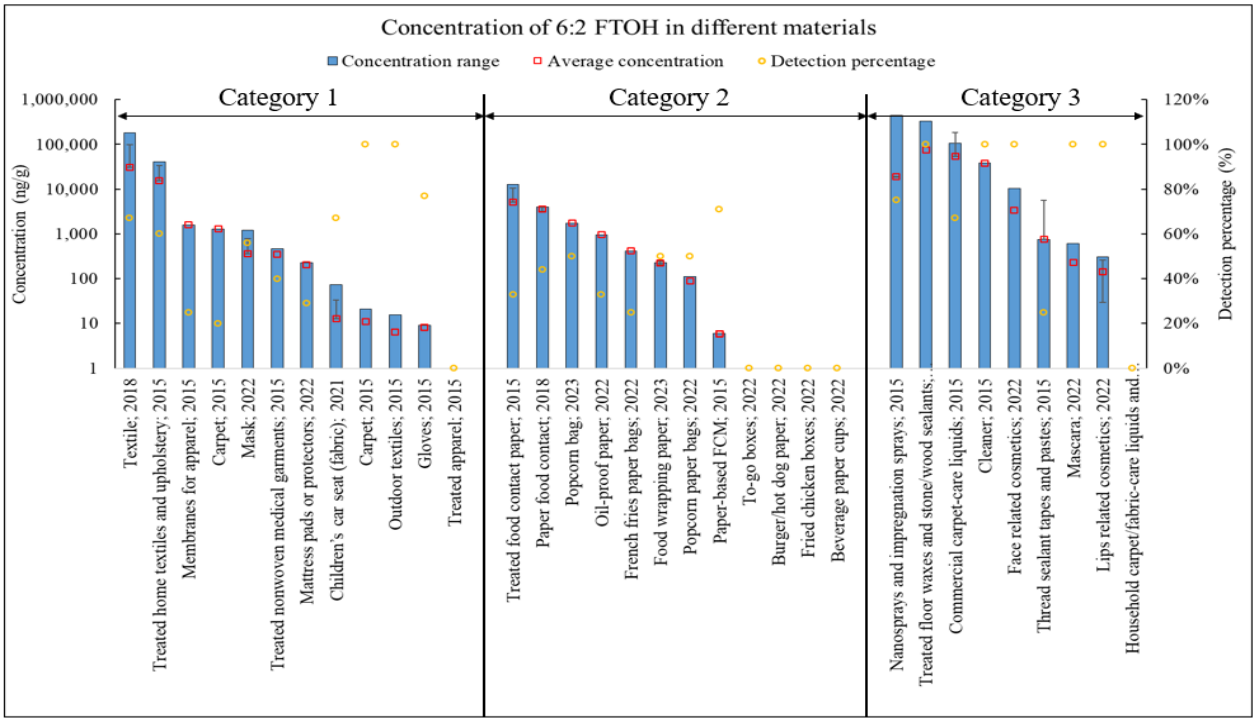

Figure 1. The concentrations and detection percentages of 6:2 FTOH in various materials (based on literature review)

Table 1. Selected consumer products to be further studied (tentative) for FTOHs in this project

	#	Item	Number of products
Category 1: Textiles, Apparel, and Carpets	1	Waterproof mattress protector	3
	2	Carpet	3
	3	Polyester textiles	3
	4	Apparel	3
	5	Tablecloth	3
	6	Napkin	3
	7	Glove	3
	8	Facemask	3
Category 2: Food and Food Packaging Products	1	Donut/ Pastry bag	3
	2	Popcorn bag-before baking	3
	3	Popcorn bag-after baking	3
	4	Food wrapping paper	3
	5	Bagasse plates (Food bowl)	3
	6	Paper tableware	3
	7	Oil-proof paper	3
	8	French fries paper	3
Category 3: Liquid and Semi-liquid Products	1	impregnation products	3
	2	Waterproof Mascara	3
	3	Lipstick	3
	4	Face cream	3
	5	Cleanser	3
	6	Anti-fog spray	3
	7	Treated floor waxes and stone/wood sealants	3
	8	Paint	3
Total items = 24		Total samples = 72	

References:

Dewapriya, P., Chadwick, L., Gorji, S. G., Schulze, B., Valsecchi, S., Samanipour, S., ... & Kaserzon, S. L. (2023). Per-and polyfluoroalkyl substances (PFAS) in consumer products: current knowledge and research gaps. *Journal of Hazardous Materials Letters*, 100086.

Gaines, L. G. (2023). Historical and current usage of per-and polyfluoroalkyl substances (PFAS): A literature review. *American Journal of Industrial Medicine*, *66*(5), 353-378.

Goukeh, M. N., Abichou, T., & Tang, Y. (2023). Measurement of fluorotelomer alcohols based on solid phase microextraction followed by gas chromatography-mass spectrometry and its application in solid waste study. *Chemosphere*, *345*, 140460.

Kotthoff, M., Müller, J., Jürling, H., Schlummer, M., & Fiedler, D. (2015). Perfluoroalkyl and polyfluoroalkyl substances in consumer products. *Environmental Science and Pollution Research*, *22*, 14546-14559.

Lerch, M., Fengler, R., Mbog, G. R., Nguyen, K. H., & Granby, K. (2023). Food simulants and real food–What do we know about the migration of PFAS from paper based food contact materials?. *Food Packaging and Shelf Life*, *35*, 100992.

Liu, X., Guo, Z., Folk IV, E. E., & Roache, N. F. (2015). Determination of fluorotelomer alcohols in selected consumer products and preliminary investigation of their fate in the indoor environment. *Chemosphere*, *129*, 81-86.

Siao, P., Tseng, S. H., & Chen, C. Y. (2022). Determination of perfluoroalkyl substances in food packaging in Taiwan using ultrasonic extraction and ultra-performance liquid chromatography/tandem mass spectrometry. *Journal of Food and Drug Analysis*, *30*(1), 11.

Wu, Y., Miller, G. Z., Gearhart, J., Peaslee, G., & Venier, M. (2021). Side-chain fluorotelomer-based polymers in children car seats. *Environmental Pollution*, *268*, 115477.

Metrics:

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

- *One of the TAG members asked how the two projects are related and collaborate with each other. The research team explained that with combined efforts, the two projects would benefit from each other and bring more significant outcomes. One project focuses on water-soluble PFAS while the other project focuses on volatile PFAS. These two types of PFAS (water-soluble versus volatile PFAS) may be transformed to each other. The PFAS analysis expertise and resources in each project will be used and helpful in the other project.*
- *One of the TAG members suggested considering the impact of air-water interface, Gibbs free energy, and Henry's law constant on mass transport during the PFAS fate experiments and modeling. The research group agreed on the importance of these factors and would consider these parameters during the analysis of the experiment data and in the modeling equations.*
- *One of the TAG members suggested measuring more volatile PFAS than FTOHs. She further suggested polyfluoroalkyl phosphate diesters (diPAPs). Some PFAS may be converted to FTOHs during measurement. The research team will review the literature on diPAPs measurement and then determine if they can be measured by the resources available to the research team.*

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.

Fate and Transport of Volatile PFAS in Bench-Scale Municipal Solid Waste Landfills. Presented by Mojtaba Nouri Goukeh at the first Technical Awareness Group Meeting. January 9th, 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?

This is mentioned in our response to the first question. There is collaboration between two Hinkley Center-funded PFAS projects.

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:

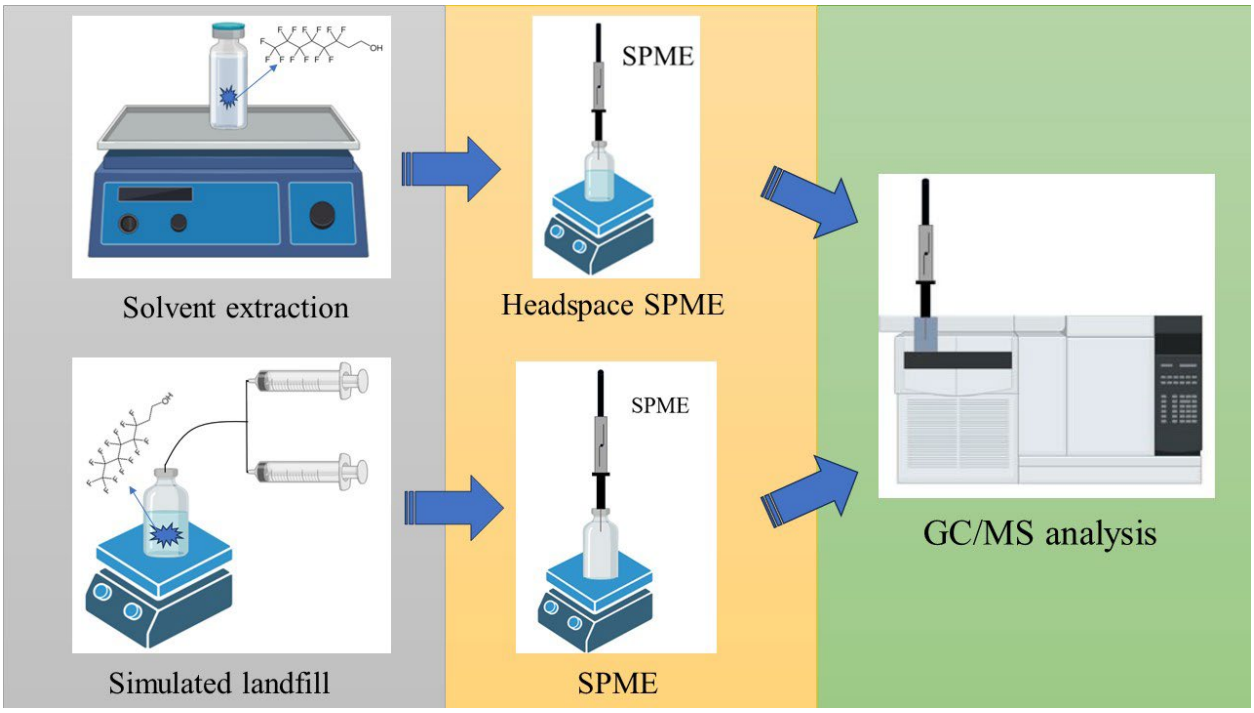

Figure 1. Measurement of fluorotelomer alcohols (FTOHs)

Figure 2. Equipment (*i.e.*, gas chromatography - mass spectrometry) for measurement of FTOHs