Thermal degradation of PFCAs can lead to the formation of potentially toxic fluoroalkenes and alkanes

Ivan A. Titaley, Florentino B. De la Cruz, Morton A. Barlaz, Staci L. Massey Simonich, Jennifer A. Field

Oregon State University

NC STATE UNIVERSITY

Objectives

- Determine the byproducts of perfluorocarboxylates (PFCA) following thermal treatment

PFCAs thermal degradation led to the formation of unsaturated fluoroalkenes and fluoroalkanes, some of which are predicted to be carcinogenic, mutagenic, or toxic by the European Chemicals Agency (ECHA)

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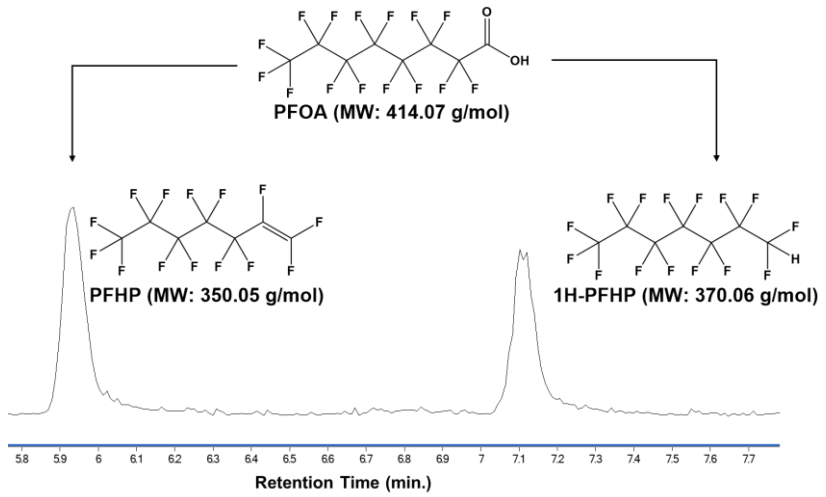


Technical Approach

Thermal Desorption (TD)-GC-MS

- 50 ng PFCAs deposited on TD tube
- PFCAs were thermally desorbed at 320°C (Markes International)
- Volatile products were analyzed with GC-MS (60 m DB-VRX, EI mode)

Project Overview

Current:

PFCA standards → TD-GC-MS → Product analysis

- Initial work performed with PFOA
- Followed by mix of PFCAs (C4-C14)

Project Overview

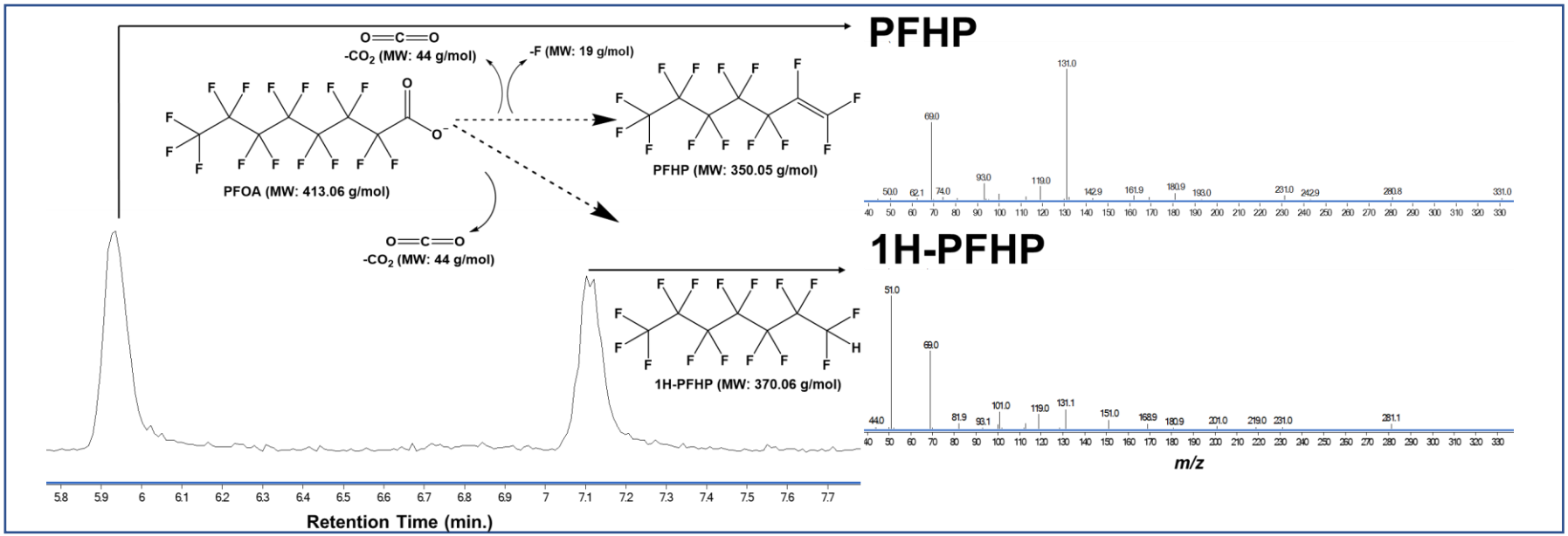
Future:

- Repeat analysis with other PFAS standards
- Use thermogravimetric analysis (TGA) to determine the breakdown temperature

Results to Date

- Thermal byproducts of PFOA:
  - Perfluoroheptene (PFHP, fluoroalkene)
  - 1H-perfluoroheptane (1H-PFHP, fluoroalkane)
- PFHP is *predicted* by ECHA to be carcinogenic, mutagenic, or toxic
- Degradation of PFCAs to fluoroalkene and fluoroalkane has been previously mentioned (Kissa, 2001; Krusic *et al.*, 2005, Xiao *et al*., 2020)

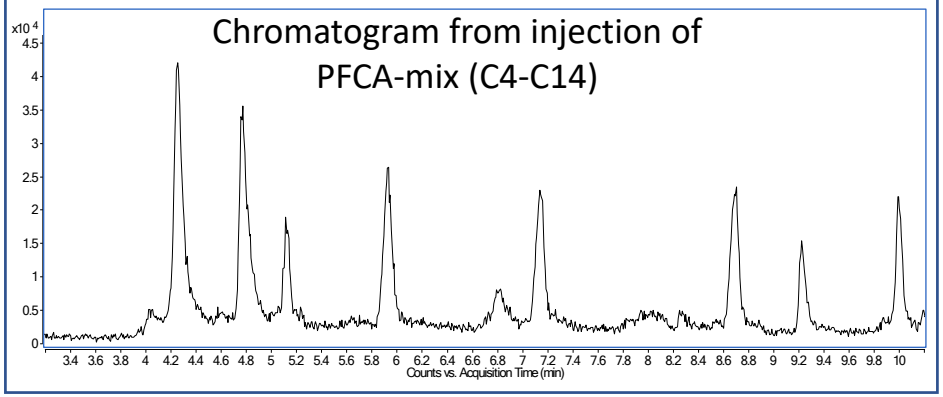
- Thermal byproducts predicted to be carcinogenic, mutagenic, or toxic by ECHA:
  - Perfluorooctene and 1H-perfluorooctane (PFNA products)
  - Perfluorohexene (PFHpA product)
  - Perfluoropentene (PFHxA product)
- Thermal byproducts of PFBA and PFPA were not observed



Lessons Learned and Next Steps

- Thermal remediation (sub-incineration) studies of PFCAs need to consider the formation of thermal byproducts
- Once identified, assessment on the potential carcinogenicity/mutagenicity/ toxicity of PFCAs thermal byproducts should be performed
- Next step: replicate the experiment with other PFAS, combined with TGA

- Mixture of PFCAs injected, desorbed, and analyzed with TD-GC-MS showed the presence of fluoroalkane and fluoroalkene mixtures



Additional Resources

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Correspondence

Comment on "Release of Volatile Per- and Polyfluoroalkyl Substances from Aqueous Film-Forming Foam"

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Ivan A. Titaley, Ph.D.

Postdoctoral Scholar

Oregon State University

ivan.titaley@oregonstate.edu