

Case Study: Estimating the Mass of PFAS in Building Materials

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Motivation

PFAS found in elevated levels around urban areas.

PFAS are added to paints:

- Surfactants
- Flow agents
- Durability/ stain proofing agents

We hypothesize that exterior coatings are a significant source of PFAS in the environment.

Production of PFAS

PFAS added to paint formulations

Paints applied to exteriors of homes

Elevated PFAS levels in urban areas

PFAS are released

Exterior surface weathering

Quick Facts: Canada

- 95% of paints are imported from the US¹
- Estimated demand for paints (2024): 692 000 t¹
- 7 million single family homes (2016)²

Quick Facts: United States

Primary material in newly built homes US (2022)⁴

Masonry	Concrete & Stucco	Vinyl	Wood
• 189,000 homes	• 519,000 homes	• 250,000 homes	• 45,000 homes

Method

Four primary exterior materials

Product Testing for total fluorine (F) N=67

* PIGE: particle-induced gamma-ray emission spectroscopy

Building Plans N=4

Surface Area Calculations

Estimation of mass of PFAS in Exterior Building Materials

Key assumptions:

- Application of products was completed in 1 layer
- All surfaces exposed to the environment must be protected with a coating
- A single coating type can be applied to multiple different substrates
- PIGE measurements represent organic F

Mass Estimation Formula

- $$\frac{g_{fluorine}}{cm^2_{PM}} = \frac{g_{fluorine}}{cm^2_{sample}} \times \frac{cm^2_{sample}}{g_{product}} \times \frac{g_{product}}{cm^2_{PM}}$$
- $$g_{fluorine} \text{ per Primary Material (PM)} = \frac{g_{fluorine}}{cm^2_{PM}} \times \text{Surface Area of PM (cm}^2\text{)}$$
- $$\sum \text{Total F house exterior} = \frac{g_{fluorine}}{SA_{masonry}} + \frac{g_{fluorine}}{SA_{con \& stuc}} + \frac{g_{fluorine}}{SA_{vinyl}} + \frac{g_{fluorine}}{SA_{wood}}$$

* Calculation excludes volatile PFAS

Exterior products

- Marked as Fluorinated? Fluorinated ingredients?
- Marked as highly durable, weatherproof, stain resistant, good flow
- Oil vs Water based
- Sheen
- Substrate: masonry, concrete & stucco, vinyl, wood, metal
- Ingredients on Safety Data Sheet

Results

LOD = 5 µg/cm²

PIGE testing: Summary

- 52% (35/67) had total detectable F above the LOD
- Maximum: 6170 µg/g

Products above LOD

Products above LOD

Detection frequencies of products with total F

No relationship between price and PFAS content

Metal: 101m²

g_{fluorine}: 1g, 2g, 7g

Masonry: 13 m²

g_{fluorine}: 8g, 13g, 35g

Primary Material: Masonry

Total F in house exterior:

10 th percentile	Median	90 th percentile
9g	15g	42g

Metal: 411m²

g_{fluorine}: 33g, 41g, 142g

Wood: 66m²

g_{fluorine}: 4g, 11g, 41g

Concrete: 283m²

g_{fluorine}: 20g, 39g, 159g

Primary Material: Concrete & Stucco

Total F in house exterior:

10 th percentile	Median	90 th percentile
57g	91g	342g

Vinyl: 82m²

g_{fluorine}: 1g, 2g, 7g

Stucco: 14m²

g_{fluorine}: 8g, 13g, 35g

Primary Material: Vinyl

Total F in house exterior:

10 th percentile	Median	90 th percentile
9g	15g	42g

Wood: 172m²

g_{fluorine}: 1g, 2g, 8g

Primary Material: Wood

Total F in house exterior:

10 th percentile	Median	90 th percentile
1g	2g	8g

PIGE: QA/QC

Sample 1	<LoD
Duplicate 1	<LoD
Sample 2	<LoD
Duplicate 2	<LoD
Sample 3	1060
Duplicate 3	1490
Sample 4	<LoD
Duplicate 4	<LoD
Sample 5	2780
Duplicate 5	2360
Sample 6	619
Duplicate 6	275

- 6 lab duplicates: Duplicates and samples were replicable
- 6 lab blanks: Blanks showed TF below the LOD

Check out our poster on ¹⁹F NMR

Take Home Message

Based on our estimations, exterior building materials could be a significant source of PFAS to the environment.

Next steps:

- Promoting PFAS-free alternatives
- Disclosing PFAS used in coatings industry
- Investigating and phasing out of intentionally and unintentionally added PFAS

What can you do?

Acknowledgements:

Environment and Climate Change Canada / Environnement et Changement climatique Canada

Citations:

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