Cosmetics contribute to the PFAS load at wastewater treatment plants in California

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Per- and polyfluoroalkyl substances (PFASs) are virtually everywhere...
... which means PFAS exposure is highly complex
How much of the PFAS load measured at WWTPs can be attributed to cosmetics?

… and it is nearly impossible to identify the source of PFASs to wastewater treatment plants (WWTPs)
We found 40 distinct PFAS ingredients in 16 cosmetic product subcategories.

Data sources: Clearya, Consumer Product Information Database (CPID), U.S. FDA’s Voluntary Cosmetic Registration Program (FDA VCRP), Mintel, and EWG’s Skin Deep Database

Bălan et al. (in review at ES&T)
The PFAS universe

- PFBA
- PFBS
- PFHxA
- PFOA
- PFNA
- Etc.

Perfluoroalkyl acids (PFAAs)

Used in products

- Perfluoroctyl triethoxysilane
- Perfluorononyl ethyl carboxydecyl PEG-10 dimethicone
- diPAP
- Etc.

- PTFE
- Perfluorodecalin
- Etc.

Perfluoroalkyl acid precursors (pre-PFAAs)

Fluoropolymers and more
What we typically measure

\[
\sum \text{PFAAs, ng/L}
\]

PFBA, PFHxA, PFOA, PFNA, PFBS, etc.

Perfluorooctyl triethoxysilane

Perfluorononyl ethyl carboxydecyl PEG-10 dimethicone

diPAP

Perfluorodecalin

PTFE

Etc.
Total Oxidizable Precursor (TOP) assay

- Oxidative reaction cleaves perfluoroalkyl group from non-fluorinated portion of molecule
- Perfluoroalkyl groups transformed to PFAAs
Total Oxidizable Precursor (TOP) assay

\[ \sum \text{PFAAs}_{\text{post reaction}} - \sum \text{PFAAs}_{\text{pre reaction}} = \sum \text{pre-PFAAs} \]

The mass of the fluorinated side-chain groups in cosmetics can be compared to TOP assay data for wastewater.
Extractable or Adsorbable Organic Fluorine (EOF or AOF)

PFBA
PFHxA
PFOA
PFNA
PFBS
Perfluorooroctyl triethoxysilane
Perfluorononyl ethyl carboxydecyl PEG-10 dimethicone
diPAP
Perfluorodecalin
PTFE

Total organic fluorine
For cosmetics sold in California during a one-year period in 2019-2020, we calculated the...

What's the total mass of PFAS ingredients, organic fluorine, and fluorinated side chains?

What's the total mass of cosmetics sold in CA?

What fraction of products in each category contain PFAS?

What's the concentration of each PFAS ingredient in each product type?

Which PFAS ingredients are PFAA precursors?

How much fluorine is in each PFAS ingredient?

Bălan et al. (in review at ES&T)
Cosmetics sold in California during a one-year period contain 650 to 56,000 kg PFASs, including 330 to 20,000 kg fluorinated side chains.

Bălan et al. (in review at ES&T)
Shaving creams and gels, hair care, facial cleansers, and sun care accounted for >90% of the total organic fluorine in cosmetics

Bălan et al. (in review at ES&T)
Makeup accounted for less than 3% of the total fluorine

“Makeup” includes:
- blush
- bronzer and highlighter
- eye brow
- eye liner
- eye shadow
- face powder
- foundation and concealer
- lip cosmetics
- mascara

Bălan et al. (in review at ES&T)
Hair care products and facial cleansers contribute over 80% of the PFAA precursors (makeup contributes less than 1.6%)

Bălan et al. (in review at ES&T)
Cosmetics can explain some of the total organic fluorine measured at WWTPs

Bălan et al. (in review at ES&T)
Cosmetics contribute at least 4% of the precursor-derived PFAAs measured at WWTPs in the SF Bay Area

Some of these side chains could form perfluorooctanoic acid (PFOA)

Bălan et al. (in review at ES&T)
... plus 280 to 8,000 kg/yr ultra-short chains (one or two carbons)

Some of this will convert to trifluoroacetic acid (TFA)

Bălan et al. (in review at *ES&T*)
It takes a village

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  - David Andrews (EWG)
  - SFEI team
Will the PFAS levels go down due to AB 2771?

- Cosmetics containing intentionally-added PFASs banned in CA as of January 1, 2025
- ... but so are textiles (AB 1817)

Monitor again in 2025!
Let’s stay in touch!

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