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Simplifying Progress

PFAS | "Forever Chemicals"

Per- and Polyfluoroalkyl Substances

Per- and Polyfluoroalkyl Substances (PFAS) are a family of more than 4,700 chemical molecules that exhibit non-stick, chemical-resistant, heat-resistant, and waterproof characteristics, among others. The US Environmental Protection Agency (EPA) database lists more than 12,000 PFAS with confirmed structures. However, European agencies have adopted a broader definition of PFAS than the US EPA.

Due to their unique chemical properties, PFAS have been used in various industries and consumer goods, including cosmetics, firefighting foam, food packaging, textiles, cookware, and automobiles. After being released from industrial plants, PFAS eventually enter water bodies and oceans, from where they are released into the atmosphere via aerosols. Rainfall then brings these chemicals back to the earth's surface, where they can persist for decades.

The same stable chemical bonds that make PFAS attractive to manufacturers also make them resistant to degradation. Due to their inherent durability, PFAS persist in the environment and can be found in air, water, sediment, soil, and even rain. One study detected PFAS in remote locations such as Antarctica and the Himalayas. This is concerning due to the growing evidence of the harmful health and environmental impacts of these chemicals.

Although the largest global producers of PFAS have discontinued certain products, the production of alternative fluorochemicals continues. This necessitates ongoing research and surveillance.

Negative Impacts of PFAS

Effects on human health

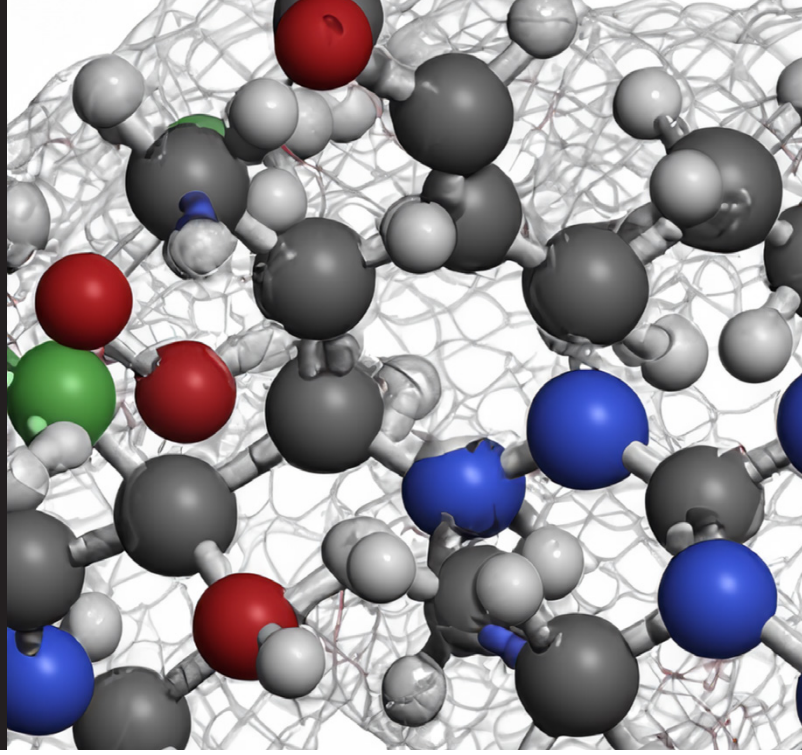
- Development of kidney and testicular cancer
- Liver damage
- Elevated cholesterol levels
- Weakened immune function
- Decreased fertility or complications during pregnancy
- Interference with hormone function

Effects on environment

- Bioaccumulation
- Contamination of groundwater and drinking water
- Harmful effects on reproduction, development and the immune system of animals

PFAS as “Forever Chemicals”

PFAS have stable carbon-fluorine bonds, the strongest covalent bonds in chemistry, along with varying carbon chain lengths. These chemical bonds require significant energy to break, which makes them extremely durable or stable to degradation in the environment—and the human body. Currently, the US Food and Drug Administration (FDA) assesses food products for six PFAS contaminants (PFOA, PFOS, PFNA, PFHxS, HFPO-DA, GenX, and PFBS) that may pose a risk to human health.



Regulations

International

The Stockholm Convention on Persistent Organic Pollutants, established in 2004, is a global treaty aimed at protecting the environment and human health from the effects of Persistent Organic Pollutants (POPs), which include PFAS.

They classify the chemicals according to Annexes A–C:

- Prohibited **(A)**
- Restricted **(B)**
- Unintentional production **(C)**

United States of America

The EPA is committed to implementing specific actions and adopting more robust policies to protect public health, preserve the environment, and hold polluters accountable.

In the EPA’s fifth Unregulated Contaminant Monitoring Rule (UCMR 5), the agency established minimum reporting levels (MRLs) for the contaminants under UCMR 5, which include 29 PFAS.

Europe

The revised Directive 2020/2184, dated 16 December 2020, pertaining to the quality of drinking water includes parameters for PFAS. It targets 20 PFAS and sets a limit of 0.10 µg/L for the combined total of these compounds in drinking water.

REACH Regulation, introduced in 2006 to regulate the production and use of chemical substances, classifies PFOA, PFOS, GenX, and PFBS as Substances of Very High Concern (SVHC).

Sample Preparation for PFAS Determination

Materials and tools used for environmental sampling should be free from contaminants or interfering substances at levels less than one-third of the MRL. Sartorius offers a variety of trusted solutions for sample preparation workflows, ensuring time efficiency and robust, reproducible results.

PFAS guidelines for testing are governed by various regulations and standards, including EPA 533, EPA 537.1, EPA 8327, EPA 1633, ISO 25101, ISO 21675, and ASTM E3302. These standards are evolving due to the growing global awareness of PFAS and their adverse effects.

Workflow

Step 1: Preparation of solvents

The preparation of solvents for LC-MS requires ultrapure water to ensure accuracy and reliability in the analysis. Any contaminants present in the water can interfere with the measurements.

Step 2: Preparation of standards

Precise weighing is crucial when preparing standards or laboratory control samples. Deviations can lead to significant errors in concentration, potentially compromising the validity of the results.

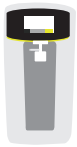
Step 3: Pipetting

To reliably detect trace contaminants, it is critical to utilize every microliter of sample. Accurate pipetting is also vital to ensure reliable data from the sample and surrogate spiking solutions.

Step 4: Filtration

Filtration devices play a vital role in clarification, prefiltration, and sterile filtration, as they help remove particles that could interfere with detection and potentially block the chromatography column.

Solutions



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Tips for Contamination-Free PFAS Sampling

Do's

- Wear cotton clothing or well-laundered synthetic fabrics
- Use nitrile gloves without powder
- Use PFAS-free equipment and supplies, including caps
- Use pesticide-free or higher-purity reagents and solvents
- Use pipettes that are free of target analyte with disposable polyethylene tips

Dont's

- Wear water-repellent, waterproof, stab-resistant, fire-repellant clothes
- Use cosmetics, moisturizers, sunblock, or insect repellents, which include PFAS
- Use plastic clipboards, waterproof logbooks
- Bring packaged food/drinks
- Use aluminum foil labels, permanent markers, sticky notes
- Use chemical ice

References

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