

PFAS Basics Primer

Introduction

Per- and polyfluoroalkyl substances (PFAS) are man-made chemicals that have been widely used in industry and consumer products worldwide since the 1950s. They have been used in non-stick cookware, water-repellent clothing, stain resistant fabrics and carpets, cosmetics and firefighting foams, and products designed to resist grease, water, and oil.

The most commonly produced and studied PFAS are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). There are numerous other PFAS compounds. PFOA and PFOS have been phased out of production and use in the United States, but other countries may still manufacture and use them.

Basic Chemical Properties and Uses of PFAS

PFAS compounds consist of both a fluorocarbon tail and an active functional group. Therefore, they have two separate sets of characteristics. The fluorocarbon tails possess strong bonds and hydrophobic properties, while active functional groups are strong to weak acids and shows hydrophilic properties. Because of their hydrophobic properties, PFAS have surfactant characteristics. Therefore, PFAS, which are highly soluble in water and very resistant to degradation, can persist in human and other animal tissue for years. ¹

PFAS were widely used in the manufacture of many common household and commercial products. Household products containing PFAS include fabric treatments (e.g., stain and water-resistant apparel) and products requiring resistance to chemical/oil/heat resistant (e.g., non-stick cookware). Commercially, PFAS were used as a process surfactant in oil well stimulation, car washes, chromium plating, and textile coaters. In addition, PFAS were very popular as a firefighting agent (e.g., Aqueous Fire Fighting Foams).^{2 3}

Human Exposure to PFAS

During production and use, PFAS can migrate into the soil, water, and air. Due to their widespread use and persistence in the environment, PFAS have been found in the blood of people and animals throughout the world and at low levels in a variety of food products and the environment generally. The level of PFAS in human and animal blood and tissue can increase with repeated exposure over time. The following are documented primary sources of human exposure to PFAS. ⁴

- Drinking contaminated municipal water or private well water
- Eating fish caught from water contaminated by PFAS
- Ingestion of contaminated soil or dust
- Eating food packaged in material that contains PFAS (e.g., grease-resistant paper, fast food containers/wrappers, microwave popcorn bags, pizza boxes, and candy wrappers)

ELI Environmental Health & Safety Senior Officer Council

- Using consumer products, such as non-stick cookware, stain resistant carpeting, and water repellant clothing
- Cleaning products
- Personal care products (shampoo, dental floss) and cosmetics (nail polish, eye makeup)
- Paints, varnishes, and sealants

Health Effects Associated with PFAS

The health effects associated with exposure to the primary PFAS compounds in the environment have been widely studied and reported. While it is difficult to show that the substances directly cause health conditions in humans, scientific studies have shown that exposure to some PFAS in the environment may be linked to harmful health effects in humans and animals. Some studies of human exposure to PFAS indicate that such exposure may: ^{5 6}

- Affect growth, learning, and behavior of infants and older children;
- Lower a woman's chance of getting pregnant and cause pregnancy induced hypertension;
- Interfere with the body's natural hormones (e.g., thyroid disease);
- Increase blood cholesterol levels;
- Cause auto-immune disease (e.g., ulcerative colitis)⁷; and,
- Increase the risk of contracting testicular and kidney cancer.

In addition, though not conclusive, other scientific studies regarding human exposure to mixtures of PFAS indicate the following possible health conditions. ⁶

- Liver disease
- Birth defects
- Miscarriages and stillbirths
- Preterm birth and low birth weight
- Nineteen (19) other cancers and eleven (11) other non-cancer effects

Regulation of PFAS

The regulation of PFAS compounds at both the federal and state level is at an early stage but is continuously evolving. The US Environmental Protection Agency has established health advisories to support states, tribes, and local communities in addressing PFAS exposures and has announced that it will be promulgating federal drinking water standards for PFAS compounds in the near future. As a part of this effort, EPA is working to identify methods of remediating PFAS in the environment. However, no reliable, cost-effective method of remediating PFAS compounds from water and soil has yet been developed. In some limited situations, EPA has recently begun requiring that PFAS be considered in Superfund remedial and removal actions and through Safe Drinking Water Act Emergency Administrative Orders. ⁸

ELI Environmental Health & Safety Senior Officer Council

At the state level, many states have adopted the federal health advisories or set lower values. In addition, as noted in the table below, some states have established maximum contaminant levels for PFAS compounds in drinking water.⁹

	PFOA MCL	PFOS MCL
USEPA Lifetime Health Advisory	70 ng/L	70 ng/L
AK, CT, DE, IA, ME, MA, NH, PA, RI	70 ng/L	70 ng/L
California	14 ng/L	13 ng/L
Michigan	70 ng/L	11 ng/L
Minnesota	35 ng/L	27 ng/L
Nevada	667 ng/L	667 ng/L
New Jersey	14 ng/L	13 ng/L
New York	10 ng/L	10 ng/L
North Carolina	2000 ng/L	-----
Oregon	24000 ng/L	300000 ng/L
Texas	290 ng/L	560 ng/L
Vermont	20 ng/L	20 ng/L

Conclusion

Due to the high persistence of PFAS compounds and their wide dispersion in the environment, millions of people throughout the world are at possible risk of adverse PFAS-associated health effects. However, the science regarding the health consequences of PFAS exposure and methods of removing PFAS from the environment are still relatively uncertain and require further development.

Note: The author would like to express appreciation to Stephen Zemba, with Sanborn, Head and Associates, Inc., whose presentations on the topic helped form the basis of this Primer.

References

¹ https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_naming_conventions__3_16_18.pdf

² https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_fate_and_transport__3_16_18.pdf

³ https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf

⁴ <https://www.epa.gov/pfas/basic-information-pfas#exposed>

⁵ <https://www.epa.gov/pfas/basic-information-pfas#health>

⁶ http://www.c8sciencepanel.org/prob_link.html

⁷ <https://ntp.niehs.nih.gov/pubhealth/hat/noms/pfoa/index.html>

⁸ <https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos>

⁹ <https://www.asdwa.org/pfas/>