PROVIDENCE

PER- AND POLYFLUOROALKYL SUBSTANCES WHITE PAPER

INTRODUCTION / BACKGROUND

Per- and polyfluoroalkyl substances (PFAS) are a family of over 9,000 man-made chemicals widely used in various consumer products since the mid-1900s. Two of the most studied PFAS are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). These compounds are remarkably stable and resistant to degradation under a wide range of conditions, giving them the name *forever chemicals*. The water- and stain-resistant properties of these compounds have been desirable for use in a variety of products and industries. PFAS is in thousands of consumer and industrial products. Examples of common uses of PFAS include:

- non-stick cookware,
- waterproof textiles,
- stain resistant carpet and upholstery,
- food packaging,
- firefighting foam agents,
- electronics, and
- personal care products.

Since the early 2000s, the presence of PFAS has been documented in the environment specifically in water, air, and soil samples worldwide. PFAS are readily soluble in water and migrate easily. Common routes for PFAS to enter the environment include the application of PFAS-containing firefighting foam for both training and emergency uses, household laundering of PFAS-laden clothing and materials (entering the public sewer and passing through wastewater treatment facilities), emissions and discharges from industrial facilities, and the disposal of consumer products and industrial wastes into landfills.

The human health impacts of PFAS exposure are currently under intense research. Research has shown a significant link between PFAS concentrations in serum (blood) and many cancers including testicular, kidney, prostate, ovarian, lymphoma [Vieira et al., 2013] and neurotoxic effects. The long half-life of PFAS (4.8 and 3.5 years for PFOA and PFOS in humans, respectively [Olsen et al., 2007]), leads to its ability to bioaccumulate which makes exposure (and risk) cumulative.

REGULATORY ACTIONS

In 2016, to reduce the human health risk due to exposure to PFAS, the United States Environmental Protection Agency (USEPA) introduced a human health advisory level for PFAS in drinking water. The level was 70 parts per trillion (ppt) of PFOA and PFOS combined. Because the federal health advisories are not enforceable limits, many states have adopted PFAS regulatory limits themselves. Some states adopted the 70 ppt level for their own maximum contaminant level (MCL) and groundwater remediation clean-up level. Other states have adopted lower or higher standards, and some have not adopted any state-level regulatory limits. Michigan and Maine have also imposed limits on the land application of biosolids from wastewater treatment plants due to the presence of PFAS in their residuals.

In 2022, the USEPA issued an interim updated health advisory at much lower concentrations; 0.004 ppt for PFOA and 0.2 ppt for PFOS in drinking water. The USEPA also included levels for additional PFAS compounds (10 ppt hexafluoropropylene oxide (HFPO) dimer acid and its ammonium salt [GenX chemicals] and 2,000 ppt perfluorobutane sulfonate [PFBS]).

PFAS SAMPLING AND ANALYSIS

Site assessments and sampling for PFAS require highly trained sampling technicians and laboratory staff. Obtaining accurate and valid results at such low detection limits demands careful attention to potential cross-contamination. Laboratory and field equipment must be PFAS-free. Laboratories can provide PFAS-free water for trip and equipment blanks and rinse water. Glass sampling bottles should be avoided as

PFAS can adsorb to the glass surface and alter results. Polytetrafluoroethylene (Teflon™) tubing or lined caps can contaminate samples as well.

Materials used in the field and the sampling equipment must be free of PFAS. To avoid cross contamination, common materials like the following must be avoided:

- sticky notes,
- permanent markers,
- waterproof paper,
- latex or powdered gloves,
- plastic clipboards, and
- blue ice.

Field and laboratory personnel must carefully prepare for PFAS sampling by selecting appropriate clothing: not new, not treated for water- or stain-resistance, and not laundered with fabric softeners. They must also avoid the application of any personal care products that potentially contain PFAS such as:

- cosmetics,
- lotion,
- sunscreen,
- insect repellant, and
- deodorant.

Care must be taken to avoid handling food and beverage containers that may contain PFAS. Due to the complexities and risk of cross-contamination, PFAS sampling must be performed by specially trained personnel (MDEQ, 2018).

Laboratory methods and detection limits are quickly evolving and advancing to meet the current demands for low detection limits and the growing list of PFAS compounds. The type of PFAS analysis and method selected is generally based on the sample media and the number of different PFAS compounds measured (often in suites of 16, 28, or 32 individual compounds). Current methods can generally detect to the 70 ppt level and even as low as the proposed human health advisory level of 0.004 ppt; however, the method detection level must be confirmed with the laboratory.

TREATMENT TECHNOLOGIES

While conventional industrial and municipal treatment systems are not shown to be effective at PFAS removal, several established and emerging technologies have been found to provide effective PFAS treatment. Established technologies include:

- granular activated carbon (GAC),
- ion exchange (IX) resin, and
- reverse osmosis (RO) or
- nanofiltration (NF).

Additional emerging technologies such as: electrocoagulation, foam fractionation, thermal destruction, phytoremediation, and super-critical oxidation are being studied. Treatment technologies which concentrate the PFAS into a brine stream or adsorbed onto a media still require consideration of how those waste streams are handled. PFAS destruction of these waste streams through high-temperature chemical breakdown or incineration is a potential option; however, research into the validation and monitoring of PFAS destruction is not yet complete.

CONCLUSION

Developing a site-specific investigation into PFAS presence at a specific facility involves careful sampling and assessment with considerations of the latest regulatory and scientific information on a quickly evolving topic. Treatment strategies require balancing the treatment efficacy and cost as well as performing bench-scale and pilot testing to confirm treatability.

SOURCES

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