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PFAS: Sources, Regulations, and Treatment Options

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PFAS, or per- and polyfluoroalkyl substances, refer to a class of more than 3,000 man-made chemicals. The most familiar of these are perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA). PFAS have been produced as complex mixtures and used in commercial goods since the 1940s. Their unique physical and chemical properties such as extreme thermal and chemical stability, and oil, grease, and water repellency make them ideal for applications such as:

- Textile coatings
- Paper products
- Food packaging
- Non-stick cookware
- Aqueous film-forming foams (AFFF) for firefighting

PFAS accumulate over time in the bodies of humans and animals. This accumulation is associated with negative health effects including changes in hormone, liver, thyroid, and pancreatic function. The increasing number of studies published on the effects of PFAS on humans suggest that PFAS could affect fetal development and increase chances of certain cancers, immune system disorders, and fertility problems. Because of these health risks, there is a need to address PFAS contamination in the environment and public works facilities.

Environmental Sources

Sources of PFAS include primary manufacturing facilities which produce PFAS and secondary manufacturing facilities that use PFAS to produce consumer goods. Spills and other unintentional releases contribute to environmental contamination with PFAS, but that is only part of the story. Releases of PFAS into the environment also occur through air emissions and disposal of manufacturing facilities' solid waste and wastewater.

Major releases have been documented for AFFF containing PFAS mixtures, as well as from landfill leachates and wastewater treatment plants (WWTPs) that accept industrial wastes. Even domestic wastewater is a source of PFAS to the environment. PFAS have also been measured in WWTP biosolids and drinking water residuals. Application of these solids to agricultural land subsequently contaminates the soil, allowing PFAS to bio-concentrate by uptake from plants, consumption of contaminated plants by livestock, and eventual human consumption of plants and contaminated livestock. Drinking water sources (both surface water and ground water) have also become contaminated, in some cases to high levels. Municipal solid waste disposal and private wastewater disposal are also environmental sources of PFAS.

Federal Discovery and Regulation

Because of the prevalence of PFAS in the environment and anticipated health risks, PFAS became contaminants of emerging concern in the early 2000s. Since then, regulations and advisories have been set forth by federal, state, and international regulatory authorities. In 2009, the US Environmental Protection Agency (USEPA) set a short-term provisional health advisory of 200 ng/L (parts per trillion [ppt]) for PFOS and 400 ppt for PFOA. This was superseded in May 2016 when USEPA published a Lifetime Health Advisory (LHA) for drinking water of 70 ppt for individual and combined concentration of PFOS and PFOA. Select PFAS were included as part of the USEPA Unregulated Contaminant Monitoring Rule 3 (UCMR3) and will likely become part of National Pollution Discharge Elimination System (NPDES) permits and have associated federal Maximum Contaminant Levels (MCLs).

Sampling for PFAS in sanitary collection systems

Increasing State Regulations

State PFAS regulations are quickly gaining momentum. On January 10, 2018, Michigan Governor Rick Snyder's office announced a legally-enforceable limit of 70 ppt for individual and combined concentration of PFOS and PFOA in ground water for drinking water purposes. This was an abrupt decision, pulling the PFAS rule out of broader legislation for immediate enforcement, while the rest of the legislation for other contaminants will continue through the normal, lengthier legislative review process. Two days later, the Village of Sparta, Michigan shut down one of its drinking water wells after detection of PFAS.

The Texas Risk Reduction Program (TRRP) has derived risk-based inhalation exposure limits for select PFAS. California's Proposition 65 has proposed labeling requirements and a prohibition on discharging of PFAS to drinking water sources. Washington State requires reporting of PFOS in children's products and is currently preparing a chemical action plan (CAP) for PFAS. Vermont and New York, with other states under development, regulate PFOS and PFOA as hazardous waste. Vermont considers waste hazardous when it contains ≥20 ppt of combined PFOS and PFOA. In addition, New York has regulations specifying storage and registration requirements for AFFF and similar firefighting products. Regarding drinking water, surface water, wastewater, and soil, Alaska, Connecticut, Colorado, Delaware, Iowa, Maine, Michigan, Minnesota, Nevada, New Hampshire, New Jersey, North Carolina, Oregon, Texas, and Vermont have either adopted or proposed standards and guidance values in drinking and ground water, health-based standards, or surface water regulations. Currently, New Jersey is the only state with an MCL in drinking water (13 ppt and 14 ppt for perfluorononanoic acid [PFNA] and PFOA).

Current Treatment Options Are Limited

Most conventional drinking water and wastewater treatment processes have been ineffective in removal or destruction of PFAS. Advanced separation processes such as reverse osmosis and nanofiltration have been demonstrated as effective; however, they are not always technically or financially feasible. The USEPA recommended best practice for removal of PFAS from water is sorption to activated carbon and ion exchange media.

Costs for regeneration, disposal as hazardous waste, and incineration of spent media are expensive, and it is important to consider the lifecycle costs of any implemented technology for PFAS removal. Before deciding on a treatment option, site-specific information must be carefully collected and analyzed. Bench- and/or pilot-scale testing is recommended to provide better estimates of treatment performance and long-term costs.

Construction of full-scale GAC treatment facility

Beyond Conventional Treatment

Research into innovative technologies for efficient and cost-effective removal of PFAS is ongoing at universities and research and development (R&D) institutions worldwide. A wide range of treatment options are being considered, from destructive to stabilizing, and simple to very complex. Enhanced chemical treatment methods, as well as new, inexpensive ways to regenerate activated carbon and other sorption media are getting closer to market, but they need to be proven in the field as pilot systems for specific applications. Partnerships between utilities, R&D institutions, technology practitioners, and regulators are key to finding long-term solutions. It is important to forge these relationships early and stay in communication as regulations begin and emerging technologies become available.

As more states continue to tighten regulations of PFAS, Ohio will not be far behind. Battelle and B&N are working to assist public works officials and proactively address anticipated upcoming regulations with new and emerging technologies.

Developing PFAS isotherms on GAC

About the Authors

Brian Yates, P.E., of Burgess & Niple has led a wide range of environmental projects on both the public and private sides of the industry. He manages projects, designs, and advocates for clients by coordinating with regulatory agencies on compliance issues. He has been published many times in international publications and conference proceedings.

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