

Per- and Polyfluoroalkyl Substances (PFAS): Treatment Options for Soil and Groundwater

Gary M. Birk, P.E. (gary.birk@tersusenv.com) and David F. Alden, P.E.
(david.alden@tersusenv.com) (Tersus Environmental, Wake Forest, NC, USA)
John Archibald, P.Eng (john.archibald@tersusenv.com) (Tersus Environmental, Grimsby, ON,
Canada)

Background/Objectives. Per- and polyfluoroalkyl substances (PFASs) are surfactants, polymers and other substances that are widely distributed across the higher trophic levels and are found in air, soil and groundwater at sites across the US (U.S. EPA, NSCEP, 2014). This diverse group of compounds is resistant to heat and repel water and oil. For decades, they have been used in hundreds of industrial applications and consumer products such as carpeting, apparels, upholstery, food paper wrappings, and metal plating. Surfactant applications used heavily in the military include aqueous film-forming foams (AFFFs) used to extinguish fires involving highly flammable liquids.

The toxicity, mobility and bioaccumulation potential of PFASs pose potential adverse effects for the environment and human health. PFAS have been found at very low levels both in the environment and in the blood samples of the general U.S. population. To provide a margin of protection from a lifetime of exposure to perfluorooctanoic acid (PFOA) and perfluorooctyl sulfonate (PFOS) from drinking water, EPA has established the health advisory levels at 70 parts per trillion (EPA 800-F-16-003).

PFASs are fluorinated organic compounds in which the hydrogen atoms of the hydrocarbon skeleton are substituted fully or partially by fluorine atoms. In view of the strong covalent bond between the fluorine and the carbon atoms, these compounds are considered non-degradable and they persist in the environment.

Practitioners have difficulty remediating these compounds at a reasonable cost because PFASs are extremely resistant to thermal, chemical and biological degradation processes. Literature shows that PFOS (potassium salt) is substantially non-volatile.

Approach/Activities. The current state of the practice for addressing highly concentrated source zones, mitigate mass flux of impacts to aquifers, or PFAS in extracted water includes the use of granular activated carbon (GAC). Unfortunately, GAC is only a temporary solution as it is effective at removing only a portion of PFAS from groundwater (Ross et al., 2017). This is due to GAC's low binding capacity for PFOS as compared to nonpolar organic hydrocarbons and the low effective removal of shorter chain perfluoroalkyl acids (PFAAs), the daughter products resulting from biotransformation of polyfluorinated precursor compounds. As the PFAS family of compounds includes anions, cations and zwitterions, new sorbent media are being developed to remove both long and short chain PFASs that combine hydrophobic interactions with electrostatic interactions.

Liquid surface-active reagents are also being developed for use as an initial pretreatment. In the pretreatment phase, dissolved PFASs are precipitated as micro-flocs by metering the liquid active compound into a stirring tank. With removal efficiencies of 96 to 98 percent, the precipitants can be concentrated to a very high degree, the life of sorbent media is significantly extended. This constitutes a considerably more sustainable approach.

Results/Lessons Learned. The presentation will include results and lessons learned from the latest laboratory and field implementation for the treatment of PFAS impacted soil and groundwater. The presentation will also provide an update on advances in point-of-entry (POE) systems.