Ultra Short Chain Perfluorinated Substances

TURI reviewed the available information on ultra-short chain perfluorinated substances. Substances are considered ultra-short when they have a 1-3 carbon chain length. Many ultra-short PFAS remain unknown or unidentified as they may be manufacturing byproducts, proprietary information limitations, and analytical detection challenges. The few available studies conclude that ultra-short-chain PFAAs are frequently found in the environment and are present at high concentrations in water connected to point sources such as sites where AFFFs are used, landfills, and hazardous waste management facilities (Björnsdotter et al, 2019). Less is known about the toxicity of ultra-short-chain PFAAs. Some studies have reported toxicity of TFA to aquatic organisms.

One study looked at the presence of ultra-short chain PFAS in AFFF formulation and groundwater. They found PFEtS and PFPrS in all five of 3M's AFFF that were manufactured over a twelve year period. PFEts was found in 8 of the 11 groundwater samples, and PFPrS was found in all 11. The presence of PFEtS and PFPrS at these 11 sites, some of which have been closed since 1990, may indicate that ultrashort PFSAs are as persistent as their long chain homologues (Barzen-Hanson et al, 2015).

Short chain PFASs are highly mobile in the environment because of high solubility in water and poor adsorption to organic matter. Short-chain PFASs are also highly persistent, and continued emissions will result in environmental accumulation, leading to increased human external exposure. In terms of alternative chemistries short chains should not be recommended, as a larger amount of short-chain PFASs is needed in the firefighting foam products to achieve acceptable performance compared to the previously used C6/C8 mix (Ateia et al, 2019). Below are a few ultra-short chain substances that were mentioned or sampled for in the literature.

- **Trifluoroacetic acid (TFA) (C2)** (CAS #: 76-05-1) is the most studied among the ultra-short-chain PFAAs. A well-known source of TFA is the degradation of hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs) (Björnsdotter et al, 2019).
- **Perfluoropropanoic acid (PFPrA) (C3)** (CAS #: 422-64-0) has been reported in tap water, precipitation, surface water, and wastewater influent and effluent.
- **Trifluoromethane sulfonic acid (TFMS) (C1)** (CAS #: 1493-13-6) has been recently reported for the first time in surface water and groundwater at concentrations up to 1000 ng/L.
- **Perfluoroethane sulfonic acid (PFEtS) (C2)** has been reported in tap water (0.9 ng/L) and wastewater influent and effluent.
- **Perfluoropropane sulfonic acid (PFPrS) (C3)** (CAS #: 423-41-6) has been reported in tap water and wastewater influent (0.05−7.5 ng/L) and effluent (0.05−4.1 ng/L). Furthermore, PFEtS and PFPrS have been reported in AFFFs formulations at varying concentrations (Björnsdotter, 2019).

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