Understudied Per- and Polyfluoroalkyl substances (PFAS) in the Environment

Jinxia Liu[1]

[1] McGill University, Montreal, QC, Canada

PFAS (per- and Polyfluoroalkyl Substances) have been under increasing scrutiny by regulators in recent years because they are associated with a range of negative health effects. While regulators have focused mainly on certain types, such as perfluorooctane sulfonate (PFOS) and carboxylate (PFOA), most PFAS are produced in other forms, such as low-molecular-weight surfactants and high-molecular-weight polymers. This talk will focus on the types of PFAS that may be found in significant amounts in the environment, but have never been thoroughly studied.

The identification and quantification of fluorosurfactants from aqueous film-forming foams (AFFF) have made considerable progress since 2012. EPA Methods 533, 537, 537.1, and 1633 (draft) provide methods for quantifying 40 PFAS in water, activated sludge, soil, sediment, and fish tissues. However, many polyfluoroalkyl substances (aka precursors) derived from AFFFs have not yet been included in standard methods. In recent studies, we discovered dozens of non-anionic PFAS in drinking water, biosolids, and composts in Canada and France and more new structures in AFFFs, demonstrating their prevalence. In future regulatory actions, these understudied structures should be considered.

In addition, mounting evidence suggests (e.g., by measuring total organofluorine content) that a significant portion of the organofluorine from other sources is present in the environment and humans but remains unidentified, even using advanced high-resolution mass spectrometry instruments. Organofluorine originating from unknown sources remains a matter of debate. It is believed that a significant fraction may come from polymeric PFAS, unreacted raw materials, intermediates, synthesis byproducts, and degradation products. Unfortunately, they have not been adequately included in monitoring lists or analytical methods. There has been insufficient attention paid to polymeric PFAS despite their high production volumes and extensive uses. First, side-chain fluorinated polymers (SCFPs) are the most understudied polymeric PFAS. These compounds are used to impart water and oil repellency and soil resistance to fabrics, textiles, and apparel in consumer products and are released into the environment after use. The production volumes of SCFPs were at least one order of magnitude higher than those of many non-polymeric PFAS. Furthermore, SCFP formulations can contain up to 5% of non-polymeric PFAS, including unreacted raw materials, intermediates, and synthesis byproducts. In the course of their use or after disposal, these materials may be partially released into the atmosphere, wastewater, or solid waste. Due to their relatively small sizes and sometimes the presence of hydrolyzable functional groups, SCFPs can also degrade in the environment, resulting in long-term sources of non-polymeric PFAS. Other understudied groups are fluoropolymers (e.g., polytetrafluoroethylene and perfluoropolyether). Despite extensive uses, they are among the least studied PFAS. Preconceptions that these compounds are mostly high molecular weight and highly stable also need to be re-examined. In summary, polymeric PFAS, their degradation products, and related materials must be thoroughly studied and monitored to fully understand their potential environmental impact.

Keywords

Emerging contaminants, PFAS, water, soil, biosolids, organofluorine