RISK MANAGEMENT

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Per/Poly Fluorinated Compounds (PFCs) in the Environment

Sources and Nature of PFCs

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are a class of persistent compounds used to impart nonstick, water repellent, and/or stain-resistant properties to clothing, furnishings, carpet, cookware, contact paper, cosmetics, and other consumer goods. These compounds also have widespread use in firefighting foams and industrial processes. Through the manufacturing and use of these consumer goods, PFCs are released into the air, adhere onto dust, accumulate in crops and migrate into soil, groundwater, surface water, municipal wastewater and biosolids. A subset of PFAS is per/poly fluorinated compounds (PFCs), which are those chemicals that are completely fluorinated and contain no hydrogen bonds. Of the numerous chemicals that fall into this category, the “long-chain” compounds perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA, often times referred to as “C8”) receive the most attention in terms of toxicological studies and environmental issues. The strong chemical bonds that form these compounds lead to their resistance to thermal, biological and chemical degradation, allowing them to accumulate in the environment. PFCs are soluble in groundwater and tend not to adsorb to most soil types. Half-lives of PFCs in the environment have been shown to last for years.

Environmental Health Risks

PFCs became commercially available in the late 1940’s and human health risks were first recognized in the early 1960’s. Beginning in the early 2000’s, research linked to legal cases in Ohio and West Virginia1 established probable cause for links between human exposure and disease correlation between PFCs accumulating in the liver, kidneys, blood and fatty tissues, and high cholesterol, ulcerative colitis, thyroid disease, testicular and kidney cancers, and pregnancy-related hypertension. Recent studies have also focused on the impact of PFCs on the immunizations of children, and breast milk is also considered to be a source of PFCs in infants.

Because of their widespread use, persistence and mobility, PFCs have been detected in the blood stream of nearly all Americans tested at an average concentration of 5 parts per billion (ppb), with an average half-life in the blood stream of 2 to 9 years, depending on the individual 2. Drinking water for over 6 million people in the US has been contaminated with PFCs at levels exceeding a 2016 lifetime health advisory of 70 parts per trillion (ppt) issued by the U.S. Environmental Protection Agency (USEPA). PFCs have also been found in fish and wildlife with possible carcinogenicity and immunotoxicity effects. As PFOA and PFOS are being phased out of production, alternatives with similar properties but with less toxicological/ecological data are emerging as substitutes. These newer PFCs still contain precursor chemicals that can revert into PFOA and PFOS, and because of this are considered to present potential risks.

Regulatory Rulemaking Action

In May 2016, the USEPA established a lifetime health advisory of 70 ppt total combined concentration of PFOA and PFOS in drinking water. Several individual states and other countries have also established regulatory and non-regulatory limits for PFOS and PFOA in drinking water using human health risk assessment methods. For example, the state of New Jersey is close to setting an advisory level of 14 ppt for PFOA in drinking water and Minnesota has established a health advisory for two short-chain PFCs. Further regulatory rulemaking is anticipated as additional toxicological information becomes available. Europe, Canada and Australia have also been active setting health advisory levels. A recent study revealed levels of PFOS exceeding the European Union standard of 1 µg/m2 in most carpets, outdoor textiles, leather samples and many other consumer products.

Regulatory efforts have focused primarily on controlling the production of specific long-chain PFCs. In 2006, under the direction of USEPA's PFOA Stewardship Program 4, various manufacturers voluntarily agreed to completely phase out production in the United States by 2015. In 2009, PFOS was added to Annex B (Restriction) of the Stockholm Convention on Persistent Organic Pollutants with the long term goal of reducing and ultimately eliminating the production and/or use of these chemicals. In light of known human health impacts and subsequent regulatory involvement, the U.S., European, and Australian PFC manufacturers have shifted production from long-chain (generally six or eight carbon atoms or more) to short-chain (six or fewer carbon atoms). Non-fluorinated alternatives that are inherently less hazardous to human health and long-term ecosystem health are also now being developed for firefighting foams, waterproofing of durable fabrics, and food contact paper. Although PFCs are receiving attention in the United States, Europe and Australia, production of long-chain PFCs is still occurring in Asia.

PFC Exposure Pathways and Response Costs

Public attention is increasingly being directed towards remediating health risks of PFCs discovered in drinking water. Legal cases in Ohio and New York have resulted in several significant financial settlements that have heightened attention to the presence of PFCs:

- In 2017, a $670.7 million settlement by Dupont resolving a long running class action toxic tort lawsuit brought by Mid-Ohio Valley residents exposed to high levels of the chemicals[5].

- In 2016, the Township of Hoosick Falls, New York reached an $850,000 settlement agreement with Saint Gobain Performance Plastics and Honeywell for PFOA contamination in the town's public water supply[6].
- City of Newburgh, New York - Officials are pursuing superfund cost recovery from the US Department of Defense (DoD) over its' historical use of PFOA at a former military base which now threaten the public water supply[7].

Additionally, DoD is currently advancing a series of protocols for PFC contaminated sites. At one DoD site near Colorado Springs, Colorado, $4.3 million is being spent for construction and operation of a water filtration system to reduce PFC contamination attributed to the use of aqueous film-forming foam (AFFF) at a nearby Air Force Base. Accordingly, military bases and airports are rapidly shifting to water rather than AFFF for training exercises or to firefighting foams that do not contain PFCs. Current stockpiles of firefighting foams that contain PFCs are reserved only for possible use on actual fires or are otherwise disposed of or managed safely.

Because drinking water is such an important pathway of exposure to PFAS, it is becoming increasingly common for regulators to address PFC contamination in municipal drinking water supplies. Data collected by the USEPA between 2013 and 2015 through its Third Unregulated Contaminant Monitoring Rule (UCMR3) showed that the drinking water of over 6 million U.S. residents is contaminated with PFOA and PFOS at levels that exceed the USEPA's lifetime health advisory [3]. This sampling program monitored six PFCs, mostly long-chain compounds, in 66 major water supplies across the United States. As a result, associated disposal of PFCs and PFC-containing wastes will also be targeted to decrease drinking water contamination. Additionally, changing regulations at the federal and state level continue to assess risks with emphasis on the broader group of PFCs beyond PFOA and PFOS.

Sampling/Analytical Testing/Remedial Options

Environmental sampling of PFCs has its own set of standards and protocols. In order to avoid cross contamination during investigation, sample containers, sampling equipment, decontamination agents, and personal protective equipment (PPE) typically used at an environmental investigation site must be replaced with PFC-free materials. For analytical testing, modified EPA Method 537 is the currently accepted testing method for analyzing PFCs in water. A newer analytical testing method, Total Oxidizable Precursors (TOP), is also being introduced for detection of PFC chemicals in water, particularly precursor compounds. Various states and environmental organizations are continuing to develop improved sampling guidance and analytical methods for PFCs.

Conventional remediation technologies for treatment of water impacted by PFCs including carbon adsorption, reverse osmosis, ion exchange, and chemical oxidation have had varying degrees of success in removing a broad range of PFCs. For the examples cited where these treatment methods have or are currently being applied, remedial technologies have been shown to be very expensive. Newly developed technologies that either act as improved sorbents of PFCs (PlumeStop®, PerFluorAd®, RemBind™) or as an actual destruction process are also gaining momentum here in the U.S. after being tested in Australia and Europe.

Future Changes in PFC Regulations

Several anticipated changes in the future for environmental regulation and management of PFCs include:

- Improved techniques for source identification of PFCs.
- Drinking water will be screened for a broader class of PFCs given the increasing production of short-chain PFCs.
- Collaboration between USEPA and the Agency for Toxic Substances and Disease Registry to develop health-protective drinking water advisories for PFCs beyond PFOA and PFOS, and establish mitigation strategies in areas where exposures are found above health-protective limits.
- Federal and state governments may require labeling of PFC-containing products and building materials and establish procurement guidelines to avoid products with PFCs whenever possible.
- Guidance on safely transportation, disposal and destruction of PFC and PFC-containing products after their useful life span.

Helpful Resource Links

The following online resource links contain helpful regulatory and governmental agency information detailing actions being taken to identify, reduce and control the risks for environmental exposure to PFCs:

https://www.epa.gov/pfas/basic-information-about-and-polyfluoroalkyl-substances-pfass

https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos

http://www.secnav.navy.mil/eie/Pages/PFC-PFAS.aspx

https://www.cdc.gov/biomonitoring/PFCs_FactSheet.html

References

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2. National Center for Environmental Health/Agency for Toxic Substances and Disease Registry (ATSDR)/Center for Disease Control (CDC), An Overview of Perfluoroalkyl and Polyfluoroalkyl Substances and Interim Guidance for Physicians Responding to Patient Exposure Concerns, September 2016.
3. Environmental Science and Technology Letters (2016, Vol. 3, 344-350).
4. https://web.archive.org/web/20081027061359/http://www.epa.gov/opptintr/pfoa/pubs/pfoastewardship.htm
5. http://investors.dupont.com/investor-relations/investor-news/investor-news-details/2017/DuPont-Reaches-Global-Settlement-of-Multi-District-PFOA-Litigation/default.aspx
6. http://www.townofhoosick.org/pdf2016/HOFAPR_SGPPAgreement121616.pdf
7. https://www.nytimes.com/2016/08/13/nyregion/military-base-contaminated-water-in-newburgh-ny-state-says.html

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