ARCADIS Design & Consultancy for natural and built assets

THE RAPID EMERGENCE OF PFASs TO PROMINENT CONTAMINANTS OF CONCERN

WHAT ARE PFASs?

Poly- & Perfluoroalkyl substances (PFASs) are a large group of emerging contaminants that have been used in a wide array of commercial goods and products since the 1940's. PFASs are thermally stable and repel oils and water with impressive surface tension levelling properties. For example, they have been used in some firefighting foams, for coating fabrics and textiles, in non-stick surfaces, and applied in hydraulic and lubricant oils. Some PFASs, also termed as fluorosurfactants, have been the key ingredient in "film forming" Class B firefighting foams used to extinguish liquid hydrocarbon fires. Since the mid-1960s foams have been used at terminals and refineries for repeated fire training events and in fire supressant systems at tank farms.

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WHY A PROBLEM?

Globally, environmental regulations considering PFASs are rapidly being promulgated to very conservative (low) levels, have generally focused on perfluorinated compounds and have been evolving since 2009. That was when one "long chain" (C8) PFAS called perfluorooctanesulfonic acid (PFOS) was added to the international Stockholm Convention on Persistent Organic Pollutants (POPs) which put in place restrictions regarding its production and use. PFASs show no sign of biodegradation at all and so have been described as "forever chemicals." PFASs are generally soluble and hence very mobile in the environment. Depending on the site setting, they can be transported with groundwater well beyond the original source area, and form large plumes.

The "long chain" PFASs (known as C8), including PFOS, accumulate in humans through consumption of impacted drinking water.

Replacement PFASs are "short chain" (such as C6) and while the understanding of their toxicology and bioaccumulation potential is evolving, there is some evidence that short-chained PFASs accumulate in the edible portion of crops are more mobile in the environment than the long-chained variety, making them a potentially larger threat.

Given growing evidence of human health risks and potential ecological harm, more and more countries are now regulating an increasing number of PFASs including both long and short chain varieties, while the latter are still commonly used as commercial replacements (e.g. C6 in firefighting foams).

There are many more proprietary PFASs present in commercial products than are regulated. These polyfluorinated varieties have evaded detection by common analytical methods but in the environment will be transformed to the increasingly regulated perfluorinated PFASs. Firefighting foams, for example, comprise hundreds of individual PFASs which have not been accounted for until recent analytical advances have enabled the total amount of PFASs to be measured using a novel technology termed the total oxidizable precursor (TOP) assay. In the environment, these polyfluorinated PFASs will all slowly transform the perfluorinated compounds, so regulators in Australia have recently adopted this advanced analytical tool for sampling environmental matrices and compliance.

PFASs differ from hydrocarbons as they are much more mobile and ultra-persistent, so regulators perceive them as causing permanent damage to drinking water aquifers and natural resources.

The costs for changing foam delivery infrastructure and incinerating the C8/C6 foams may be substantial but must be balanced with the potential environmental liabilities associated with continued use of PFASs.

As PFASs can accumulate in the human blood or crops their environmental risk profile is somewhat distinct from hydrocarbons, but a further concern is rising pubic concern, press attention and thus political focus on PFASs.

PFASs are known to threaten drinking water supplied in many countries with increased awareness and regulatory scrutiny being most evident in Scandinavia, Germany, Australia, Canada, and since early 2016 in the United States. Acceptable guidance concentrations for drinking water are very conservative (in the parts per trillion (ng/L) range), and the threat of third party litigation from communities affected by PFASs in their drinking water has created an increased need for environmental management services related to PFAS vulnerability, investigation, and restoration.

In the US, PFASs have been made a campaign issue in the NY governors' race by Governor Cuomo, thereby bringing these chemicals some highly visible notoriety, which has now made them a core focus of the current US administrations environment policy. However, the greatest current financial and brand liabilities are associated with providing PFASs treatment to public water supplies as well as settling third party litigation related to drinking water exposure or loss in property value.

For multinational companies, and particularly US traded companies, the initial conundrum is how to assess these potential risks and liabilities without triggering an increase in reserves that can affect the business value and bottom line.

CONTINUED FIRE EXTINGUISHMENT

As a result of the environmental liabilities associated with the continued use of PFASs in firefighting foams, an increasing number of stakeholders are swapping out C8 foams for C6 or fluorine free foams (F3), whilst evaluating the conversion of firefighting capabilities to the use of F3 for tank farm protection. The costs for changing foam delivery infrastructure and incinerating the C8/C6 foams may be substantial, but must be balanced with the potential environmental liabilities associated with continued use of PFASs. The tradeoff between effective fire extinguishment and continued use of PFASs in firefighting foams is being addressed by a consortium of oil companies with LASTFIRE, who are doing tests on F3 and C6 PFASs foams at progressively larger scales. The results so far show that some F3 foams exceed extinguishment performance of some C6 foams. However, their ability to extinguish very large tank farm fires is yet to be proven. Therefore, Arcadis is assisting LASTFIRE in organizing a Foam Summit Conference and a series of very large fire extinguishment demonstrations at the Dallas/Fort Worth Airport in October 2018.

ARCADIS CAN HELP

Arcadis has a long history of managing PFASs with our first projects in Belgium, Germany, and the UK more than 14 years ago. We now have more than 75 projects or portfolios representing 300 individual sites in 12 countries. Our strength is centered on our knowledge of complex PFASs chemistry combined with significant expertise in environmental risk assessment and our long-standing involvement with research and development (R&D) on remedial technologies. A large part of what we do is focused around cost-effective and advocacy strategies centered on leveraging environmental risk assessment and modelling to demonstrate if exposures to human health and ecological receptors is significant and actionable. This avoids excessive expenditure managing PFASs that are not associated with risk and prioritization of subsequent investigations and remediation on the sites (or sources) where the financial liabilities may be the greatest. A well-known early example of where we applied these techniques is the Buncefield terminal fire in the UK in 2005 where we applied human health and ecological risk assessment techniques to demonstrate protection of several watersheds supplying water to London.

In June 2016, Arcadis authored the publicly available CONCAWE report, titled "Environmental Fate and Effects of Poly- and Pefluoroalkyl Substances (PFAS)" (Pancras et al., 2016). Arcadis has pioneered advanced PFASs analytical techniques such that sources of PFASs can be identified and managed.

For remediation, Arcadis has a detailed understanding of multiple remedial options (Ross et al., 2018) and has been doing pioneering work with partners in the PFASs space for remediation of PFASs impacts to the environment, the extraction of PFASs from impacted groundwater and the sealing/containment of firefighting training facilities to protect the environment.

For soils, we are focusing on the ability to provide alternatives to expensive off-site incineration such as stabilization of PFAS source areas in place, via soil mixing with organoclays and carbon fixants, use of soil washing, or use of mobile onsite thermal remedies, all of which can provide pragmatic cost-effective solutions.

Most recently, Arcadis' treatment focus and R&D has developed ultrasound induced sonolysis, which uses high frequency sound waves to create localized bubbles of high temperature plasma to destroy both long and short chain PFASs in concentrated wastes from OZF or firefighting foams.

Arcadis has significant expertise in using conventional groundwater treatment for PFASs as our water team has designed and installed approximately 12 large scale water treatment systems for PFAS removal in the U.S. and Germany. Recently, we introduced a new technology at full scale in Australia called ozofractionation (OZF), which can remove the full range of PFASs from water (validated by TOP assay) by concentrating it in a small volume waste stream. OZF can provide a significant cost advantage over existing technologies such as use of granular activated carbon (GAC) which is ineffective for removal of some PFASs and creates large volumes of waste requiring high temperature regeneration or incineration.

Most recently, Arcadis' treatment focus and R&D has developed ultrasound induced sonolysis, which uses high frequency sound waves to create localized bubbles of high temperature plasma to destroy both long and short chain PFASs in concentrated wastes from OZF or firefighting foams. This is an energy efficient destructive technique that can be used in conjunction with OZF to completely destroy the small volume of resultant concentrated waste. We are currently testing and demonstrating the effectiveness of sonolysis as a lower cost, more sustainable alternative to high temperature incineration.

Arcadis has in house fire engineering services, has built more sustainable sealed and contained fire training areas, as well as expertise with cleaning PFASs in pipework and tanks. In collaboration with LASTFIRE, Arcadis provides a complete foam assurance package. Finally, Arcadis is poised to offer a package of services which manage all activities involved with replacing the current fluorine based foams with fluorine-free firefighting foams and the associated infrastructure in fire suppressant systems at refineries and depots.

REFERENCES

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