Remediation of Poly- and Perfluoro Alkyl Substances: New Remediation Technologies for Emerging Challenges

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Poly- and perfluoro alkyl substances (PFAS) comprise a diverse class of contaminants which include PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid). PFAS are not amenable to bioremediation or conventional chemical oxidation and are difficult to remediate in situ in soil and groundwater systems. Further complicating the remediation challenges are the presence of precursor PFAS that are often present at locations where AFFF (aqueous film forming foam) has been released and are not analysed for by standard analytical laboratory methods (US EPA method 537). These precursors can act as a source of perfluorinated carboxylates and sulphonates, as some precursors are less mobile but they all will biotransform over time forming perfluorinated compounds as dead end daughter products.

Remediation of PFAS impacted sources and plumes will require multiple approaches to achieve objectives to address sources and evolving plumes often to be protective of human health via treatment of water abstracted as a potable supply.

PFAS are relatively ubiquitous in the environment at very low concentrations, but point sources such as some industrial or many domestic landfills, areas used for fire training, some biosolids applications and locations of manufacture of PFAS themselves or derivative products could all be point sources of high PFAS concentrations, potentially causing elevated concentrations local to these sites.

Innovative and emerging remediation solutions for PFAS include a number of types of technologies to address highly concentrated source zones, mitigate mass flux of impacts to aquifers or address PFAS in abstracted water. Use of granular activated carbon (GAC) to treat PFAS will only effectively remove a proportion of these contaminants, whilst offering a very low binding capacity for PFOS (as compared to hydrocarbons), so can be costly.

Challenges of more comprehensive PFAS treatment are currently addressed using technologies such as reverse osmosis or nanofiltration. There are new precipitation technologies for water treatment, novel ion exchange resins and sorptive media which show promise and will be summarized.

Conventional chemical oxidation, which promotes formation of the sulphate and hydroxyl radicals as strong oxidants appears ineffective against some perfluorinated compounds, such as PFOS (perfluorooctane sulfonate). However, recent laboratory work has demonstrated that activated persulfate could be capable of degrading PFOS and the degradation mechanism is hypothesized to be a combination of oxidation and reduction as defluorination is observed. The decreases in PFOS concentrations are only observed when a specific activation method is employed, as with the smart combined oxidation and reduction (ScisoR®) technology. Recent results from laboratory trials with this technology will be presented.

Ian Ross PhD

Dr. Ian Ross is a biochemist by training and now works for ARCADIS as a technical expert for assessment of contaminated land sites and remediation. He started R&D examining the biodegradation of xenobiotics some 23 years ago and worked for Blagden Chemicals, ICI and the Defence Science and Technical Laboratories (part of the UK Ministry of Defence) whilst at Aberystwyth, Bangor and Cambridge Universities.

He started working for ARCADIS in 2002 delivering innovative solutions for soil and groundwater remediation, and delivered multiple cutting edge in situ remediation projects involving addition of nitrate, sulphate, carbohydrates and differing oxidants to soil and groundwater.

To enable successful implementation of innovative strategies, which offered clients more cost effective and sustainable business outcomes, he set up and ran the European Treatability Laboratory which enabled design of innovative remediation projects for ARCADIS across Europe. This laboratory enabled research in collaboration with several UK Universities with multiple Ph.D. and MSc students who developed novel contaminated land solutions.
He designed and implemented the world’s first in situ remediation of carbon disulfide using activated persulfate, which won the 2011 UK brownfield briefing award for best in situ remediation project and the Italian Sapiem 2012 Innovation award.

He designed a combined soil washing and chemical oxidation project for a landfill contaminated with pharmaceutical waste which won a Brownfield Briefing award in 2012.

He spent 3 years as the technical and business manager for FMC Environmental Solutions in EMEA developing a detailed understanding of the remediation business and opportunities across Europe and further afield, winning work by designing large scale remediation projects in China, Hungary and South Africa.

As a result of his marketing of ARCADIS’s remediation capabilities at European conferences, ARCADIS were requested to tender for environmental works at a large pharmaceutical site and won a series of projects involving the largest site investigation done by ARCADIS UK and a series of remediation projects at the same site. He collaborated on technical proposals to win ARCADIS a series of substantial ERD projects in the UK and worked as part of a guaranteed remediation team devising innovative strategies to position ARCADIS as a provider cutting edge solutions for clients which offer a more cost effective and sustainable outcomes.

His recent focus has been on PFAS (poly/per fluorinated alkyl substances) as a result of developing novel in situ remedial solutions and he has assisted ARCADIS by authoring and reviewing the CONCAWE PFAS guidance document, to be published in 2016.

Caitlin H. Bell, PE
Caitlin Bell is a Senior Environmental Engineer and 1,4-Dioxane Lead for Arcadis North America. Ms. Bell focuses on subsurface treatment of soil and groundwater using in-situ techniques. Specifically, she focuses on in-situ bioremediation applications for a variety of chemicals of concern, including emerging contaminants. She serves as a technical resource to clients on topics such as molecular biology tools, bioaugmentation, compound specific isotope analysis, and challenging bioremediation approaches for compounds like 1,4-dioxane. Ms. Bell was a member of the team that authored the Interstate Technology & Regulatory Council’s Environmental Molecular Diagnostics technical guidance document and has presented routinely on remediation topics at industry conferences.