CRC CARE FACT SHEET 12

Perfluorochemicals (PFCs)

Perfluorochemicals (PFCs) are chemicals that can improve the ability of fire-fighting foam to smother fire. This feature makes them very attractive to manufacturers, and as such they have long been used in fire-fighting foam. PFCs are also widely used in the treatment of fabrics and leather, and in paper products, food packing and insecticides.

Despite their widespread use, evidence suggests that PFCs are dangerous to human health, and that the chemicals in PFCs move into ecosystems and up food chains to accumulate in animal and human tissue. PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid) are two commonly used PFCs.

Threats to people and wildlife

There is a growing global concern about the risks that PFCs pose to human health and the environment, as these chemicals have been used on fires at tens of thousands of emergency and training sites worldwide over the past half-century. PFOS is known to accumulate in the liver and blood, and has been linked to bladder cancer, liver cancer, endocrine disruption, and developmental and reproductive toxicity including neonatal mortality.[1] Fatal effects have been noted in animal studies.

In 2006, researchers examined the tissue of pelicans living in Cartagena Bay, Colombia, an area that receives both industrial and urban sewage discharges from the city of Cartagena (population 925,000).[2] Although the amounts involved were tiny, the research showed how PFCs were distributed throughout the bodies of the birds feeding in a PFC-contaminated food chain.

Humans are also accumulating PFCs in body tissue. PFOS has been widely detected in the blood serum of people in the US, although concentrations appear to be decreasing. In contrast, research demonstrates that blood levels of PFOS are rising in China.[3] Research at the Mount Sinai School of Medicine (NY, USA) into PFOS levels in pregnant women demonstrated an association with preeclampsia[4], and with altered thyroid hormone values reported by researchers from University of Quebec, Canada.[5] Research at Boston University in US[6] has also detected a link between PFCs and attention deficit hyperactivity disorder (ADHD) for children aged 12–15.

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Are there safe levels of PFCs?

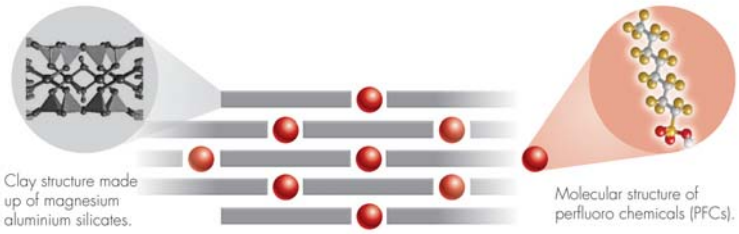
While no national or state jurisdiction has yet legislated maximum levels of PFC allowed in soil or water, the Stockholm Convention on Persistent Organic Pollutants has listed PFCs as chemicals of concern to human health.[7] The US EPA standard for PFOS levels for both drinking water and wastewater is 0.02 ppb.[8] PFC-contaminated animal food chains in the US have had PFOS levels as high as 59,500 ppb.[2]

PFOS and PFOA in the environment

Although PFOS and PFOA are increasingly being phased out of modern foams, they still dominate residual contaminants at many sites globally. Many of the world's 49,000 airports (including 450 civilian and military airports in Australia) have regularly used foam in fire-fighting exercises for years, as well as in actual aircraft fires. The chemicals have been subsequently detected in nearby groundwater and streams. Foams are also deployed on a range of other fires including traffic, truck and railway accidents and even building fires. In these instances, the foam can escape into the surrounding urban or rural environment and contaminate local creeks and water supplies.

Remediation

After being approached by an external client interested in a PFC-contamination clean-up solution, CRC CARE researchers experimented with clay-based materials that offer high adsorption properties. The plate structure of clays, in particular, presents a very high surface area per unit of material available for adsorption.

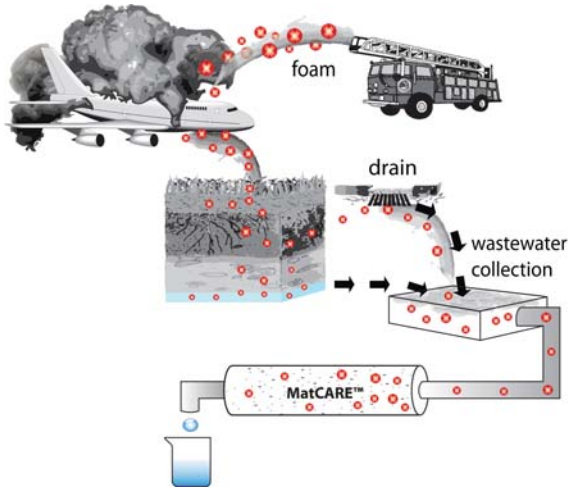


The modified form of clay used in MatCARE™ and its checkerboard molecular structure has a unique ability to attract and bind anions. This serves to trap the anionic contaminant PFCs. Tailoring of the mineral constituents enables fine-tuning of the adsorption behaviour of the clays, and thus the effectiveness of the clean-up process.

After testing several possibilities, one clay type was selected for modification in response to a series of experiments.The results were excellent, with full recovery of the PFCs, and none of the wastewater breaking through the clean-up medium. To date, CRC CARE has completed two wastewater treatment projects, resulting in the production of more than 200,000 L of water now safe for reuse.

In further laboratory trials, this modified clay, named MatCARE™ [9], has removed PFOS, PFOA and other fluorinated surfactants to below detection limits. Amounts exceeding 10,000 ppb have been removed from wastewater, and in contaminated soil MatCARE™ can immobilise fluorosurfactants of concentrations >50 ppm.

As research reveals more about the long-term effects of PFCs on people and animals, governments and communities are likely to demand increasing restrictions on their use and tolerate lower levels of environmental contamination. If that eventuates, this new Australian technology could suddenly be in international demand.



The origin and movement of PFCs is represented by the red particles. If drainage from the wash down or subsequent rainfall can be effectively trapped and passed through MatCARE™ (a CRC CARE trademark product), the PFCs can be captured and prevented from entering local ecosystems.

[1] Betts, KS 2007, 'Perfluoroalkyl acids: what is the evidence telling us?', *Environmental Health Perspectives* vol. 115, iss. 5, pp. A250 – 6.

[2] Oliver-Verbel, J, Tao, L, Johnson-Restrepo, B, Guette-Fernandez, J, Baldiris-Avila, R, O'Byrne-Hoyos, I & Kannan, K 2006, 'Perfluorooctane sulfonate and related fluorochemicals in biological samples from the north coast of Colombia', *Environmental Pollution* vol. 142, iss. 2, pp. 367– 372.

[3] Renner, R 2008, 'PFOS phaseout pays off', *Environmental Science and Technology* vol. 14, iss. 13, p. 4618.

[4] Savitz, D, Stein, C & Dougan, M 2009, 'Serum PFOA and PFOS pregnancy outcome', Epidemiology vol. 2016, p. S239.

[5] Dallaire, R, Dewailly, E, Pereg, D, Der,y S & Ayotte, P 2009, 'Thyroid function and plasma concentrations of polyhalogenated compounds in Inuit adults', *Journal of Environmental Science and Healt*h vol. 117 iss. 9, pp. 1380 –1386.

[6] Hoffman, K, Webster, TF, Weisskopf, MG, Weinberg, J & Vieira, VM 2010, 'Exposure to polyfluoroalkyl chemicals and attention deficit/hyperactivity disorder in US children 12-15 years of age', *Environmental Health Perspectives* vol. 118, n°. 12, pp. 1762 –1767.

[7] http://chm.pops.int/Convention/Pressrelease/COP4Geneva8May2009/tabid/542/language/en-US/Default.aspx

[8] http://epa.gov/region04/water/documents/fact_sheet_january_2010.pdf

[9] Kambala, V & Naidu, R 2011, international PCT application filed, January 2011.

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CRC CARE is a partnership of organisations providing research, technologies and knowledge in assessing, preventing and remediating contamination of soil, water and air.

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