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TECHNICAL PAPER:

OCRA use in decontamination of PFOS, PFOA and short chain precursor (SCP) contaminated water

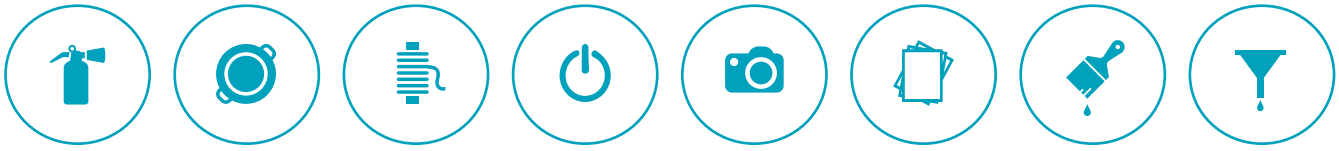
10 March 2017

For over 50 years perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) have been used extensively in fire-fighting foams, metal coatings and electronics.

PFOS and PFOA have been used in firefighting training at Australian defence sites and airports resulting in accumulation within the soils, groundwaters and surface water.

PFAS and PFOS bioaccumulate readily, binding with proteins and accumulating in blood, liver and kidneys in humans. The health issues associated with PFOS accumulation in the human body include high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer and pre-eclampsia.

PFAS Sources



In the aqueous phase these compounds are considered persistent organic pollutants. They are known as contaminates without borders, with point source contaminations evident far beyond the point of origin. Short chain precursors (SCP) which are commonly used in throughout industry and domestic settings are even more mobile and significantly more difficult to remove from groundwater and soil.

PFOA and PFOA-Precursor Distribution

Several traditional technologies have been tested for removing PFOS and PFOA from water and are currently deployed in many locations. While these technologies are adequate for the long chain PFOS and PFOA compounds, they are failing to capture the mass accumulation of (SCP) compounds. The inability to remove SCP severely limits the value of current technologies as SCP do not biodegrade, they instead biotransform into PFAAs.

Source: Arcadis

Aerobic Precursor Biotransformation to PFAAs

Source: Arcadis

The most widely used techniques for removing PFOS and PFOA from wastewater utilise granular activated carbon and/or clays which result in significant stockpiles of contaminated spent reagent. These techniques do not remove the short chain precursors.

A compounding issue with GAC absorption techniques occurs in firefighting where hydrocarbons used to start training fires or as the main propellant in vehicle/aircraft fires compete for absorption sites in the GAC. This competition decreases absorption efficacy and drastically increases reagent usage.

The OCRA process utilises ozofractionatively catalysed reagent addition in a multiphase, customisable, process that extracts PFOS, PFOA, PFAA and short chain precursors from wastewater as well as complex co-contaminates. OCRA does not result in the management of large stockpiles of contaminated spent reagents such as GAC.

OCRA can be set up in a variety of ways to target different elements and compounds, Table 1 shows the result of the demonstration plant that has been designed to remove PFAS compounds.

TABLE 1: PFAS REMOVAL

PROCESSING DATA SET 2	RAW WATER (µg/l or ppb)	STAGE A TREATED (µg/l or ppb)	STAGE B TREATED (µg/l or ppb)	STAGE C TREATED (µg/l or ppb)	GAC POLISHED (µg/l or ppb)	REMOVAL PERCENT	MIXED FRACTIONATE (µg/l or ppb)	HIGHEST FRACTIONATE (µg/l or ppb)
PFBS	1.9	0.975	0.422	0.748	0.007	99.63%	2.91	34.7
PFPeS	1.27	0.0834	0.0268	0.062	0.002	99.84%	3.51	144
PFHxS	12.5	0.0584	0.0052	0.0066	0.0011	99.99%	31.87	985
PFHpS	1.52	0.0005	0.0005	0.0005	0.0005	99.97%	4.13	64.7
PFOS	52.2	0.0086	0.0119	0.0113	0.015	99.97%	121.55	1480
PFDS	0.02	0.0005	0.0005	0.0005	0.0005	97.50%	0.02	0.21
PFBA	1	0.002	0.002	0.002	0.002	99.80%	0.82	0.8
PFPeA	2.04	1.12	0.691	1.12	0.0136	99.33%	2.06	6.53
PFHxA	5.16	1.53	0.618	1.36	0.0114	99.78%	11.99	425
PFHpA	0.7	0.0126	0.0007	0.0034	0.0005	99.93%	1.56	48.1
PFOA	1.24	0.0011	0.0005	0.0005	0.0005	99.96%	3.32	80.1
PFNA	0.22	0.0005	0.0005	0.0005	0.0005	99.77%	0.42	5.62
PFDA	0.04	0.0005	0.0005	0.0005	0.0005	98.75%	0.11	1.43
PFUnDA	0.07	0.0005	0.0005	0.0005	0.0005	99.29%	0.11	1.34
PFDoDA	0.02	0.0005	0.0005	0.0005	0.0005	97.50%	0.02	0.08
PFTrDA	0.02	0.0005	0.0005	0.0005	0.0005	97.50%	0.02	0.14
PFTeDA	0.05	0.0005	0.0005	0.0005	0.0005	99.00%	0.05	0.05
FOSA	0.1	0.0005	0.0005	0.0005	0.0005	99.50%	0.18	1.86
MeFOSA	0.05	0.001	0.001	0.001	0.001	98.00%	0.05	0.05
EtFOSA	0.05	0.001	0.001	0.001	0.001	98.00%	0.05	0.05
MeFOSE	0.05	0.001	0.001	0.001	0.001	98.00%	0.05	0.05
EtFOSE	0.05	0.001	0.001	0.001	0.001	98.00%	0.05	1.99
MeFOSAA	0.02	0.0005	0.0005	0.0005	0.0005	97.50%	0.02	0.09
EtFOSAA	0.02	0.0005	0.0005	0.0005	0.0005	97.50%	0.02	0.03
4:2 FTS	0.05	0.002	0.001	0.001	0.001	98.00%	0.05	0.99
6:2 FTS	1.89	0.001	0.001	0.001	0.001	99.95%	5.83	129
8:2 FTS	0.29	0.001	0.001	0.001	0.001	99.66%	1.19	9.14
10:2 FTS	0.05	0.001	0.001	0.001	0.001	98.00%	0.05	0.19
PFHxS+PFOS	64.7	286	0.0171	0.0179	0.0161	99.98%	153.41	2465
Total 28 PFAS	82.1	234	1.78	3.31	0.0501	99.94%	191.45	3420