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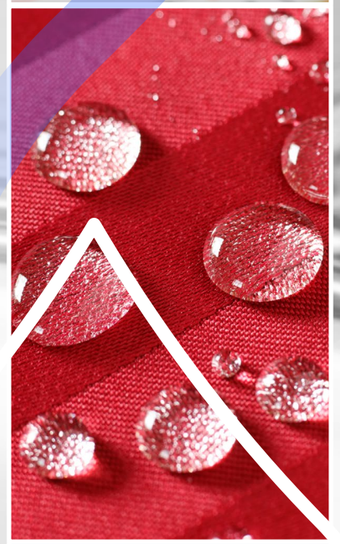
Perfluorooctanoic Acid (PFOA)



The PFOA Experts

- Responsible Party Identification
- GIS and Geomatics
- Contaminant Hydrogeology
- Fate and Transport Modeling
- Risk Assessment
- Remediation Feasibility Studies
- Soil and Groundwater Remediation
- Natural Resource Damage Assessment
- Water Resources Assessment
- Source Water Assessment and Protection
- Drinking Water Treatment
- Environmental Risk Management
- Litigation Support/Expert Witness
- Forensic Engineering
- Stakeholder/Public Participation
- Regulatory Strategy

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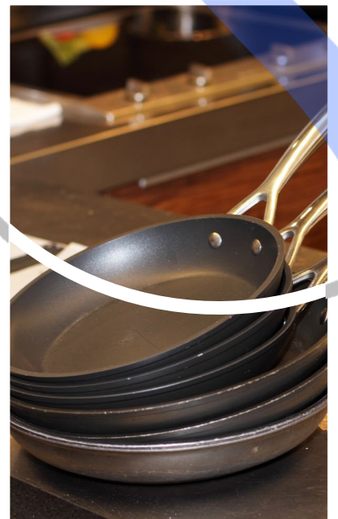
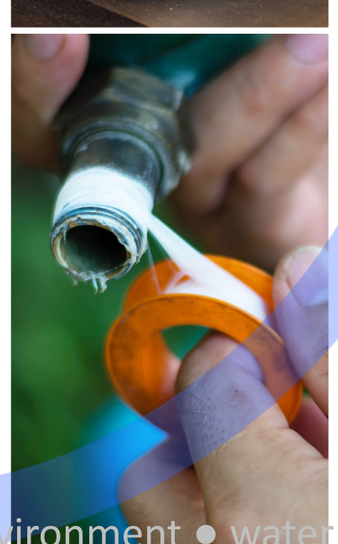




Perfluorooctanoic Acid in the Environment

Perfluorooctanoic acid (PFOA) is a synthetic, fully fluorinated organic acid. It is used in a variety of consumer products and in the production of fluoropolymers. It is also generated as a degradation product of other perfluorinated compounds. PFOA is one of a large group of perfluoroalkyl substances (PFAS) that are used to make products more resistant to stains, grease, and water. These compounds have been widely found in consumer and industrial products, as well as in food items. The eight major manufacturers of PFOAs in the United States agreed to the voluntary phase out of PFOA production by the end of 2015. However, PFOA production has increased globally and exposure to PFOA in the United States remains possible due to its legacy uses, existing and legacy uses on imported goods, degradation of precursors, and extremely high persistence in the environment and human body.

Key Points

- Highly soluble in water
- Extremely stable
- Resistant to hydrolysis, photolysis, or biodegradation
- Extremely persistent in the environment
- Mobile in soil and leaches to groundwater

Water resources contaminated by PFOA have been associated with releases from manufacturing sites, industrial sites, fire/crash training areas, and industrial or municipal waste sites where products are disposed of or applied.

PFOA is highly soluble in water and has very low volatility due to its ionic nature, and as a result, the use of conventional treatment technologies can be difficult. In drinking water treatment and groundwater remediation, the most common treatment is extraction and filtration through granular activated carbon (GAC). Alternative treatment technologies for groundwater include ion exchange, surfactant and ultrasonic treatment, reverse osmosis and advanced oxidation (AOP).

Fate and Transport Properties of PFOA

Property	Units	PFOA	Source
Molecular Weight	gram/mole	414	2,3
Density	g/cm^3	1.8	1
Melting Point	(°C)	54.3 45 – 50	1 4
Boiling Point	(°C)	192.4 188	1 4
Vapor Pressure	mm Hg at 20°C mm HG at 25°C	0.017 0.525	4 1,3
Solubility	mg/L at 25°C	3,400 – 9,500 9,500	2 1
Henry's Constant (K_h)	$atm*m^3/mole$	Not Measurable	1,3
Partition Coefficient (log K_{ow})	---	5.3	2
Sorption Coefficient (log K_{oc})	---	1.29 – 5.09 2.06	2 1,3
Half-Life in Water	years at 25°C	Stable > 92	1 2,4
Health Advisory (CA)	**ug/L**	**0.014**	5

Sources:

1. USEPA. (2016). Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA). May.
2. National Groundwater Association. (2017). Groundwater and PFAS: State of Knowledge and Practice.
3. USEPA. (2017). Technical Fact Sheet - Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA). November.
4. USEPA. (2012). Emerging Contaminants - Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA). May.
5. ITRC. (2018). Per- and Polyfluoroalkyl Substances (PFAS) Fact Sheet. Retrieved from: http://pfas-1.itrcweb.org/fact-sheets/. September.

Remediation of PFOA

Remedial Technology	PFOA Removal Efficacy
Aeration	<10%
Coagulation Dissolved Air Flotation	<10%
Coagulation Flocculation Sedimentation Filtration	<10%
Conventional Oxidation	<10%
Anion Exchange	>10%, <90%
GAC	>90%
Nanofiltration	>90%
Reverse Osmosis	>90%

Source: National Groundwater Association. (2017). Groundwater and PFAS: State of Knowledge and Practice.

State Guidelines for PFOA in Water

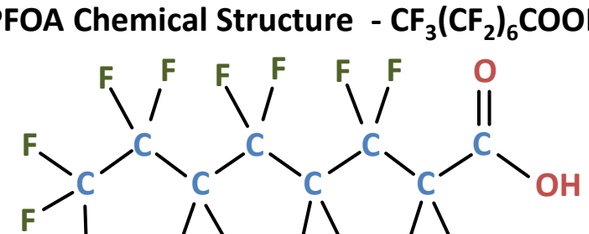
State	Concentration (ug/L)	Source
Alabama	0.07*	3
Alaska	0.07*	2,3
Arizona	0.07*	3
California	0.014	2
Colorado	0.07*	2,3
Connecticut	0.07*	3
Delaware	0.07*	1
Iowa	0.07*	3
Illinois	0.4	3
Kentucky	0.4	3
Maine	0.07	2
Massachusetts	0.07*	3
Michigan	0.07*	4
Minnesota	0.035	3
Nevada	0.667	2
New Hampshire	0.07*	3
New Jersey	0.014	2
New York	0.07*	3
North Carolina	2	2
Oregon	24	2,3
Texas	0.29	2,3
Vermont	0.02*	1,2,3
West Virginia	0.07*	3

* Cumulative PFOA and PFOS concentration.

Sources:

1. USEPA. (2016). Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA). May.
2. ITRC. (2018). Per- and Polyfluoroalkyl Substances (PFAS) Fact Sheet. Retrieved from: http://pfas-1.itrcweb.org/fact-sheets/. September.
3. National Groundwater Association. (2017). Groundwater and PFAS: State of Knowledge and Practice
4. Michigan Department of Environmental Quality. (2018). State Takes Action to Strengthen Environmental Criteria in Response to PFAS Contamination. Retrieved from: http://www.michigan.gov/deq/0,4561,7-135--457220--,00.html. January 9.

PFOA Chemical Structure - $CF_3(CF_2)_6COOH$



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