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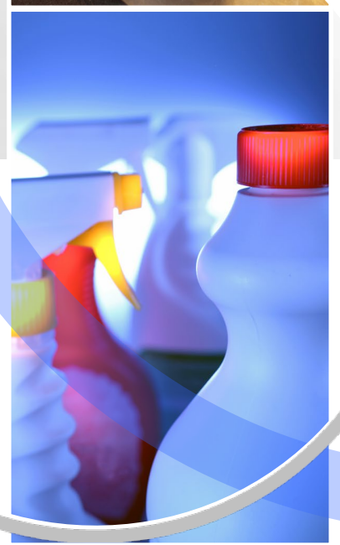
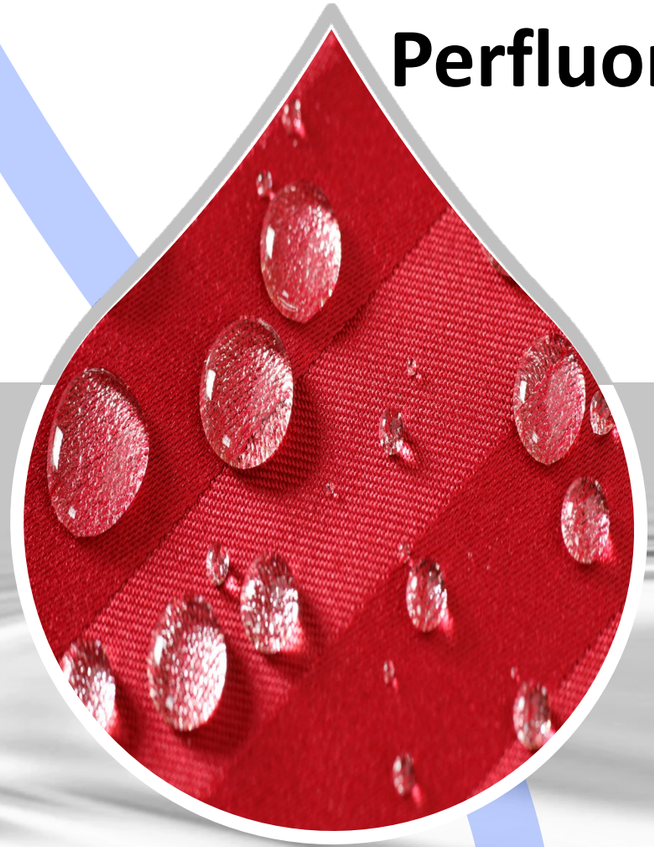
Perfluorooctanesulfonic Acid (PFOS)





The PFOS 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

environment ● water ● strategy

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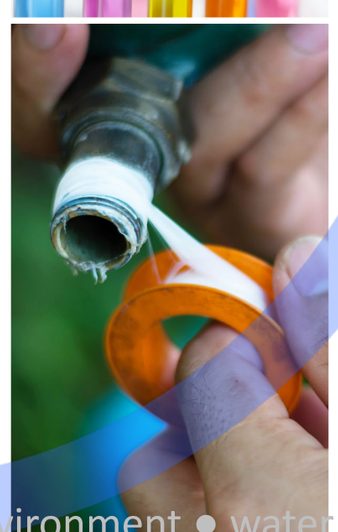


Perfluorooctanesulfonic Acid in the Environment

Perfluorooctanesulfonic acid (PFOS) is a synthetic, fully fluorinated organic acid. It is used in a variety of consumer products and is generated as a degradation product of other perfluorinated compounds. PFOS 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. In 2002, the only major manufacturer in the United States agreed to phase out production of PFOS. Exposure to PFOS 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 PFOS 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.

PFOS 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 groundwater, 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 PFOS

Property	Units	PFOS	Source
Molecular Weight	gram/mole	500	1,2,3
Density	g/cm^3	1.8	1
Melting Point	(°C)	>400	4
Boiling Point	(°C)	258 - 260 133	1,3 4
Vapor Pressure	mm Hg at 20°C mm HG at 25°C	$2.48e^{-6}$ $2.0e^{-3}$	2,4 1,3
Solubility	mg/L at 25°C	370 (fresh water) 520 – 570 (purified) 680	2 2 1,3
Henry's Constant (K_h)	$atm*m^3/mole$	Not Measureable $3.05e^{-9}$	1,3 4
Partition Coefficient (log K_{ow})	---	Not Measureable 6.43	1,4 2
Sorption Coefficient (log K_{oc})	---	2.4 – 4.7 2.57	2 1,3,4
Half-Life in Water	years at 25°C	Stable >41	1 2,4
Health Advisory (CA)	**ug/L**	**0.013**	5

Sources:

1. USEPA. (2016). Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS). 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 PFOS

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

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

State Guidelines for PFOS in Water

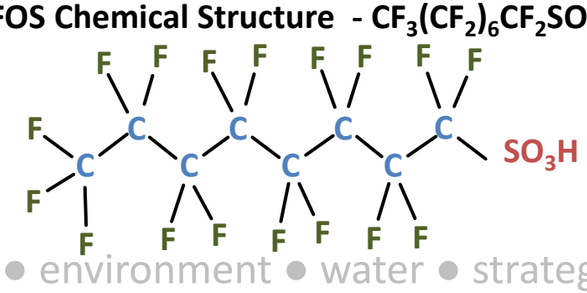
State	Concentration (ug/L)	Source
Alabama	0.07*	3
Alaska	0.07*	2
Arizona	0.07*	3
California	0.013	2
Colorado	0.07*	2,3
Connecticut	0.07*	2,3
Delaware	0.07*	1,2
Iowa	0.07*	3
Illinois	0.2	3
Kentucky	0.2	3
Maine	0.07*	2
Massachusetts	0.07*	2,3
Michigan	0.07*	2,4
Minnesota	0.027	2,3
Nevada	0.667	2
New Hampshire	0.07*	3
New Jersey	0.013	2
New York	0.07*	3
North Carolina	2	1,2
Oregon	300	2,3
Texas	0.56	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 Perfluorooctane Sulfonate (PFOS). 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.

PFOS Chemical Structure - $CF_3(CF_2)_6CF_2SO_3H$



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