

PFAS DESTRUCTION BY ELECTROCOAGULATION EC Manufacturer's Test for the US Bureau of Reclamation

PFOA and PFOS destruction onsite at atmospheric temperature and pressure.

The Electrocoagulation system passes electrons, (amps) through water and metal plates. BME Environmental's manufacturer's has been supplying commercial atmospheric electrocoagulation systems since 1999. BME holds the engineered copyrights to a designed remediation process that includes the electrocoagulation and other technology systems.

Well water containing carbon fluoride bond chemicals are removed effectively with the electrocoagulation. Below is the analysis of the results for a water company in Colorado on August 16, 2023.

Analyte Method: EPA 537.1	Raw Water Results ng/l	EC 1 min AI Results ng/l	Percent Removed
Perfluorooctanesulfonic acid (PFOS)	23.0	< 1.9	> 91.74%
Perfluoroundecanoic acid (PFUnA)	< 1.9	< 1.9	> 0.00%
Perfluorohexanoic acid (PFHxA)	20.0	< 1.9	> 90.50%
Perfluorododecanoic acid (PFDoA)	< 1.9	< 1.9	> 0.00%
Perfluorooctanoic acid (PFOA)	17.0	< 1.9	> 88.82%
Perfluorodecanoic acid (PFDA)	< 1.9	< 1.9	> 0.00%
Perfluorohexanesulfonic acid (PFHxS)	32.0	< 1.9	> 94.06%
Perfluorobutanesulfonic acid (PFBS)	32.0	< 1.9	> 94.06%
Perfluorophetanoic acid (PFHpA)	5.6	< 1.9	> 66.07%
Perfluorononanoic acid (PFNA)	< 1.9	< 1.9	> 0.00%
Perfluorotetradecanoic acid (PFTeDA)	< 1.9	< 1.9	> 0.00%
N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSSA)	< 1.9	< 1.9	> 0.00%
Hexafluoropropylene Oxide Dimer Acid (HFPO -DA)	< 1.9	< 1.9	> 0.00%
9-Chlorohexadecafluoro -3-oxanonane -1-sulfonic acid	< 1.9	< 1.9	> 0.00%
11-Chloroeicosafluoro-3-oxaundecane -1-sulfonic acid	< 1.9	< 1.9	> 0.00%
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	< 1.9	< 1.9	> 0.00%

When carbon fluoride bond chemicals have been concentrated, the carbon fluoride bonds can be destroyed on site at atmospheric temperatures and pressures using a specific component. The end resultant level of PFAS is below the USEPA's new standard of 4 ng/l. The analysis data shows the final result is 1.9 ng/l. You will also notice that PFOA, PFOS, PFHxS, PFNA, and PFDA concentration were less than the EPA proposed limit of 4 ppt.

When the specific component is blended with the water feeding the electrocoagulation unit, the iron ions created from the iron sheet reacts with the component to destroy the carbon fluoride bond in the PFOS, PFOA, etcetera. Landfill leachate PFOA, and PFOS was removed from the water by 99%, and the coagulated solids PFOS and PFOA was minimal, see result below.

	<u>PFOA</u>			<u>PFOS</u>		
	PFOA Liquid ng/l (ppt)	% Removal Liquid	PFOA Solids ng/l (ppt)	PFOS Liquid ng/l (ppt)	% Removal Liquid	PFOS Solids ng/l (ppt)
Landfill Leachate as Received	1,540			421		
Electrocoagulation + (Component)	<3.94	99.74%	70	<2.36	99.44%	20

Electrocoagulation Systems not only separates the PFAS from the water, but also destroys the PFAS in the coagulate solids.

Traditionally, PFOA and PFOS is removed from water and concentrated in a hazardous waste stream like Reverse Osmosis Reject, or Ion Exchange regeneration liquid; or captured in a solids like granular activated solids. The Electrocoagulation System actually destroys the carbon fluoride bond, changing the molecular structure into non-hazardous and therefore does not create a hazardous waste. The resultant residue waste can be buried or taken to a landfill and will not harm the ecosystem.

An example of the reduction of PFOA and PFOS in the solids when the specific component and electrocoagulation are combined is shown on page 3.

Fluoride Carbon Bond Destruction in the Solids One of the Strongest Single Bonds in Chemistry

	PFOA Liquid ng/l (ppt)	% Removal Liquid	PFOA Solids ng/l (ppt)	PFOS Liquid ng/l (ppt)	% Removal Liquid	PFOS Solids ng/l (ppt)
Landfill Leachate as Received	1,540			421		
Electrocoagulation Aluminum Blades	193	87.47%	31,000	11.1	97.36%	8,230
Electrocoagulation Iron and Aluminum	284	81.56%	12,600	11.6	97.24%	3,390
Electrocoagulation Iron and Component	<3.97	99.74%	70	<2.36	99.44%	20

EPA New Regulation Limit for PFOA & PFOS is 4 ng/l (ppt)

You will notice that the PFOA and PFOS in the liquid is below the EPA proposed limit of 4 parts per trillion when the component and iron blades are used. The concentration of PFOA and PFOS in the solids is less than the expected limit of 500 parts per trillion.

The United States Bureau of Reclamation used Total Organic Fluorine (TFO) as an indicator that the carbon fluoride bond was actually destroyed as compared to simply breaking up the longer carbon fluorine chains as shown below.

BME Environmental's remediation process with the electrocoagulation system comes in a variety of sizes commercially. The onsite mobile scale is between 50 to 135 gpm and more. When larger flow volume is required, units are simply combined in parallel flows of 270, 405, 540, 675 gallons per minute and more. Plant version can process flows from 250 to 10,000 GPM where required.