ASSOCIATION OF WATER TECHNOLOGIES

2024 Wastewater Training

Brought to you by:

AWT Wastewater Sub Committee

PFAS/PFOS Overview

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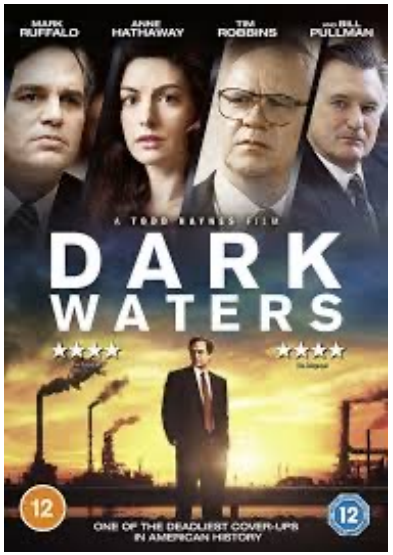
Interested in becoming AWT Wastewater Sub Committee Member, contact Angela Pike apike@awt.org

PFAS/PFOS Chemicals

TODAY'S TOPICS

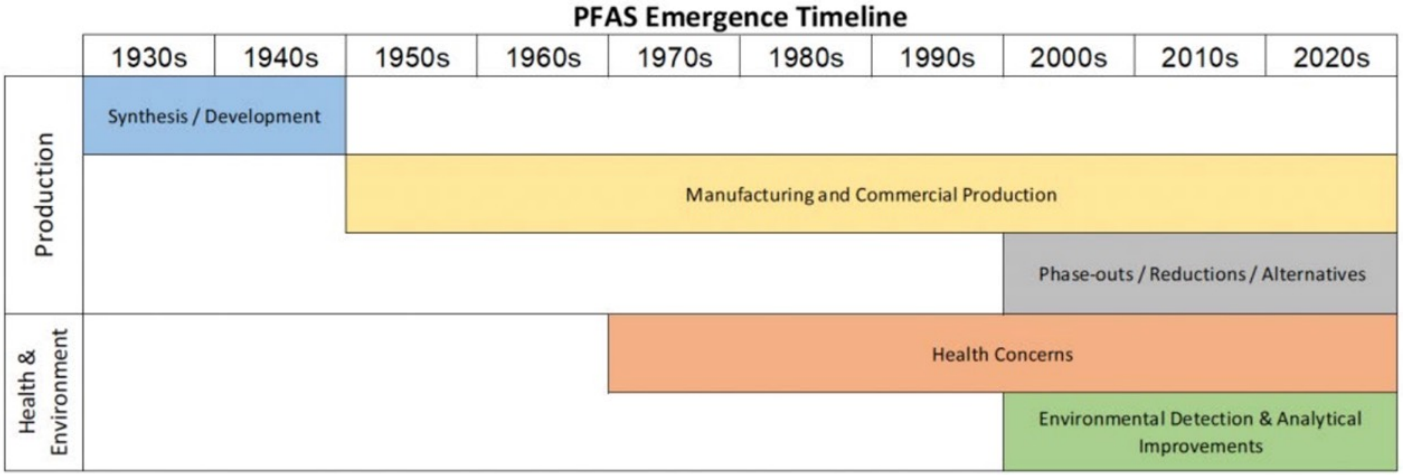
- History of PFAS
- What are PFAS/PFOS compounds
- Where do they come from
- Why are they regulated
- Sample collection
- Regulatory status
- Treatment options
- Destruction/Disposal
- Commercial opportunities



PFAS/PFOS Chemicals

HISTORY OF PFAS

- These compounds have existed since the 1930's
- Widespread commercial applications began in the 1950's
- The unique physical and chemical properties of PFAS impart oil, water, stain, and soil repellency, chemical and thermal stability, and friction reduction to a range of products.

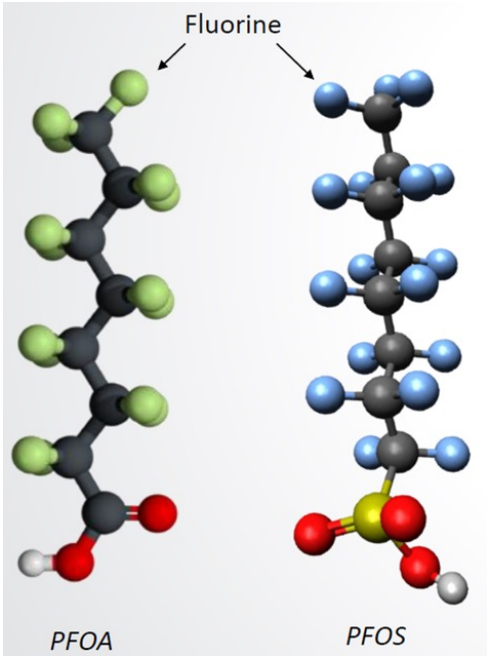


PFAS/PFOS Chemicals

WHAT ARE PFAS/PFOS COMPOUNDS

A very large class of synthetic chemicals

- **Chains** of carbon (C) atoms surrounded by fluorine (F) atoms, with different terminal ends
- **Complicated chemistry -** thousands of different variations exist in commerce
- **Widely used** in industrial processes and in consumer products
- **Mobile** via multiple air, water pathways
- Some PFAS are known to be **PBT**:
  - **Persistent** in the environment
  - **Bioaccumulative** in organisms
  - **Toxic** at relatively low (ppt) levels



PFAS/PFOS Chemicals

WHAT ARE PFAS/PFOS COMPOUNDS

- Approximately 96 compounds are currently targeted by EPA (list is growing)
- Most researched & bioaccumulates in human blood & persists in humans for years.
- PFAS are anthropogenic chemicals and do not occur naturally in the environment.
- Are comprised of a carbon backbone containing many carbonfluorine (C-F) bonds (the C-F bond is the shortest and strongest in nature).
- Due to their unique chemical structure, PFAS are very stable and are resistant to biodegradation.

The “Forever Chemicals”

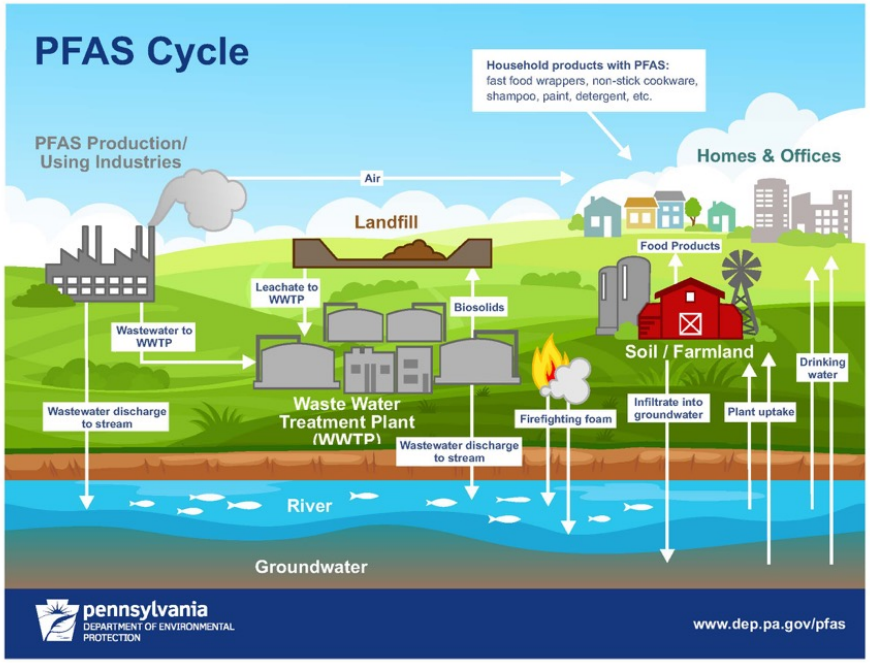
PFAS/PFOS Chemicals

WHERE DO THEY COME FROM

- Industrial surfactants, emulsifiers, wetting agents
- Class B fire-fighting foams (AFFF)
- Electrical wire casings, thread seal tapes
- Food contact paper and packaging
- Clothing and carpets
- Outdoor textiles and sporting equipment
- Ski and snowboard waxes
- Non-stick cookware
- Cleaning agents and fabric softeners
- Polishes and waxes, and latex paints
- Pesticides and herbicides
- Hydraulic fluids
- Windshield wipers
- Paints, varnishes, dyes, and inks
- Adhesives
- Medical products
- Personal care products {for example, shampoo, hair conditioners, sunscreen, cosmetics, toothpaste, dental floss)

PFAS/PFOS Chemicals

WHY ARE THEY REGULATED

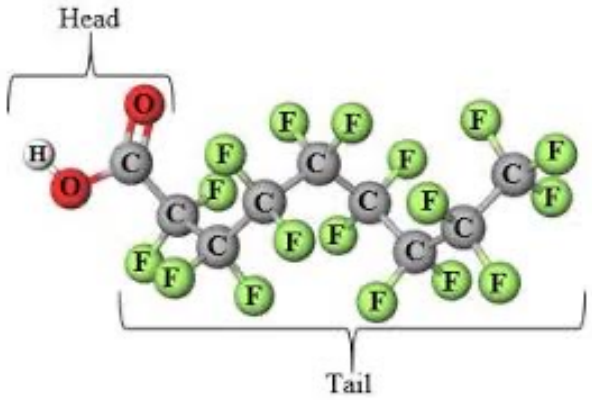


This infographic shows the different pathways PFAS can take to contaminate water, soil and food products.

PFAS/PFOS Chemicals

WHY ARE THEY REGULATED

- Carcinogenicity (kidney & testicular)
- Cardiovascular tox (serum cholesterol)
- Endocrine tox (thyroid)
- Immunotoxicity (immume dysregulation)
- Reproductive toxicity (preg. hypertension)
- Bioaccumulative
- Maternal transfer Shorter chains (‘replacements’)
- Developmental toxicity (observed in zebrafish)
- Endocrine toxicity
- Hematoxicity
- Hepatotoxicity
- Neurodevelopmental toxicity
- Ocular toxicity (delayed pupil response in rodents)
- Reproductive & developmental toxicity



PFAS/PFOS Chemicals

WHY ARE THEY REGULATED

BREAKING NEWS **– *Philadelphia Inquirer***

What to know about 'forever chemicals,' artificial turf, 6-former Phillies die from brain cancer deaths, and our story.

Jessica Griffin / Staff Photographer

Heather Whitehead, a doctoral candidate in chemistry and biochemistry, is working with samples of artificial turf obtained from Veterans Stadium at the University of Notre Dame on Feb. 9, 2023. The research is ongoing.

PFAS/PFOS Chemicals

BEST PRACTICES FOR SAMPLE COLLECTION

- Wash hands and use new nitrile gloves for each sample collected
- Groundwater, surface water, or drinking water samples should not be filtered as the glass fiber on the filter can potentially absorb PFAS
- Collect the PFAS sample first, prior to collecting samples for any other parameters into any other containers. This avoids contact with any other type of sample container, bottles or package materials
- Do not place the sample bottle cap on any surface when collecting the sample, and avoid all contact with the inside of the sample bottle or its cap
- When the labeled sample is collected, place the samples in an individual sealed plastic bag separate from all other sample parameter bottles
- Samples must be chilled during shipment and should arrive at the lab at <6 C +/-2 SPECIALTY SERVICES FIELD

Source: Pace Analytical

PFAS/PFOS Chemicals

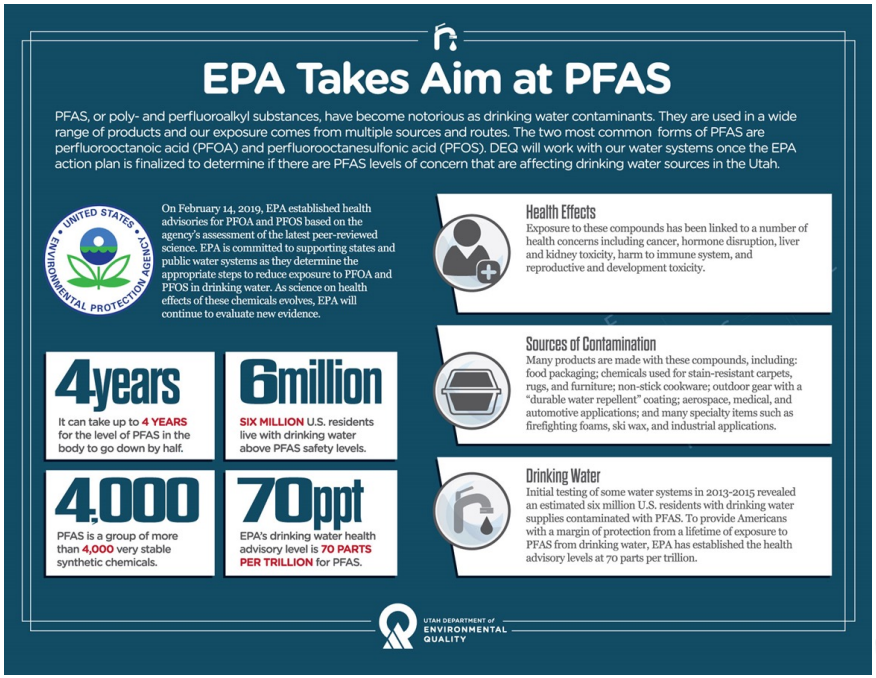
REGULATORY STATUS

State-Level PFAS Action

- Many states using the EPA's tox assessments to set their own legally enforceable limits
- EPA has granted states authority to set their own NPDES permits
- Limits are often below detection range

Federal-Level PFAS Action

- Awaiting EPA effluent guideline limitations, to be published in 2023



PFAS/PFOS Chemicals

REGULATORY STATUS?

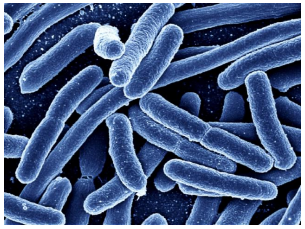
UPDATE - EPA's Proposed Action for the PFAS NPDWR

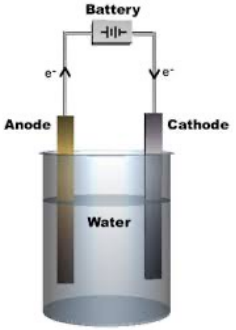
Compound	Proposed MCLG	Proposed MCL (enforceable levels)
PFOA	0 ppt*	4.0 ppt*
PFOS	0 ppt*	4.0 ppt*
PFNA	1.0 (unitless) Hazard Index	1.0 (unitless) Hazard Index
PFHxS		
PFBS		
HFPO-DA (commonly referred to as GenX chemicals)		

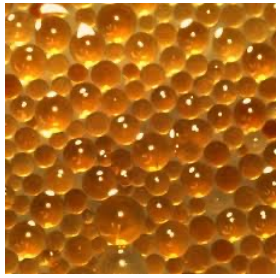
Source: US EPA

PFAS/PFOS Chemicals

TREATMENT OPTIONS?







PFAS/PFOS Chemicals

TREATMENT OPTIONS?

- Adsorptive media +
- Aeration and air stripping
- Biological filtration
- Biological treatment +
- Chlorine
- Chlorine dioxide
- *Conventional treatment ~*
- Granular activated carbon +
- Hydrogen peroxide
- Ion exchange +
- Membrane filtration +
- Electrochemical, electrocoagulation ~
- Ozone
- Ozone + hydrogen peroxide
- Powdered activate carbon ~
- Super Critical Water Oxidation +
- Ultraviolet radiation
- Ultraviolet + hydrogen peroxide

Source: US EPA

PFAS/PFOS Chemicals

Treatment Type	PFOA	PFOS	Other Compounds
Coagulation/flocculations/sedimentation	1-20% [b]	1-80% [b]	1-5% [b]
Granular Activated Carbon - frequent replacement	>48% - >90% [c]	>89% to >98% [a]	>22% - >90% [c]
Anion Exchange	51-90% [c]	90-99% [a]	Faster breakthrough of shorter chain compounds [b]
Membrane Filtration	0% (b), 10-50% [c]	0-23% [a]	<10% for most compounds
Biological Treatment (including slow sand filtration and river bank filtration)	<10% [c]	0-15% [a]	Highly variable, in some cases concentrations increased [c]
Reverse Osmosis	>90% [c]	93-99% [a]	>90% [c]
Oxidation (ozone)	<10% [c]	0-7% [a]	<10% [c]
Advanced oxidation (UV-TiO2)	<10% [c]	15% [a]	<10% [c]
Powdered Activated Carbon	No data	10-97% [a]	No data

Source: US EPA

PFAS/PFOS Chemicals

TREATMENT OPTIONS

Granular Activated Carbon

- Disposable Media
- Relatively High removal rates
- Commercially available
- NSF approved

Reverse Osmosis, Nanofiltration

- Capital equipment cost
- High removal rates
- PFOS/PFOA Concentrate

Electrolysis

- Capital equipment cost
- High energy cost
- Very effective removal rates
- PFOS/PFOA containing sludge

Biological

- Capital Equipment
- Large footprint
- Slow removal rates
- High energy cost

PFAS/PFOS Chemicals

TREATMENT OPTIONS?

Adsorbents

- Disposable Media
- High removal rates
- Best empty bed contact time
- Commercially available
- NSF approved

Ion Exchange Resin

- Disposable Media/Regenerate
- Most efficient removal rates
- Loose bond
- Commercially available
- NSF approved

Supercritical water oxidation (SCWO)

- Mobile technology
- High temperature and pressure to effectively destroy PFAS in contaminated wastewater

PFAS/PFOS Chemicals

DESTRUCTION/DISPOSAL - *Current*

- Biosolids
  - Land Application
- Industrial Sludge Cake
  - Landfill
- Domestic Waste
  - Landfill

PFAS/PFOS Chemicals

DESTRUCTION/DISPOSAL - *Future*

- Incineration
- Arid Climate Landfill (Disposal Cells)
  - RCRA Subtitle C facilities
- Deep Well Injection
  - Class 1

PFAS/PFOS Chemicals

COMMERCIAL OPPORTUNITIES

- Regulation as a driver
- There is a tremendous amount of R&D activity happening globally
- Now is the time to form an understanding of the problem
- Be prepared to field questions from customers and prospects
- Industrial customers will need to address the issue in coming months and years
- Could provide additional revenue streams for WTSC's
- Compliance will have a cost, as will non-compliance