Treatment Guide for **Removing PFAS from Drinking Water**

There are multiple treatment options available that can **remove 90% or more of PFAS** at drinking water treatment facilities. Here are pros and cons for common and emerging solutions.

Per- and polyfluoroalkyl substances (PFAS) are a group of chemicals that have been widely used in various industrial and consumer products for their water-resistant, non-stick, and heat-resistant properties.

PFAS are known to persist in the environment and can accumulate in the human body, leading to potential health risks.

Overview

Treatment Technique	Capitol Cost	Operating Cost	Removal Effectiveness
Activated Carbon	$	$$	90-100%
Ion Exchange	$	$$	90-100%
High-Pressure Membranes	$$$	$$$	>90%
Plasma Treatment	$$$	$$$	70-99%
Novel sorbents	$$$	$$	90-99%

Ready to get started, or have questions about what might work in your community? Contact **Miles Jensen** at *mjensen@sehinc.com*

Activated Carbon Treatment

Granulated activated carbon (GAC) and powdered activated carbon (PAC) are the most studied and used forms of PFAS removal. They are widely used for when high PFAS removal rates are possible.

PROS

- Often 100% effective for a period of time, depending on the type of PFAS that needs to be removed and various other factors.
- Effectively removes PFAS from drinking water when it's used in a flow through filter mode after particulates have already been removed.
- Effective adsorbent because it is a highly porous material and provides a large surface to which contaminants may adsorb.
- Effectively removes a variety of co-contaminants, including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons (TPHs), and others.
- GAC is highly effective when used on longer-chain PFAS like PFOA and PFOS.

CONS

- Strong possibility of competitive adsorption when compounds other than PFAS are present, such as natural organic matter.
- Breakthrough of certain PFAS will inevitably begin to occur once the media adsorption capacity has been met by the contaminants in the water, which will require the spent resin to be replaced with new media
- Shorter chain PFAS tend to break through faster than longer chain PFAS.
- This treatment method requires the largest footprint.
- Typically set up in a "lead-lag" operation where the flow passes through two equally sized vessels to ensure complete removal.
- PFAS removal capacity is generally much lower than ion exchange resins.

Ion Exchange Treatment

Ion exchange (IX) is made up of special positively charged ion exchange material – commercial resins or petrochemical compounds – shaped as beads that can attract and hold the contaminated materials from passing through a targeted water source. Several factors influence IX performance, including influent contaminant concentration, treatment design, PFAS chain length, and competing ion concentrations.

PROS

- Effective on a broad range of PFAS, including short chains.
- Cheapest treatment method in terms of capital and operating expenses.
- Much like GAC and PAC, IX resins that have a high capacity for many PFAS are designed to be a single-use product.
- Significantly smaller footprint than GAC.
- Higher PFAS capacity than GAC resulting in an extended bed life.

CONS

- Once IX resin has reached its limit, breakthrough of the PFAS will require the spent resin to be replaced with new media.
- Fouling can occur, which may require additional pre-treatment and expenses.
- PFAS removal effectiveness is impacted by any chloride concentration in the water; chlorine should be removed prior to IX treatment.
- IX doesn't remove co-contaminants.

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High-Pressure Membrane Treatment (i.e., Reverse Osmosis)

High-pressure membranes, like reverse osmosis (RO) and nano filtration (NF), effectively remove PFAS and additional contaminants in water. RO and NF membranes are semi-permeable membranes that retain PFAS on the pressurized side of the membrane while the purified water passes through.

PROS

- More than 90% effective at removing a wide range of PFAS, including shorter chain PFAS.
- Effectively removes a variety of co-contaminants, including SVOCs, TPH, total organic carbon (TOC), ammonia, hardness, and others.
- RO and NF require the smallest footprint.

CONS

- RO and NF waste ~20% of the feedwater used to generate a concentrated waste stream containing rejected constituents.
- Wasting feedwater is a major challenge in PFAS applications because the stream contains PFAS and needs to be properly disposed of to reduce contamination back into the supply waters.
- Fouling can occur, which may require additional pre-treatment and expenses.
- RO and NF have high operating expenses due to their energy demands.
- Corrosion control is required in downstream water distribution systems.
- RO and NF required minerals to be added back into a treated water stream for drinking water applications.

Novel Sorbents

Novel sorbents are materials that have been specifically designed to adsorb PFAS contaminants from water; is still in the development stages. These materials have high surface areas and unique chemical properties that allow them to selectively adsorb PFAS from water.

PROS

- Can be highly effective at removing PFAS contaminants from water, with removal rates from 90% to 99%.
- Often more selective than traditional sorbents, which can reduce the potential for other contaminants to be removed from the water.
- Can be used in a variety of settings, from point-of-use treatment systems to large-scale treatment facilities.
- Can be produced from sustainable and renewable resources, reducing the carbon footprint associated with their production and use.

CONS

- Still very much in the development stages.
- High capital costs, as they require specialized materials and manufacturing processes that currently limits availability.
- May require specialized training and expertise to operate and maintain effectively.
- May require special approval by State agencies for use in potable water.
- Effectiveness of novel sorbents can be influenced by several factors, including pH, temperature, and the presence of competing ions in the water.
- Long-term effectiveness of novel sorbents is not well-established and further research is needed to determine their durability over time.

Plasma Treatment

Plasma treatment involves exposing the contaminated material to a high-energy plasma, which can break down the PFAS into less harmful compounds. It is still in the development stages. This process can be effective in treating a wide range of PFAS contamination and can be targeted to specific types of PFAS. Plasma treatment can be used in situbioremediation (situ), meaning that the contaminated soil or water does not need to be removed. Several factors can influence the performance of plasma treatment, including the power and duration of the plasma exposure, the composition of the gas used to create the plasma, and the type and concentration of the PFAS present in the environment. However, plasma treatment requires specialized equipment and expertise and may produce hazardous byproducts that require additional treatment and disposal.

PROS

- Plasma treatment can be a rapid and effective way to remediate PFAS contamination.
- Plasma treatment can be targeted to specific types of PFAS, allowing for more efficient and effective treatment.
- Plasma treatment can be used in situbioremediation, meaning that the contaminated soil or water does not need to be removed, reducing disruption to the environment.
- Plasma treatment has the potential to break down PFAS into less harmful compounds, reducing the long-term environmental impact of contamination.

CONS

- Plasma treatment is still in the research and development stages, and its effectiveness and safety need to be further validated.
- Plasma treatment requires specialized equipment and expertise, making it more expensive than other treatment options and may limit availability.
- May require special approval by State agencies for use in potable water.
- The process may produce hazardous byproducts that require additional treatment and disposal.
- The use of plasma treatment may require permits and regulatory approval.

Note: This guide is for informational purpose only. Many emerging treatment options are still in the research phase, and their effectiveness, safety, and scalability for large-scale treatment continue to be evaluated. Refer to EPA.gov for the latest rules and regulations.