

FAQS: Removing Poly- and Perfluoroalkyl Substances (PFAS) with Selective Ion Exchange Resins



What are PFAS?

Poly- and perfluoroalkyl substances (PFAS), also known as “forever chemicals,” are a group of man-made chemicals that includes perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), GenX, ADONA and many other chemicals. PFAS has been manufactured and used in a variety of industries around the globe, including in the United States, since the 1940s. PFOA and PFOS have been the most extensively produced and studied of these chemicals. Both have been phased out of manufacturing in the US at this time.

What are the health risks of PFAS?

PFAS are very persistent in the environment and the human body meaning they don't break down and they can accumulate in body tissues over time. Exposure to PFAS can lead to adverse health outcomes in humans and are estimated to be in the drinking water of over 110 million people. Studies indicate that PFOA and PFOS can cause reproductive and developmental, liver, kidney and immunological health effects in laboratory animals. Both chemicals have caused tumors in animal studies. The most consistent findings from human epidemiology studies include increased cholesterol and liver enzymes, decreased vaccine response, thyroid disease, decreased birth weight and some types of cancer.

How does PFAS get into our water supplies?

Aqueous film-forming foam (AFFF) has been a major source of PFAS contamination since its use in the late 1960s to extinguish petroleum fires at airfields, oil refineries and military installations. Other important PFAS sources include the manufacture of consumer and industrial products such as Teflon-coated utensils, carpets, pizza boxes, popcorn bags, chrome plating, pesticides, textiles, semiconductors and the manufacture of wires and cables. After decades of disposing of PFAS-containing items in landfills, leachate sent to wastewater treatment plants (WWTP) has resulted in additional contamination of WWTP effluents and biosolids that are subsequently used as fertilizer.

As municipalities discover that levels of PFAS in water systems exceed new Federal Health Advisory levels, many questions arise. This guide can help you find answers to make your drinking water clean and safe.

What technology is available that can reduce PFAS to less than detectable levels?

Purofine® PFA694E is a single-use PFAS-selective ion exchange resin that can remove fluorocarbon (PFAS) compounds to non-detectable (ND) levels as defined by EPA Method 537.1.

Purolite® A592E is also a single-use PFAS-selective ion exchange resin that is appropriate for point-of-use (POU) and point-of-entry (POE) applications.

What are the current regulations for PFAS in drinking water?

Health advisory levels vary throughout the world. However, in May 2016, The US EPA issued Health Advisory (HA) levels of 70 parts per trillion (ppt) for PFOS and PFOA combined. To date, the EPA has not issued a Maximum Contaminant Level (MCL) for PFAS in drinking water. Many US states have issued health guidelines and a few have issued MCLs for several PFAS, inclusive of PFOA, PFOS, PFNA, PFHxS and PFHpA. The Interstate Technology Regulatory Council (ITRC) maintains an up-to-date listing of proposed and published regulatory changes by individual states on its website.

What other names are used to refer to PFAS?

Polyfluoroalkyl substances, perfluorinated chemicals, PFCs and fluorocarbon chemicals, are additional names used for the category of PFAS or its subsets.

A listing of the more commonly found PFAS includes:

- Perfluorobutanoic acid (PFBA)
- Perfluoropentanoic acid (PFPeA)
- Perfluorohexanoic acid (PFHxA)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorooctanoic acid (PFOA)
- Perfluorononanoic acid (PFNA)
- Perfluorodecanoic acid (PFDA)
- Perfluoroundecanoic acid (PFUnA)
- Perfluorododecanoic acid (PFDoA)
- Perfluorotridecanoic acid (PFTrDA)
- Perfluorotetradecanoic acid (PFTA)
- Perfluorobutanesulfonic acid (PFBS)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluorooctanesulfonic acid (PFOS)
- Hexafluoropropylene oxide dimer acid (HFPO-DA) (GenX)
- 4,8-dioxa-3H-perfluorononanoic acid (ADONA)
- N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
- N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
- 9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
- 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF30UdS)

What are short- and long-chain PFAS?

The term “long-chain” is used to describe sulfonic-based PFAS with 6 or more carbons in the polymer chain (e.g. PFOS and PFHxS), and carboxylic acid-based PFAS with 8 or more carbons in their polymer chain (e.g. PFOA and PFNA). “Short-chain” PFAS refers to those compounds having fewer carbons than the “long-chain” definitions used above (e.g. PFBS and PFBA).

What are the most popular removal methods for PFAS from water and wastewater?

Granular Activated Carbon (GAC) is currently in widespread use, but the industry is quickly moving to single-use PFAS-selective resins as greater benefits are realized. PFAS-selective resins can be operated with much shorter empty bed contact times vs GAC, resulting in capital cost that is often a fraction of that for GAC. Equally important, the operating capacity for PFA694E is generally many times higher than that for GAC, resulting in significantly lower operational costs. Reverse osmosis is another treatment option but creates a large PFAS-laden waste stream. Synthetic media has also been used in limited applications. Foam fractionation or regenerable ion exchange resins have been proven useful when the influent PFAS concentrations are high for example in the parts per million range. The effluent water from these latter treatment technologies is often polished for final PFAS removal, using a single-use PFAS-selective resin such as Purofine PFA694.

Can ion exchange resin remove both short- and long-chain PFAS?

Yes. Ion exchange resin removes PFAS by two mechanisms—by ion exchange and by adsorption. GAC predominantly removes PFAS by adsorption. PFAS-selective resin can remove short-chain PFAS compounds (e.g. PFBS and PFBA) to non-detectable (ND) levels. The operating capacity of the resin and the leakage of PFAS into the treated water varies, depending on the specific PFAS, the background water chemistry and the empty bed contact time for which the system is designed.

Are Purofine® PFA694E or A592E certified for use in drinking water?

Yes, both Purofine PFA694E and A592E are certified to ANSI/NSF-61 standard for use in drinking water.

Are Purofine® PFA694E or A592E anion resins or adsorbents?

Both ion-exchange and adsorption removal mechanisms are built into these products. PFAS-selective functional groups on the resins target the anionically-charged “head” of the PFAS molecule, while the hydrophobic tail end of the PFAS molecule is strongly adsorbed onto the hydrophobic surface of the resins. Binding of PFAS compounds is therefore quick, requiring smaller treatment systems with relatively short empty bed contact times.

Does background water chemistry affect operating capacity of Purofine® PFA694E or A592E?

Yes, anions typically found in water (e.g. sulfate, nitrate, bicarbonate and chloride) will have the largest impact on the operating capacity of the resins. In addition, elevated levels of naturally occurring organic matter or total organic carbon (TOC) can negatively impact capacity. Our unique PFAS modeling capability takes all of these factors into consideration in predicting PFAS operating capacity and leakage for our resins.

Are there any pH and anionic excursions upon startup?

PFA694E and A592E are supplied in the chloride form. On start-up, chloride will be released by the resins while other anions like sulfate, nitrate and bicarbonate will be picked up by the resins. Removal of bicarbonate in the water will result in a temporary reduction in pH of the treated water but it will recover within a few hours of rinsing or being put into service. Once beyond the start-up phase, the pH of the treated water will not change relative to that in the raw water until the resin is replaced. Concentrations of sulfate and chloride in the treated water will usually stabilize after a few hundred bed volumes of water have been treated.

Which resins are suitable for use in POU/POE devices?

It is impractical to do extended rinsing to stabilize the pH and ionic concentrations of resins used in POU/POE devices. For such cases, Purolite provides specially buffered resin versions known as PFA694EBF and A592EBF. These resins are preconditioned to eliminate the reduction in pH at start-up. They are also preconditioned to avoid higher chloride to sulfate mass ratio (CSMR) in the treated water vs that in the raw water, since higher CSMR can raise concerns about increased lead corrosion in the distribution pipework. Purolite can provide further guidance on designs for POU and POE devices.



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