

TREATMENT OF PFAS IN DRINKING WATER WITH FLUORO-SORB® ADSORBENT

RESULTS OF THE ORANGE COUNTY WATER DISTRICT PILOT STUDY

Summary:

Orange County Water District (OCWD) located in Fountain Valley, CA is studying the use of adsorptive media to remove per- and polyfluoroalkyl substances (PFAS) from groundwater that is intended to be used as drinking water. This work is part of OCWD’s PFAS Facilities Treatment Project, which includes building drinking water treatment plants within the county to address PFAS contaminated groundwater. In December 2019, OCWD initiated an ongoing 2-year pilot-scale column study to identify and test adsorptive media for removal of PFAS from groundwater used as drinking water in impacted regions of north and central Orange County, including 19 large cities and water districts.

The pilot study compared 14 media, including several types of ion-exchange resins (IXR), granulated activated carbon (GAC), and other adsorbents. FLUORO-SORB® 200 adsorbent showed the longest time and greatest number of bed volumes before breakthrough of perfluorooctanoic acid (PFOA) at the detection limit of 2 ng/L in the column effluent. Because Fluoro-sorb adsorbent exhibited superior performance, OCWD concluded that its potential future use as an adsorptive media in filtration systems could achieve PFAS treatment goals with significant annual cost savings, relative to GAC or IXR. The cost savings is due to reduced frequency of media replacement and the low volume of media (treatment footprint) required (OCWD 2021).

Pilot Test Set-Up:

PFAS-contaminated groundwater from a well in Anaheim, CA (named the Bessie well) located adjacent to the Warner Basin was used to supply water for the pilot study. The Warner Basin is a surface water basin (percolation pond) used by OCWD to recharge local river water to the Orange County groundwater aquifer, and therefore, the Bessie well is conservatively representative of a typical Orange County drinking water source. The initial average PFAS concentrations in the pilot study influent from the Bessie well are shown in Table 1. A pilot skid consisting of 2-inch diameter transparent polyvinyl chloride (PVC) columns that are 2.5 feet in height were loaded with media. The bed depth of the Fluoro-sorb adsorbent column was 16 inches, with an empty bed contact time (EBCT) of 2 minutes. Influent water from the Bessie well was passed through a 5-micron cartridge filter to remove suspended solids and then through the pilot column at a constant flow rate for over a year. PFAS in the column effluent was measured over time with US EPA Method 537.1.

Table 1: Summary of pilot study influent PFAS concentrations as measured by US EPA Method 537.1 (Bessie well is water source)

PFAS Name	PFAS Acronym	Average Concentration (ng/L)
Perfluorooctanoic acid	PFOA	16 ± 2.0
Perfluorooctanesulfonic acid	PFOS	23 ± 1.8
Perfluorobutanesulfonic acid	PFBS	14 ± 1.3
Perfluorohexanesulfonic acid	PFHxS	11 ± 0.8
Perfluorohexanoic acid	PFHxA	2.8 ± 0.3
Perfluorononanoic acid	PFNA	2.2 ± 0.7
Perfluorodecanoic acid	PFDA	3.1 ± 0.6

Note: Eleven (11) other PFAS compounds were measured by EPA Method 537.1 and not detected.

Pilot Test Results and Discussion:

PFAS concentration in the column effluent versus time and bed volumes treated is shown in Figure 1. Only concentrations of PFOA, PFOS, PFHxS, and PFBS are depicted in Figure 1, as the other PFAS compounds in the influent (PFHxA, PFNA, and PFDA) measured by EPA 537.1 occurred at concentrations too close to the method detection limit of 2 ng/L to reliably develop breakthrough curves.

The time to initial breakthrough for PFOA in the Fluoro-sorb column was 8.7 months, which is the longest of the 14 media tested (initial breakthrough was considered to be measurement above a 2 ng/L detection limit). The Fluoro-sorb column effluent had not reached 60% of the influent concentration for PFOA (9.6 ng/L), which is an approximate metric for lead bed media changeout, at nearly 15 months into the pilot

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study. Therefore, in a full-scale system with similar influent PFAS concentrations and water quality parameters, the bed life for Fluoro-sorb adsorbent is expected to be greater than 15 months. PFBS breakthrough at the 2 ng/L detection limit in the effluent was measured at 4 months and rose slowly to approximately 10 ng/L after nearly 15 months, but was significantly under the California Notification Level of 500 ng/L. PFOS was not detected in the Fluoro-sorb adsorbent column effluent for the nearly 15 month testing duration to date, indicating it is still being removed; PFHxS initial breakthrough was observed only after 14 months.

General water quality parameters for the Fluoro-sorb adsorbent column influent and effluent are shown in Table 2. The results show that the following chemical constituents were not significantly adsorbed by Fluoro-sorb adsorbent: Total Organic Carbon (TOC), Calcium, Magnesium, Iron, Manganese, Nitrate, Phosphate, and Sulfate.

Conclusions:

Fluoro-sorb adsorbent exhibited the latest PFOA breakthrough at 8.7 months compared to 13 other media tested, and was also effective for removal of PFOS, PFHxS, and PFBS. The performance was not negatively affected by the presence of TOC, cationic metals, or anions. Fluoro-sorb adsorbent is NSF 61 certified for drinking water and can be used full-scale in “dual vessels” that are designed to accommodate GAC or IXR.

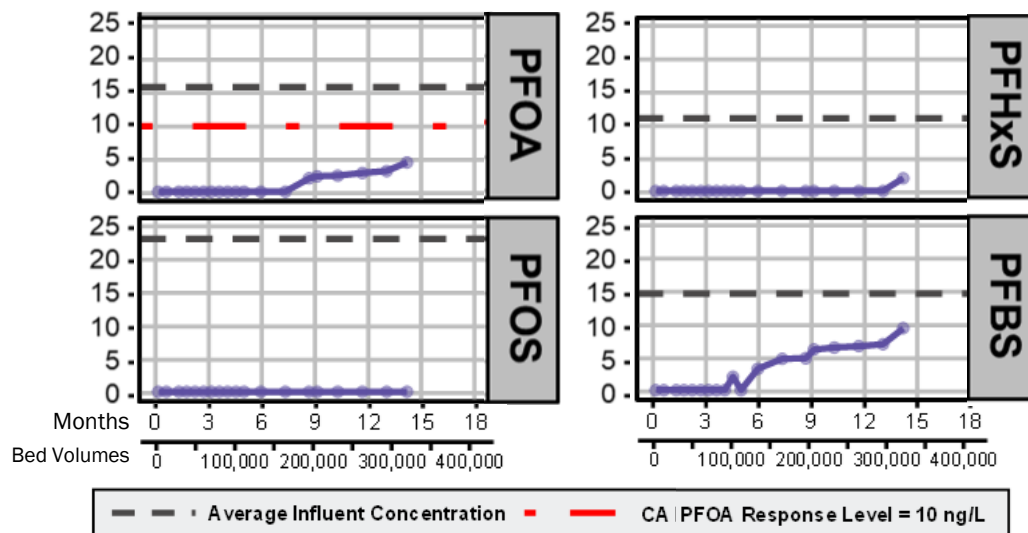


Figure 1: PFAS concentration in the FLUORO-SORB® adsorbent pilot-scale column effluent versus time and bed volumes treated.

Table 2: Influent and effluent water quality parameters in the Fluoro-sorb® adsorbent column

Parameter	Units	Average Influent Concentration	Effluent Concentration First Month Sampling	Effluent Concentration Eight Month Sampling
Total Dissolved Solids (TDS)	mg/L	624	616	604
Total Organic Carbon (TOC)	mg/L	1.3	1.22	1.34
Calcium + Magnesium	mg/L	103.9	97.7	98.1
Chloride	mg/L	130	128	122
Iron	µg/L	<5	5.5	<5
Manganese	µg/L	236	252	241
Nitrate (NO3-N)	mg/L	0.3	0.23	0.43
Phosphate (PO4-P)	mg/L	0.4	0.43	0.4
Sulfate (SO4)	mg/L	131	124	123

Reference: Orange County Water District (2021). *PFAS Phase 1 Pilot Scale Treatment Study Final Report*. March 24, 2021. https://www.ocwd.com/media/9829/2021-03-24_ocwd-pfas-pilot-i_finalreport.pdf

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