CARBON EVALUATION STUDY FOR PFOA AND PFOS REMOVAL

As commisioned by:
HDR
8404 Indian Hills Drive
Omaha, NE 68114

Prepared by:
Engineering Performance Solutions, LLC
3161 St. Johns Bluff Rd. S. Suite 3
Jacksonville, FL 32246
904-645-7775

Report #: 210.01.1117

Date: 11/07/2017

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SCOPE

Per our agreement with John J Ifkovits, Senior Hydrogeologist for HDR, Engineering Performance Solutions, LLC (EPS) has agreed to perform a rapid small-scale column test (RSSCT) to evaluate the breakthrough performance of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) using Calgon Carbon's bituminous coal-based re-agglomerated Filtrasorb 400 12 x 40 carbon (F400). The RSSCT was designed to simulate a full-scale empty-bed contact time (EBCT) of 5 minutes.

METHOD

A source water labeled Rec Pond Water was collected from Stewart Airport and shipped (on ice) overnight to the EPS facilities in Jacksonville, FL. The water was stored at 4 °C until the testing commenced.

A key feature of RSSCTs is that the GAC grains utilized in the mini-column are considerably smaller than full-scale grains. As determined by Crittenden et al. (1991), mini-columns containing finely ground GAC can accurately simulate full-scale GAC breakthrough profiles in a fraction of the time required for full-scale adsorption systems. The mini-column employed herein contained 200 x 230 mesh (mean particle size = 0.070 mm) GAC grains. Using a proportional diffusivity scaling equation, a small-scale EBCT of 0.41 minutes was needed to simulate the desired full-scale EBCT of 5 minutes for the 12 x 40 carbon.

Proportional diffusivity scaling equation = $\frac{\mathrm{EBCT_{SC}}}{\mathrm{EBCT_{LC}}} = \frac{\mathrm{R_{SC}}}{\mathrm{R_{LC}}} = tsc / tLc$

Table 1 below contains the column parameters used for the test.

Table 1

Column Details	Depth (cm)	Diameter (cm)	Flow (ml/min)
F400 @ 5 min.	3.0	0.5	1.42

As the mini-column was processing water, effluent samples were collected on a regular basis and then analyzed for PFOA and PFOS concentrations. Average influent concentration for the water was 0.049 ug/L for PFOA and 0.370 ug/L for PFOS. All samples below the minimum detection limit (MDL) were graphed at the reporting limit.

RESULTS

The RSSCTs were run to simulate 288 days of full scale use or approximately 83,000 bed volumes (BVs).

The breakthrough curve resultants for PFOA and PFOS are shown below in Figure 1 and Table 1.

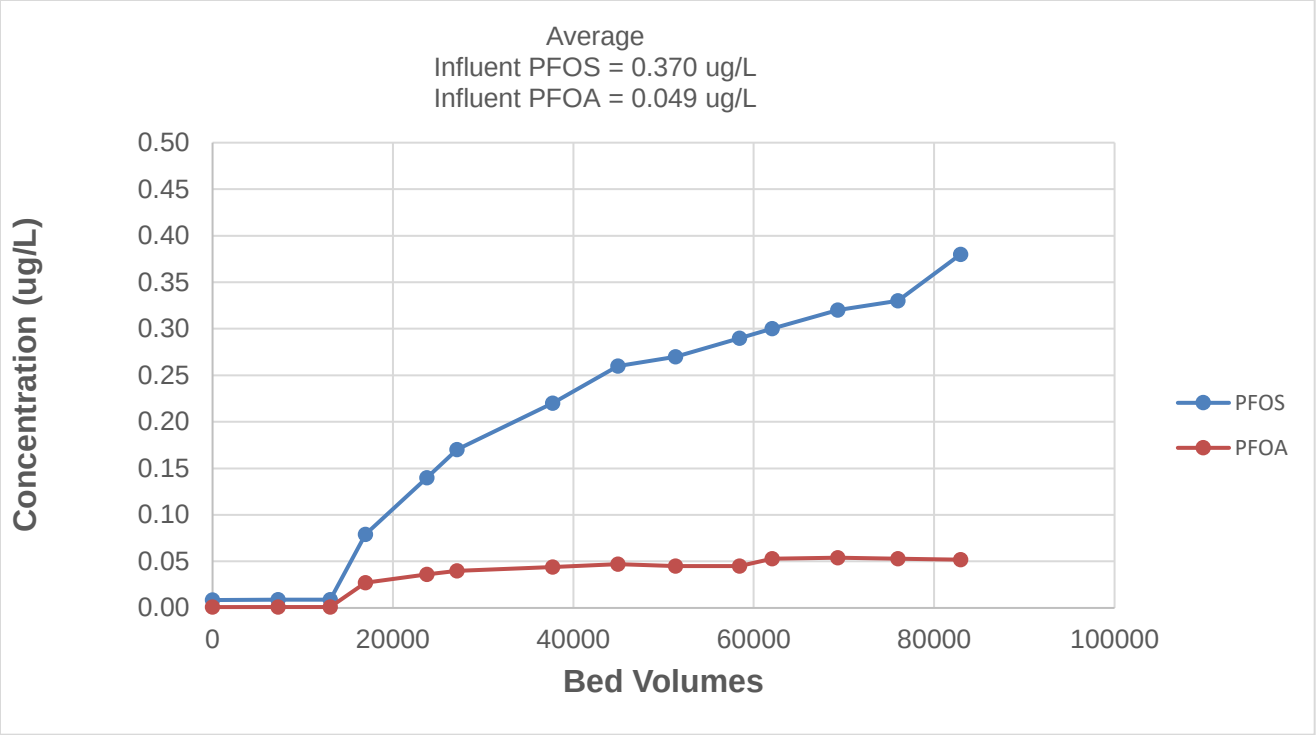

Figure 1. PFOA and PFOS breakthrough profile (simulated full-scale EBCT = 5 min, 1 day = 288 bed volumes).

As shown in Figure 1 both compounds started to show breakthrough at around 17,000 bed volumes or at around 60 days of run time. As seen in past studies GAC is quite effective in removing PFOS. Even though it is at a much higher concentration it does not reach saturation until the end of the column test at around 80,000 bed volumes or around 278 days . PFOA is show to be less efficient in removal by GAC and thus reached saturation at 45,000 bed volumes or approximately 156 days of run time.

Table 1 below shows the analytical results used in the graph above.

Table 1. F400

BVs	PFOA (ug/L)	PFOS (ug/L)	BVs	PFOA (ug/L)	PFOS (ug/L)
0	<0.001	<0.009	51322	0.045	0.270
7249	<0.001	<0.009	58426	0.045	0.290
13048	<0.001	<0.009	62050	0.053	0.300
16962	0.027	0.079	69299	0.054	0.320
23776	0.036	0.140	75968	0.053	0.330
27111	0.040	0.170	82927	0.052	0.380
37694	0.044	0.220			
44943	0.047	0.260			

< less than MDL

NOTE: Please be advised that the information contained within this report is not definitive. Changes in water quality or activated carbon quality could influence the results presented above. In other words, seasonal changes in water quality could impact removal efficiencies. Additionally, the trends and performance depicted here are specific to this facility only and should not be considered representative of any other.

REFERENCES

Crittenden JC, Reddy PJ, Arora H, Trynoski J, Hand DW, Perram DL, Summers RS. Predicting GAC performance with rapid small scale column tests. J AWWA 1991; 83:1:77-87.