

Hexavalent Chromium Removal from Groundwater by Sorbster® Adsorbent Medias

Problem

The presence of hexavalent chromium in the ground water surrounding a western US community presented significant health hazards to residents and local wildlife. Hexavalent chromium is a known carcinogen. This danger was brought into the public eye in many ways, most notable is the case promulgated by the movie Erin Brockovich. Laboratory studies showed a marked increase in cancer rates among animals that ingested contaminated water. The groundwater in this area contained hexavalent chromium levels between 16 µg/L to 250 µg/L (average 136 µg/L). For reference the US EPA has set a maximum of 100 µg/L with many states setting a more stringent standard of 50 µg/L.

There was also a secondary contaminant of interest, organic trichloroethene (TCE), that was historically detected at this site at average concentrations of 995 µg/L.

Evaluation

To remove both hexavalent chromium and TCE in one pass of the water, Sorbster® selected a dual treatment of activated carbon for the TCE followed by a Sorbster® media for the hexavalent chromium. Two different Sorbster® products were studied: Sorbster® MM-1, a highly functionalized activated alumina-based media and Sorbster® F-1, a promoted activated alumina-based media. Both medias contain an iron functionality that attracts hexavalent chromium.

Column Test Studies Completed with Western US Water

Column Conditions	Test 1: Sorbster® MM-1 Media after Activated Carbon at 30 Minute Water-to-Media Contact	Test 2: Sorbster® F-1 Media after Activated Carbon at 30 Minute Water-to-Media Contact
Column Dimensions	1" diameter x 36" high (for each media)	1" diameter x 36" high (for each media)
Media 1: Activated Carbon	Carbon V 8X30 Coal	Carbon V 8X30 Coal
Media 2: Sorbster®	Sorbster® MM-1: Lot # M829128	Sorbster® F-1: Lot # M14PA-0326Y
Media Bed Volume	461 cm³	461 cm³
1 Empty Bed Volume	461 mL	461 mL
Total Bed Volumes Treated	23.9 (11000 mL)	23.9 (11000 mL)
Flow Rate	15.4 mL/minute, up-flow	15.4 mL/minute, up-flow
Contact Time	30 minutes (EBCT)	30 minutes (EBCT)
Pretreatment	The water is pumped as received through an activated carbon column (to remove TCE and other organics) ahead of Sorbster® MM-1 column	The water is pumped as received through an activated carbon column (to remove TCE and other organics) ahead of Sorbster® F-1 column

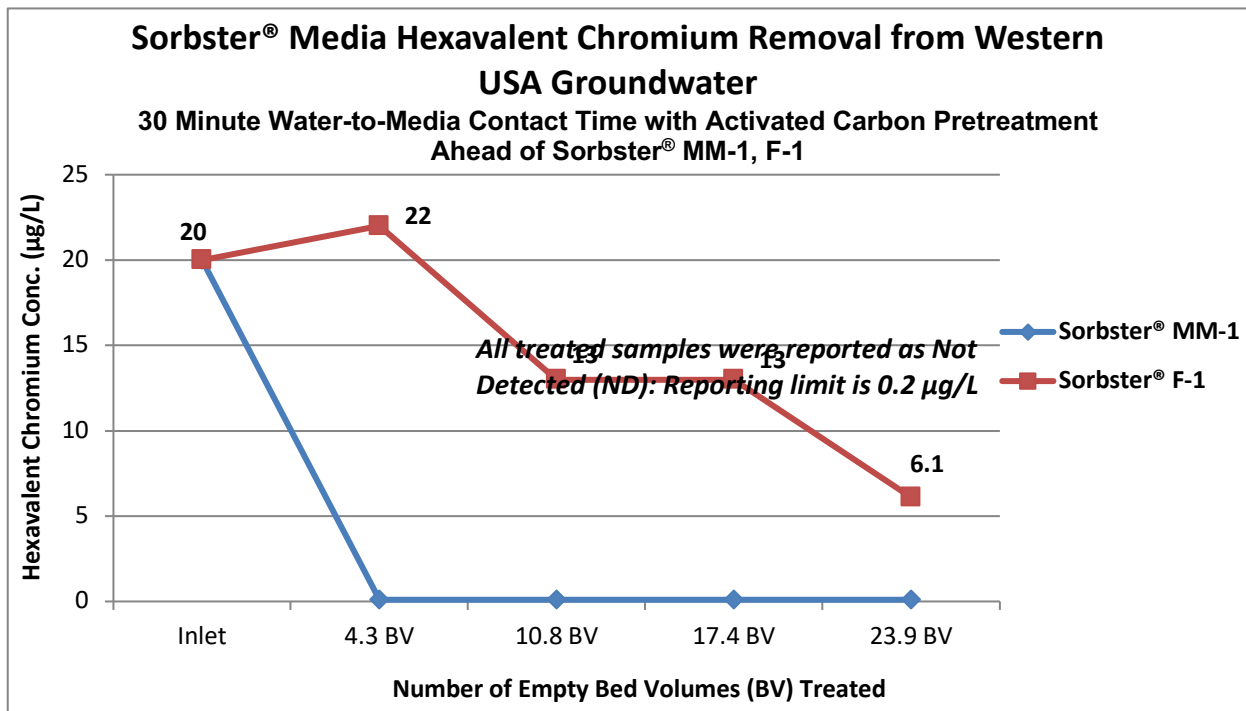
WATER DESCRIPTION:

- Groundwater for Sorbster® Testing
 - 2x5 gallon collapsible containers in coolers
- Appearance: clear, water white
- pH: 7.27
- Hexavalent Chromium Concentration
 - 20.0 µg/L (by Ion Chromatography method E218.6)
 - Value was near the minimum Cr⁶⁺ concentration (16 µg/L) reported in the historical data (1992-2013)
 - Method reporting limit is 0.20 µg/L
- Total Chromium Concentration:
 - 20.3 µg/L (by ICP/MS method 200.8)
 - Value confirms that essentially all Cr present in the water was in the form of Cr⁶⁺ as expected
 - Method reporting limit is 1.00 µg/L
- Trichloroethene (TCE): 89.0 µg/L (VOC method E624: Purge & Trap GC/MS)
 - This value was significantly lower than the historical average provided (1992-2013) of 995 µg/L TCE
 - Method reporting limit is 5.00 µg/L

Sorbster® Results

Significant, rapid and sustained removal of hexavalent chromium occurred with the Sorbster® MM-1 treatment system. Treated water indicated no detectable hexavalent chromium water over all bed volumes. Sorbster® MM-1 performance is represented by the blue line in the graph below.

Sorbster® F-1 performance, depicted by the red line in the graph below, was less rapid but did show hexavalent chromium reduction on a continuing basis over time. Final hexavalent chromium levels of 6 µg/L were attained.



In addition, the treatment system of activated carbon followed by Sorbster® media effectively reduced the TCE levels to below detection limits in all samples tested. No TCE was present in the water as it exited the carbon media, as shown in the following Table:

	Trichloroethene (TCE), µg/L (Method: E624)	
	Sorbster® MM-1 after activated carbon (30 minutes EBCT)	Sorbster® F-1 after activated carbon (30 minutes EBCT)
Inlet	89	78.2
Interbed at 23.9 BV	ND	ND
Final Effluent at 23.9 BV	ND	ND

*The reporting limit for TCE by this method is 5 µg/L

- Rapid and sustained removal of hexavalent chromium was successful with both Sorbster® adsorbent medias. For the contaminants in this water, a combination treatment of activated carbon and Sorbster® ensured that both toxic contaminants present, TCE and hexavalent chromium, were removed to below analytical detection limits.
- Further, Sorbster® MM-1 passed TCLP and CA WET leachability tests, an indication that the hexavalent chromium is permanently bonded to the media and non-hazardous waste disposal options of spent media provide additional product savings.
- Sorbster® MM-1 media provided the strongest removal of hexavalent chromium from the water at a 30-minute contact time. This functionalized aluminum product reduced the hexavalent chromium concentration to below detection limits for all treated effluent samples. Sorbster® MM-1's capacity for hexavalent chromium removal was sustained throughout this evaluation, indicative of long media life.
- Sorbster® F-1 media, a promoted activated alumina product, also demonstrated proficiency for hexavalent chromium removal however, the removal rate was not as rapid as Sorbster® MM-1. Sorbster® F-1 reduced the hexavalent chromium level steadily over time to a level approaching that attained by MM-1 media. Further chromium reduction was still occurring at the end of the study demonstrating the high adsorptive capacity of this product.
- The activated carbon pretreatment effectively removed 89.0 µg/L of trichloroethene to below the detection limit of 5.0 µg/L.
- Sorbster® MM-1 was recommended as the optimal, economically and ecologically viable, solution for the removal of Cr⁶⁺ at this site.

Contact Sorbster® for your removal needs. We can supply the most effective adsorbent products for your water.