THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**ARSENIC ADSORPTION MEDIA FILTER USED IN DRINKING WATER TREATMENT SYSTEMS**	
APPLICATION:	**REMOVAL OF ARSENIC IN DRINKING WATER**	
TECHNOLOGY NAME:	**PARA-FLO™ PF60 MODEL AAO8AS WITH ACTIGUARD AAFS50**	
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The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholders groups (consisting of buyers, vendor organizations, and permitters), and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

NSF International (NSF), in cooperation with the EPA, operates the Drinking Water Systems (DWS) Center, one of seven technology areas under the ETV Program. The DWS Center recently evaluated the performance of an adsorption media filter technology for the reduction of arsenic in drinking water. This verification statement provides a summary of the test results for the Kinetico Inc. and Alcan Chemicals Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50 System. Gannett Fleming, Inc., an NSF-qualified field testing organization (FTO), performed the verification testing. The verification report contains a comprehensive description of the test.

ABSTRACT

Verification testing of the Kinetico Inc. and Alcan Chemicals Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50 arsenic adsorption media filter system was conducted at the Orchard Hills Mobile Home Park (MHP) Water Treatment Plant (WTP) in Carroll Township, Pennsylvania from April 22, 2003 through October 28, 2003. The source water was untreated groundwater from one of the MHP's groundwater supply wells. The source water, with an average total arsenic concentration of 14 µg/L and a pH of 7.6, received no treatment or chemical addition prior to entering the treatment unit. When operated under the manufacturers' specified site conditions at a flow rate of 1.9 gpm ± 0.1 gpm, the Kinetico Inc. and Alcan Chemicals Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50 arsenic adsorption media filter system removed arsenic from the feed water to less than the detection limit (2 µg/L) for approximately 8,000 bed volumes, to less than 10 µg/L for approximately 25,000 bed volumes, and to less than the predetermined test endpoint (11 µg/L) after approximately 2,350 hours of total equipment operation for a total of approximately 29,000 bed volumes.

TECHNOLOGY DESCRIPTION

The following technology description was provided by the manufacturer and has not been verified.

The arsenic adsorption media filter system included Kinetico Inc.'s Para-Flo™ PF60 Model AA08AS filter unit, which includes two pressure filter tanks and a filter control module. The control module houses water-driven gears and mechanically interconnected pulse-turbine meter and valves to automatically initiate and control filter backwashes. The movement of the gears determines the position of the filter valves. Following the throughput of a set total volume of water, the pulse-turbine meter triggers the water-driven gears to manipulate valves, so that the operating mode of one filter is switched from service to backwash, to purge, and finally returns to service. During a backwash event, one filter supplies treated water for the backwashing filter and treated water effluent. The filter tanks operate in parallel when both are in service. Each filter was loaded with Alcan Chemicals' Actiguard AAFS50 media, a proprietary granular iron-enhanced activated alumina media. Literature for Alcan Chemicals' Actiguard AAFS50 media states that it is certified to NSF/ANSI 61.

The treatment unit is intended for use on groundwater supplies not under the influence of surface water serving small communities having limited manpower and operating skills. However, the technology is also scalable for serving larger systems. The filter system does not require electricity to operate and can operate continuously or intermittently. The filter components are modular in nature and can be installed by a qualified plumber. The tanks are freestanding, requiring only a level surface capable of supporting the weight of the unit, maintenance of ambient temperature above 35°F (1.7°C), and a feed water pressure between 30 and 125 psi.

VERIFICATION TESTING DESCRIPTION

Test Site

The verification testing site was the Orchard Hills MHP WTP in Carroll Township, Pennsylvania. The source water was untreated groundwater from the WTP Well No.1, which is one of three wells currently

used to supply the MHP. The source water was of generally good quality, with relatively low turbidity, slightly basic pH, and moderate hardness of about 99 mg/L. The source water had a high concentration of manganese, 144 µg/L on average; an average total arsenic concentration of 14 µg/L, ranging from a minimum concentration of 12 µg/L to a maximum of 17 µg/L; an average iron concentration of 34 µg/L; an average silica concentration of 19.0 mg/L; and an average alkalinity concentration of 89 mg/L.

Methods and Procedures

Operations, sampling, and analyses were performed to provide an accurate evaluation of the treatment system under the field conditions. The verification testing was conducted in two phases. The first phase, the Integrity Test, was designed to evaluate equipment operation reliability under the environmental and hydraulic conditions at the WTP site during the initial two weeks of testing. The second phase, the Capacity Test, included testing designed to evaluate the capacity of the arsenic adsorption media filter system to remove arsenic from the Well No. 1 feed water.

The Integrity Test ran for 13 full days plus 8 hours, during which the field test operator was on-site to record test data twice per day. The treatment system was operated continuously using the manual mode of operation for Well No. 1 2 hours each day and operated intermittently during the remainder of each day. During the Capacity Test, the treatment unit operated intermittently in concert with the WTP well operation. The Capacity Test continued until an arsenic concentration of 11 µg/L was detected in the treated water for a minimum of 3 consecutive samples.

Flow rate, production volume, and pressure were monitored and recorded twice per day. Grab samples of feed and treated water samples were analyzed for pH, temperature, turbidity, alkalinity, calcium, magnesium, hardness, and fluoride by the field test operator. Grab samples were collected and delivered to the PADEP Laboratory for analysis of silica, aluminum, iron, manganese, chloride, sulfate, and total phosphorus. Arsenic samples were collected and sent to the NSF Laboratories for analyses. Sample collection for some water quality parameters was more frequent during the initial two-week Integrity Test period. Arsenic samples were also collected more frequently as the treated water total arsenic concentration approached the predetermined end-point concentration for a total number of 47 arsenic samples. Three sets of samples were speciated for arsenic during the Integrity Test, to determine the relative proportion of the total arsenic concentration that was soluble, that was in the As III species, and that was in the As V species. Samples for arsenic speciation were also collected periodically during the Capacity Test.

Complete descriptions of the verification testing results and quality assurance/quality control procedures are included in the verification report.

VERIFICATION OF PERFORMANCE

System Operation

The verification testing was conducted under the manufacturers' specified operating conditions. Contact time is a critical parameter for arsenic adsorption efficiency and is dependent upon maintaining the flow rate within the design range of 1.9 gpm ± 0.1 gpm. A non-integral pressure regulating valve and diaphragm valve on the treated water line were used to control and maintain the flow rate. A relatively constant flow rate was maintained with minimal flow rate adjustments required.

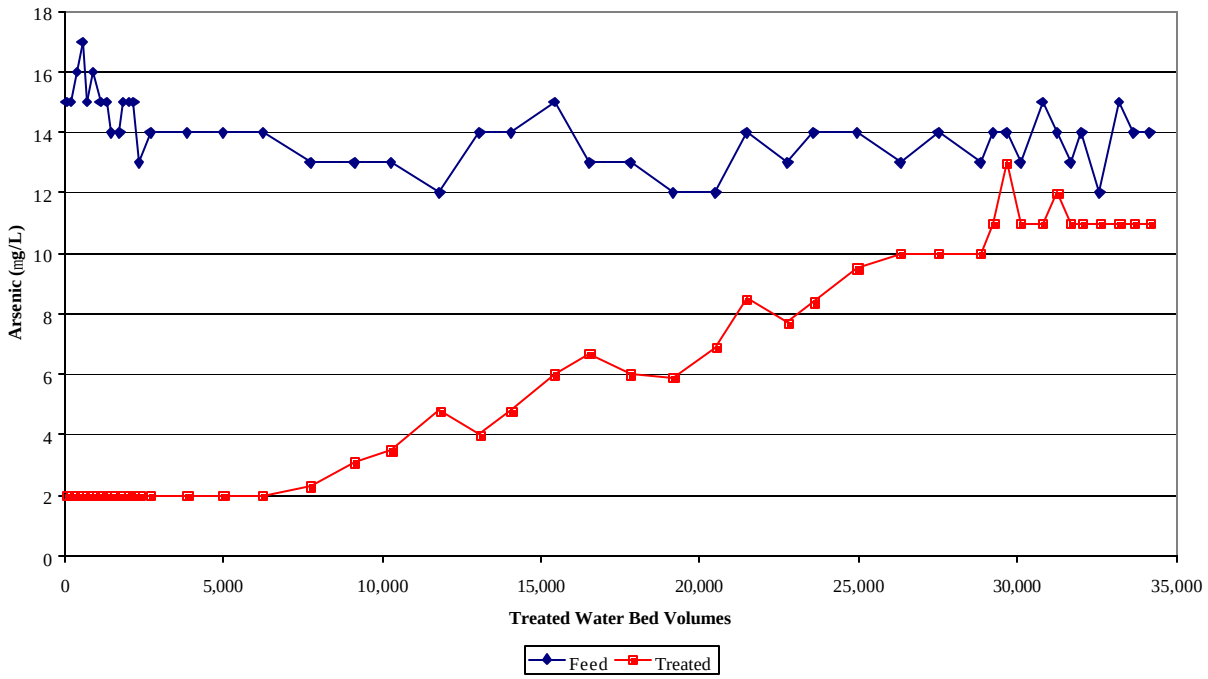
The system was operated continuously for a 2-hour period each day for the first 13 days plus 8 hours as part of the Integrity Test using the manual mode of operation for Well No. 1. The system operated intermittently in concert with the Well No. 1 operation during the remainder of the Integrity Test and throughout the Capacity Test. The filter unit operated for a total of 14.2 hours per day, on average.

The filter control module automatically initiates and controls backwashes based on a preset throughput volume. The treatment unit was set to backwash one filter following the throughput of approximately 10,500 gallons, plus or minus ten percent. A single filter was backwashed at a time. Therefore, each filter was backwashed every 21,000 gallons. Using the setscrew on the control module, filter backwashes were manually initiated at the end of the Integrity Test and monthly throughout the Capacity Test for the purpose of measuring backwash volume and testing backwash water quality. These manually initiated backwashes were performed for verification testing purposes only. Headloss across the filter unit averaged 1.1 psi during the test period, an amount only slightly greater than the 1.0 psi average headloss during the first two weeks of the test.

Water Quality Results

The feed water arsenic concentration averaged 14 µg/L, with approximately 4 µg/L as the arsenic III species and 10 µg/L as the arsenic V species. Treated water arsenic concentrations were less than or equal to the 2 µg/L detection limit during the initial 5 weeks of testing, or approximately 8,000 bed volumes of treated water. At the end of the verification test, the treated water arsenic concentration reached 11 µg/L following approximately 2,350 hours of equipment operation and treatment of approximately 28,800 to 29,200 bed volumes of water, based on the calculated media bed volume of 1.20 cubic feet. A steep breakthrough curve, which is typical with ion exchange processes, did not occur, as presented in Figure VS-1. The arsenic breakthrough curve may have been slowed by mixing of the filter media during filter backwashes.

Figure VS-1. Arsenic Breakthrough Curve
(Detection Limit = 2 µg/L)



At the beginning of the test, the treatment process reduced the pH from 7.3 in the feed water to 6.8 in the treated. As the media became conditioned by the feed water, the treated water pH increased such that, by the end of the first week of testing, the pH of the treated water was 7.5 compared to a pH of 7.7 in feed water. This pH reduction corresponded with a removal of alkalinity during the first two weeks of the test. Initially, the feed water alkalinity of 88 mg/L was reduced by 43%. However, by the end of the first week

of testing, the feed and treated alkalinity levels were essentially equal. The initial reduction in these water quality parameters was likely due to the acidic character of the coating on the virgin media.

Fluoride and silica were removed from the feed water initially, but as the total adsorption site area decreased, the preferentially favored arsenic ions out-competed the ions of fluoride and silica for the remaining adsorption sites. Initially, the feed water fluoride level of around 0.17 mg/L was reduced by up to 88%. Removal of this ion rapidly declined, so that by the end of the first two weeks of operation, fluoride was no longer being adsorbed by the media. Similarly, the initial feed water silica level of approximately 18 mg/L was reduced by up to 83%. Silica removal decreased within the first two weeks of operation to a range of 10% to 15% and remained at that level for approximately one month. Thereafter, levels of feed water and treated water silica were essentially equal.

The average feed water manganese level of 144 µg/L, which is almost three times the secondary maximum contaminant level of 50 µg/L, was reduced by an average 92% by the adsorption media. The initial treated water sulfate level (29.2 mg/L) exceeded the feed water sulfate level by 180%. Presumably, this was due to rinsing of excess coating from the media, which apparently contained a sulfate compound. After the first week of operations, the treated level of sulfate was only approximately 10% higher than the feed water sulfate. Thereafter, the feed and treated levels of sulfate were essentially equal.

The feed water total phosphorus level, which averaged 0.032 mg/L, was reduced during the entire period of verification testing. During the first 6 weeks of testing, between 60% and 70% of the total phosphorus was removed. Total phosphorus removal became more erratic thereafter, ranging between 20% and 68%. Turbidity was also reduced during the treatment process. However, concentrations of calcium, magnesium, hardness, aluminum, iron, and chloride were not significantly affected by the treatment process. Data tables presenting the on-site and laboratory water quality parameters collected during the Integrity Test and Capacity Test can be found in the verification report.

Operation and Maintenance Results

The two-phase verification test began on April 22, 2003 and ended following the conclusion of the Capacity Test on October 28, 2003. The treatment unit, including backwash cycles, operated automatically throughout the test. However, manually initiated backwashes were also performed as part of the testing process. Operator attention was required to verify and maintain a constant flow rate, to check for leaks in the piping and filter unit, and to verify that backwashes occurred as required based on throughput. Equipment operation required minimal operator attention.

Consumables and Waste Generation

No chemicals or electrical power were required. Wastewater from filter backwash, purge, and control module drive water was discharged to a sanitary sewer. The total water usage of approximately 83 gallons per backwash cycle represents less than 1 percent of the total finished water production.

Toxicity Characteristic Leaching Procedure (TCLP) and California Waste Extraction Tests (CA WET) were performed on spent Actiguard AAFS50 media. All concentrations of analyzed parameters were less than the current regulatory limits. A complete summary of the TCLP and CA WET results are provided in the verification report.

Quality Assurance/Quality Control

NSF provided technical and quality assurance oversight of the verification testing as described in the verification report, including an audit of nearly 100% of the data. NSF personnel also conducted a technical systems audit during testing to ensure the testing was in compliance with the test plan. A complete description of the QA/QC procedures is provided in the verification report.

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Availability of Supporting Documents

Copies of the *ETV Protocol for Equipment Verification Testing for Arsenic Removal* dated April 2002, the verification statement, and the verification report (NSF report #04/08/EPADWCTR) are available from the following sources:
(NOTE: Appendices are not included in the verification report. Appendices are available from NSF upon request.)

1. ETV Drinking Water Systems Center Manager (order hard copy)
   NSF International
   P.O. Box 130140
   Ann Arbor, Michigan 48113-0140
2. NSF web site: http://www.nsf.org/etv (electronic copy)
3. EPA web site: http://www.epa.gov/etv (electronic copy)