THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**POINT-OF-USE DRINKING WATER TREATMENT SYSTEM**	
APPLICATION:	**REMOVAL OF MICROBIAL CONTAMINATION AGENTS IN DRINKING WATER**	
PRODUCT NAME:	**PALL/KINETICO PUREFECTA™**	
COMPANY:	**KINETICO INCORPORATED**	
ADDRESS:	**10845 KINSMAN ROAD**	PHONE: **800-944-9283**
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NSF International (NSF) manages the Drinking Water Systems (DWS) Center under the U.S. Environmental Protection Agency's (EPA) Environmental Technology Verification (ETV) Program. The DWS Center recently evaluated the performance of the Pall/Kinetico Purefecta™ point-of-use (POU) drinking water treatment system. NSF performed all of the testing activities, and also authored the verification report and this verification statement. The verification report contains a comprehensive description of the test.

EPA created the 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, stakeholder 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.

ABSTRACT

The Pall/Kinetico Purefecta™ was tested for removal of bacteria and viruses at NSF's Drinking Water Treatment Systems Laboratory. Kinetico submitted ten units for testing, which were split into two groups of five. One group received 25 days of conditioning prior to challenge testing, while the second group was tested immediately. Both groups were identically challenged. The challenge organisms were the viruses fr, MS2, and Phi X 174, and the bacteria *Brevundimonas diminuta* and *Hydrogenophaga pseudoflava*. The test units were challenged at two different inlet pressures – 40 and 80 pounds per square inch, gauge (psig). The virus challenges were conducted at three different pH settings (6, 7.5, and 9) to assess whether pH influences the performance of the test units. The bacteria challenges were only conducted at pH 7.5.

The $\log_{10}$ reduction data is shown in Tables 2 through 5. The unconditioned units reduced all three viruses to less than detectible levels in every challenge, and the conditioned units reduced all three viruses to less than detectible levels in every challenge but one. The bacteria effluent counts for the unconditioned units were all less than 10 colony forming units (CFU)/100mL, but there were two instances where the bacteria counts for the conditioned units were higher (83,000 CFU/100mL and 600 CFU/100 mL) for reasons unknown.

The test data does not show whether inlet pressure or pH influenced test unit performance.

TECHNOLOGY DESCRIPTION

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

The Purefecta™ is a five-stage POU drinking water treatment system. It uses carbon filtration and reverse osmosis to remove chemical contaminants from drinking water, and a mechanical filtration "biofilter" to remove microorganisms. It is sold with a faucet that is installed at the kitchen sink. The "biofilter" is manufactured by the Pall Corporation and supplied to Kinetico, who manufactures the system. The Purefecta™ is designed to produce approximately four gallons of reject water for every gallon of treated water.

The test units were evaluated without the carbon filters or sediment filter in place to eliminate the possibility that these filters could temporarily trap a portion of the challenge organisms, causing a positive bias of system performance.

VERIFICATION TESTING DESCRIPTION

Test Site

The testing site was the Drinking Water Treatment Systems Laboratory at NSF in Ann Arbor, Michigan. A description of the test apparatus can be found in the test/QA plan and verification report. The testing was conducted in November and December of 2003.

Methods and Procedures

The testing methods and procedures are detailed in the *Test/QA Plan for Verification Testing of the Pall/Kinetico Purefecta™ Point-of-Use Drinking Water Treatment System for Removal of Microbial Contamination Agents*. Ten Purefecta™ systems were tested for bacteria and virus removal performance using the bacteriophage viruses fr, MS2, and Phi X 174, and the bacteria *B. diminuta* and *H. pseudoflava*. The challenge organisms were chosen because they are smaller than most other viruses and bacteria, and so provide a conservative estimate of performance.

The test units were randomly split into two groups of five. One group was conditioned for 25 days prior to challenge testing by operating the units daily using the test water without challenge organisms. The second group was challenged without receiving the 25-day conditioning period. The test units were challenged at both 40 and 80 psig inlet pressure. The test water for the bacteria challenges was set to pH 7.5 ± 0.5, and the virus challenges were conducted at pH 6.0 ± 0.5, 7.5 ± 0.5, and 9.0 ± 0.5. The challenge schedule is shown in Table 1. The different challenge conditions were intended to evaluate whether inlet pressure or pH influences bacteria and virus removal. However, the test water chemistry gave it little buffering capacity, which made it difficult to keep the pH within 9.0 ± 0.5 for the pH 9 virus challenges. During the 80 psig challenge for the unconditioned units, and the 40 psig challenge for the conditioned units, the initial pH was above 8.5, but it drifted down to 8.25 and 8.22, respectively, by the end of the challenge periods.

Table 1. Challenge Schedule

Day	Surrogate Challenge	pH	Inlet Pressure (psig)
1	*H. pseudoflava*	7.5 ± 0.5	40 ± 3
2	*H. pseudoflava*	7.5 ± 0.5	80 ± 3
3	*B. diminuta*	7.5 ± 0.5	40 ± 3
4	*B. diminuta*	7.5 ± 0.5	80 ± 3
5	All Viruses	6.0 ± 0.5	40 ± 3
6	All Viruses	6.0 ± 0.5	80 ± 3
7	All Viruses	7.5 ± 0.5	40 ± 3
8	All Viruses	7.5 ± 0.5	80 ± 3
9	All Viruses	9.0 ± 0.5	40 ± 3
10	All Viruses	9.0 ± 0.5	80 ± 3

On each challenge day, the test units were operated for one tank-fill period (approximately 2 to 3 hours). The end of this period was evident through engagement of the system's automatic shutoff mechanism, which causes the flow of reject water to cease. Influent water samples were collected at the beginning and end of the challenge period. After each test unit ceased operation, the entire contents of the product water storage tank were emptied into a sterile container, and a subsample was collected for microbiological analysis. All samples were enumerated in triplicate. Following each challenge period, the test units were flushed by operating them for one tank-fill period using the test water without challenge organisms.

VERIFICATION OF PERFORMANCE

Tables 2 and 3 show the virus reduction data for the unconditioned units and conditioned units, respectively. The unconditioned units reduced all three viruses to less than detectible levels in every challenge, while the conditioned units reduced all three viruses to less than detectible levels in every challenge except one. For the pH 7.5, 40 psig challenge, all three viruses were detected in the treated water from test unit number 1. However, the viruses were detected only in the first of three triplicate counts, which indicates that perhaps one of the subsamples became contaminated during the sample processing procedure.

Tables 4 and 5 show the bacteria reduction data for the unconditioned units and conditioned units, respectively. The bacteria counts for the unconditioned units were all less than 10 CFU/100mL, but there were two instances where the bacteria counts for the conditioned units were higher. The 3.15 $\log_{10}$ reduction for unit 1 corresponds to a *B. diminuta* count of 83,000 CFU/100mL, and the 4.0 $\log_{10}$ reduction for unit 5 corresponds to an *H. pseudoflava* count of 600 CFU/100 ml. The reason(s) for the two higher bacteria effluent counts are unknown.

Table 2. Virus Log_{10} Reduction Data for Unconditioned Units

pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Log_{10} Reduction				
				Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
6.0	40	fr	5.5	All effluents non-detect Log reductions equal to influents				
		MS2	5.2					
		Phi X 174	5.5					
6.0	80	fr	5.7	All effluents non-detect Log reductions equal to influents				
		MS2	5.5					
		Phi X 174	3.2					
7.5	40	fr	6.3	All effluents non-detect Log reductions equal to influents				
		MS2	5.7					
		Phi X 174	5.8					
7.5	80	fr	5.7	All effluents non-detect Log reductions equal to influents				
		MS2	5.6					
		Phi X 174	5.9					
9.0	40	fr	5.6	All effluents non-detect Log reductions equal to influents				
		MS2	5.5					
		Phi X 174	5.5					
9.0	80	fr	5.6	All effluents non-detect Log reductions equal to influents				
		MS2	5.1					
		Phi X 174	5.8					

Table 3. Virus Log_{10} Reduction Data for Conditioned Units

pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Log_{10} Reduction				
				Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
6.0	40	fr	5.2	All effluents non-detect, log reductions equal to influents				
		MS2	5.2					
		Phi X 174	3.3					
6.0	80	fr	5.2	All effluents non-detect, log reductions equal to influents				
		MS2	4.9					
		Phi X 174	2.6					
7.5	40	fr	4.5	4.2	Effluents from Units 2-5 non-detect, log reductions equal to influents			
		MS2	4.8	4.5				
		Phi X 174	2.6	2.3				
7.5	80	fr	5.2	All effluents non-detect, log reductions equal to influents				
		MS2	5.0					
		Phi X 174	3.0					
9.0	40	fr	5.7	All effluents non-detect, log reductions equal to influents				
		MS2	4.9					
		Phi X 174	3.0					
9.0	80	fr	4.9	All effluents non-detect, log reductions equal to influents				
		MS2	4.6					
		Phi X 174	3.3					

Table 4. Bacteria Log Reduction Data for Unconditioned Units

pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Log_{10} Reduction				
				Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
7.5	40	*H. pseudoflava*	6.5	6.5	5.9	6.5	6.5	6.5
		B. diminuta	8.4	7.9	7.9	7.9	8.4	8.4
7.5	80	*H. pseudoflava*	6.8	6.8	6.8	6.5	6.8	6.8
		B. diminuta	8.2	8.2	8.2	8.2	8.2	8.2

Table 5. Bacteria Log Reduction Data for Conditioned Units

pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Log_{10} Reduction Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
7.5	40	*H. pseudoflava*	7.4	7.4	7.4	7.4	7.4	7.4
		B. diminuta	8.1	8.1	8.1	8.1	8.1	8.1
7.5	80	*H. pseudoflava*	6.8	6.8	6.8	6.8	6.8	4.0
		B. diminuta	8.1	3.2	8.1	8.1	8.1	8.1

Complete descriptions of the verification testing results are included in the verification report.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

NSF personnel conducted a technical systems audit during testing to ensure that the testing was in compliance with the test plan. NSF also conducted a data quality audit of 100% of the data. Please see the verification report referenced below for more QA/QC information.

Original signed by
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United States Environmental Protection Agency

Original signed by
Gordon Bellen *07/27/04*

Gordon Bellen Date
Vice President
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NSF International

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Availability of Supporting Documents
Copies of the test protocol, the verification statement, and the verification report (NSF report # NSF 04/13/EPADWCTR) are available from the following sources:
(NOTE: Not all of the appendices are included in the verification report. The 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/dws/dws_reports.html, and from
   http://www.nsf.org/etv/dws/dws_project_documents.html (electronic copy)
   EPA web site: http://www.epa.gov/etv (electronic copy)