HARMSCO® FILTRATION PRODUCTS

Harmsco PolyPleat™ Filter Cartridges

Harmsco is pleased to offer the following information and third party evaluation data for our PolyPleat™ line of filter cartridges. These cartridges were specifically designed for the economical removal of *Cryptosporidium* and *Giardia*. As you will see, our Polypleat™ cartridges meet the requirements of NSF 53.

PolyPleat™ is available in many standard 2 ¾" filter housing configurations including, 4 ½" "Big Blue" dimensions. Harmsco also manufactures these filters in our high capacity, high surface area Hurricane Series. Our Hurricane® series is designed for single filter housing flow rates of 40 to 600 gallons per minute, which is perfect for community wells, parks, and small municipalities.

Harmsco Filtration Products offer liquid filtration solutions, which include "Point of Use" to "Point of Entry" to "Water Supply".

If you have any questions regarding this exciting product, please feel free to contact us at 800-327-3248.

Harmsco FILTRATION PRODUCTS

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Analytical Services, Inc.

Introduction

On December 16, 1996 a live *Giardia* and *Cryptosporidium* challenge study was performed on the Harmsco HIF-14 vessel and PP-D-1 cartridges at Analytical Services, Inc. in Williston, Vermont. This challenge study was performed under low differential pressure (< 5 PSID).

Methods

A pilot plant was set up as shown in Figure 1. This pilot plant included a 550 gallon reservoir tank, two 3 horsepower centrifugal pumps, an injection pump for the organisms, a Blue White F-300 flow meter, the Harmsco HIF-14 vessel and PP-D-1 filter, two pressure gauges (Helicoid 0-60 PSI, 0.25% accuracy) and influent and effluent sampling ports for organisms. The source water for the challenge study was Analytical Services, Inc.'s tap water (filtered surface water from Champlain Water District, So. Burlington). The challenge study carrier water was chlorine neutralized and pH adjusted (pH 7.0 ± 0.4) prior to the initiation of the challenge. A heat exchange unit was installed in the reservoir tank to prevent heat build-up due to recirculation of water through the pump.

The organism challenge was begun on December 16, 1996. Laser particle counts were not performed for this challenge due to time constraints and difficulties with the sensor. Live cysts and oocysts were injected into the filter influent for approximately 45 minutes. The injection pump was plumbed directly upstream of the system pump intake to ensure complete mixing (Figure 1). The system was run for approximately 36 hours at approximately 60 GPM and 4 PSID. Influent and effluent samples were collected for the first 18 hours using 293 mm polycarbonate NTE 1 μm disc filters at a calibrated flow rate. After the completion of the organism injection these filters were removed and a second set of filters were installed for the remainder of the 18 hours. After the first 18 hours the influent and effluent sampling filters were removed and a third polycarbonate filter was installed to sample the test filter effluent for the remainder of the challenge (for 18-36 hours). All sample filters were transferred to clearly labeled bottles containing physiological saline (PBS) and 5% formalin.

All sample filters were processed by blending for 30 seconds using 200 μL Tween 80, 200 μL SDS and PBS. All filter extracts were stained using a monoclonal immunofluorescent antibody (IFA) stain as specified in the protocol of ASTM P229. Enumeration of *Giardia* cysts and *Cryptosporidium* oocysts was performed using fluorescent microscopy at 300X magnification.

Analytical Services, Inc.

Challenge Study Specifications

Table 1: Pilot plant specifications for the live *Giardia* and *Cryptosporidium* challenge performed on the Harmsco HIF-14 vessel and PP-D-1 cartridges by Analytical Services, Inc..

Test Filter	HIF-14 vessel and PP-D-1 cartridges
Challenge Organisms	Live *Giardia lamblia* and *Cryptosporidium parvum*
System Flow	Approximately 60 gallons per minute
Water Type	Chlorine neutralized filtered surface water
System Pressure Start In/Out	50 psi/47 psi
System Pressure End In/Out	49.5 psi/45 psi
Δ in Pressure Start	3 psi
Δ in Pressure End	4.5 psi
Duration of Challenge Injection	46 minutes
Duration of Influent Sample Collection	18 hours 20 minutes
Influent Sampler Type	293 mm disc 1.0 mm NTE-PC
Duration of Effluent Sample Collection	
"0 - 18 hour"	18 hours 20 minutes
"18 - 36 hour"	19 hours, 20 minutes
Effluent Sample Type	293 mm disc 1.0 mm NTE-PC
Total Volume Filtered	Approximately 135,600 gallons
Date of Challenge	December 16 - 18, 1996

Analytical Services, Inc.

Results

Results of the challenge study were determined by quantitatively comparing the numbers of organisms detected in the influent and effluent samples.

Log Removal Values were calculated using the following formula:

$$LRV = LOG_{10}\left(\frac{\#\ of\ organisms\ applied\ to\ filter}{\#\ of\ organisms\ recovered\ effluent}\right)$$

Percent Removal Values were calculated using the following formula:

$$\%\ RV = \left(\frac{\#\ of\ organisms\ applied\ to\ filter\ -\ \#\ of\ organisms\ recovered\ the\ effluent}{\#\ of\ organisms\ applied\ to\ filter}\right)$$

Table 2: Results of the *Giardia* and *Cryptosporidium* Challenge performed on the Harmsco HIF-14 Vessel and PP-D-1 Cartridges by Analytical Service, Inc. on November 16-18, 1996.

Organism	Number Applied to Filter*	Number Recovered from Effluent		Cumulative Removal			
		First 18 hours	18-36 hours	First 18 hours		18-36 hours	
				LRV	% RV	LRV	% RV
Giardia lamblia	3.7×10^6	6.5×10^3	< 61	2.8	99.82 %	> 4.8	99.998 %
Cryptosporidium parvum	5.1×10^6	2.4×10^4	8.8×10^3	2.3	99.53 %	2.8	99.83 %

*Please note: Due to the limitation of the system flow meter, the calculated number of organisms applied to the filter and recovered from the filter, and therefore the removal values are approximate.

LRV = Log Removal Value

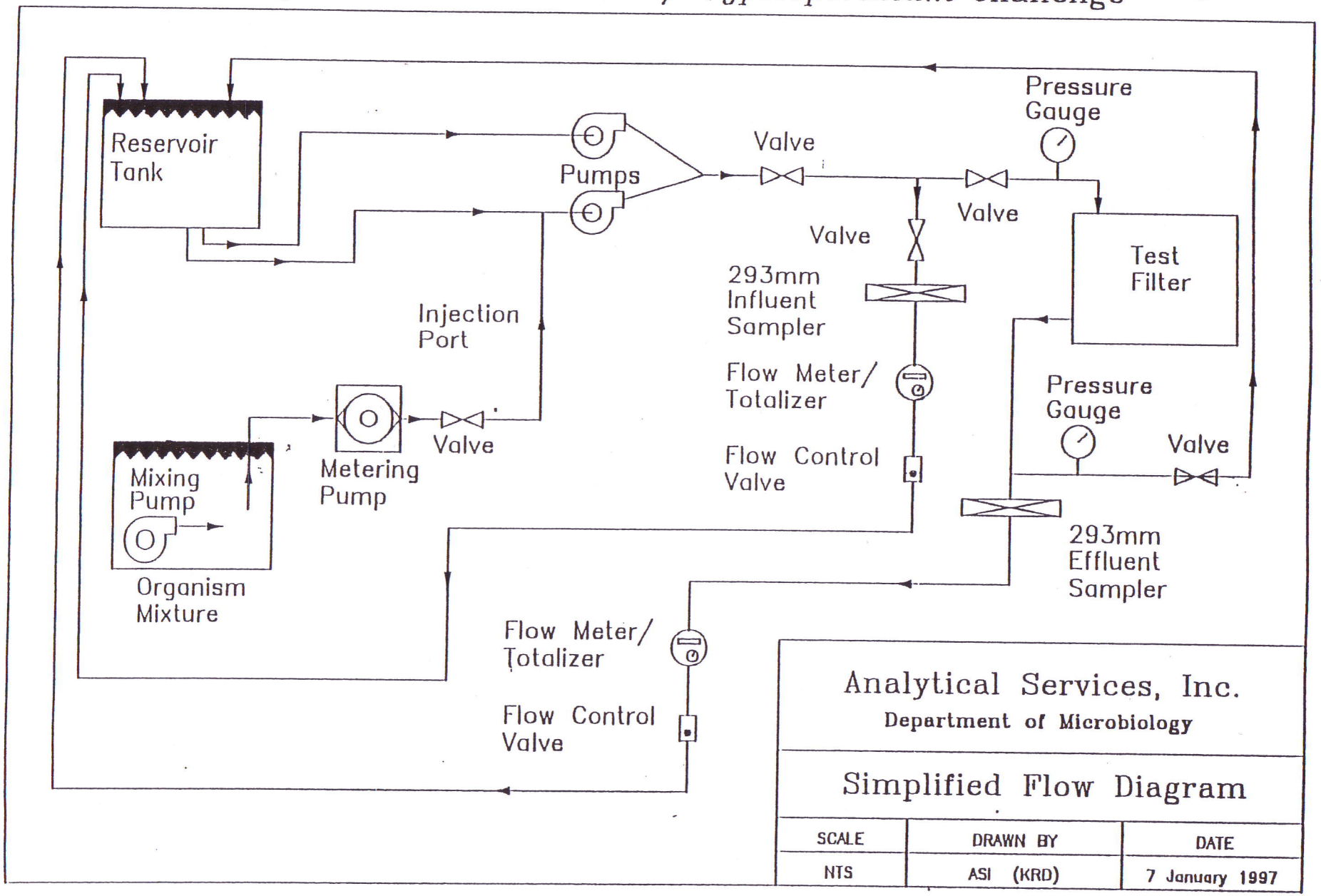
% RV = Percent Removal Value

DISCUSSION:

Good removal of both *Giardia* and *Cryptosporidium* was observed for the initial 18 hours of the challenge (≥ 2.3 log) and the second 18 hours of the study (≥ 2.8 log).

Analytical Services, Inc.

Setup For HARMSCO *Giardia/Cryptosporidium* Challenge



Analytical Services, Inc.

Introduction

On November 14, 1996 at Analytical Services, Inc. in Vermont a live *Giardia* and *Cryptosporidium* challenge study was performed on the Harmsco HUR-170-HP filter. This challenge study was performed under low differential pressure (< 3 PSID).

Methods

A pilot plant was set up as shown in Figure 1. This pilot plant included a 550 gallon reservoir tank, two 3 horsepower centrifugal pumps, an injection pump for the organisms, a Blue White F-300 flow meter, the HUR-170-HP filter, two pressure gauges (Helicoid 0-60 PSI, 0.25% accuracy) and influent and effluent sampling ports for both organisms and laser particle counts. The source water for the challenge study was Analytical Services, Inc.'s tap water (filtered surface water from Champlain Water District, So. Burlington). The challenge study carrier water was chlorine neutralized and pH adjusted (pH 7.0 ± 0.4) prior to the initiation of the challenge. A heat exchange unit was installed in the reservoir tank to prevent heat build-up due to recirculation of water through the pump.

The organism challenge was begun on November 14, 1996. Prior to the injection of organisms the differential pressure was determined at 50 and 75 GPM (25 GPM data was unavailable due to the limitation of the flow meter). Both of these flow rates exhibited a 0.5 PSID. Laser particle grab samples were also taken both prior to injection and after the completion of the challenge (Tables 3 and 4). Live oocysts were then injected into the filter influent for approximately 45 minutes. The injection pump was plumbed directly upstream of the system pump intake to ensure complete mixing (Figure 1). The system was run for approximately 36 hours at approximately 100 GPM and 1 PSID. Influent and effluent samples were collected for the first 18 hours using 293 mm polycarbonate NTE 1 μm disc filters at a calibrated flow rate. After the completion of the organism injection these filters were removed and a second set of filters were installed for the remainder of the 18 hours. After the first 18 hours the influent and effluent sampling filters were removed and a third polycarbonate filter was installed to sample the test filter effluent for the remainder of the challenge (for 18-36 hours). All sample filters were transferred to clearly labeled bottles containing physiological saline (PBS) and 5% formalin.

All sample filters were processed by blending for 30 seconds using 200 μL Tween 80, 200 μL SDS and PBS. All filter extracts were stained using a monoclonal immunofluorescent antibody (IFA) stain as specified in the protocol of ASTM P229. Enumeration of *Giardia* cysts and *Cryptosporidium* oocysts was performed using fluorescent microscopy at 300X magnification.

Analytical Services, Inc.

Challenge Study Specifications

Table 1: Pilot plant specifications for the live *Giardia* and *Cryptosporidium* challenge performed on the Harmsco LHUR-170-HP Filter by Analytical Services, Inc..

Test Filter	HUR-170-HP
Challenge Organisms	Live *Giardia lamblia* and *Cryptosporidium parvum*
System Flow	Approximately 100 gallons per minute
Water Type	Chlorine neutralized filtered surface water
System Pressure Start In/Out	50 psi/49 psi
System Pressure End In/Out	50 psi/49 psi
Δ in Pressure Start	1 psi
Δ in Pressure End	1 psi
Duration of Challenge Injection	45 minutes
Duration of Influent Sample Collection	19 hours
Influent Sampler Type	293 mm disc 1.0 mm NTE-PC
Duration of Effluent Sample Collection	
"0 - 18 hour"	19 hours
"18 - 36 hour"	16 hours, 10 minutes
Effluent Sample Type	293 mm disc 1.0 mm NTE-PC
Total Volume Filtered	Approximately 211,000 gallons
Date of Challenge	November 14 - 16, 1996

Analytical Services, Inc.

Results

Results of the challenge study were determined by quantitatively comparing the numbers of organisms detected in the influent and effluent samples.

Log Removal Values were calculated using the following formula:

$$LRV = LOG_{10}\left(\frac{\#\ of\ organisms\ applied\ to\ filter}{\#\ of\ organisms\ recovered\ effluent}\right)$$

Percent Removal Values were calculated using the following formula:

$$\%\ RV = \left(\frac{\#\ of\ organisms\ applied\ to\ filter\ -\ \#\ of\ organisms\ recovered\ the\ effluent}{\#\ of\ organisms\ applied\ to\ filter}\right)$$

Table 2: Results of the *Giardia* and *Cryptosporidium* Challenge performed on the Harmsco HUR-170-HP System by Analytical Service, Inc. on November 14 - 16, 1996.

Organism	Number Applied to Filter*	Number Recovered from Effluent		Cumulative Removal			
		First 18 hours	18-36 hours	First 18 hours		18-36 hours	
				LRV	% RV	LRV	% RV
Giardia lamblia	6.3×10^6	2.7×10^3	6.2×10^2	3.4	99.96 %	4.0	99.99 %
Cryptosporidium parvum	1.7×10^7	3.2×10^4	3.4×10^3	2.7	99.81 %	3.7	99.98 %

*Please note: Due to the limitation of the system flow meter, the calculated number of organisms applied to the filter and recovered from the filter, and therefore the removal values are approximate.

LRV = Log Removal Value

% RV = Percent Removal Value

Analytical Services, Inc.

Table # 3: Pre-Challenge Laser Particle Counts
Laser Particle Count Results

Size Range (μm)	Particles per Liter	
	Influent	Effluent
0.5-1.0	2.6×10^5	8.0×10^4
1.0-2.0	1.8×10^4	3.7×10^3
2.0-3.0	1.0×10^3	1.7×10^2
3.0-5.0	1.9×10^3	4.0×10^2
5.0-10	1.1×10^3	1.0×10^2
10-20	2.7×10^2	33
20-100	< 1	33
> 100	<1	<1

Table 4: Post Challenge Laser Particle Counts
Laser Particle Count Results

Size Range (μm)	Particles per Liter	
	Influent	Effluent
0.5-1.0	1.6×10^6	1.4×10^6
1.0-2.0	1.1×10^4	1.3×10^3
2.0-3.0	7.8×10^2	67
3.0-5.0	1.3×10^3	1.3×10^2
5.0-10	2.7×10^2	1.0×10^2
10-20	3.3×10^2	50
20-100	50	< 1
> 100	<1	<1

DISCUSSION:

Good removal of both *Giardia* and *Cryptosporidium* was observed for the initial 18 hours of the challenge ($\geq$ 2.7 log) and the second 18 hours of the study ($\geq$ 3.7 log).

Setup For HARMSCO *Giardia/Cryptosporidium* Challenge