New England Water Treatment Technology Assistance Center
University of New Hampshire • Durham, New Hampshire
NE-WTTAC
PROJECT SUMMARY REPORT

Precoat and Ceramic Media Pressure Filtration Comparison - A Case Study

Objective/Problem Statement

The Town of Jackson, NH currently extracts drinking water from wells adjacent to Ellis River using various infiltration galleries. Recent studies by the NH Department of Environmental Services (NHDES) have classified the well water as groundwater under the influence from the Ellis River thereby requiring filtration. The town has contracted with Wright-Pierce Engineers of Topsham, ME to evaluate filtration technologies for their application.

The NHDES has required that the selected filtration process demonstrate at least 2-log removals of Cryptosporidium and Giardia sized particles. An opportunity was taken to field-evaluate two pressure filtration technologies that do not typically require chemical addition and utilize similar physical removal mechanisms. The selected filtration systems evaluated were ceramic media filtration (Kinetico, Inc., Newbury, Ohio) and diatomaceous earth or precoat filtration (Separmatic Filter Milwaukee, Wisconsin).

The overall goal of the study was to assist Jackson, NH in its selection of a filtration system for its public water supply. An opportunity was taken to evaluate precoat and ceramic media filtration side-by-side, thereby making the comparison more meaningful and equitable.

Methodology

Since the source water was relatively clean with low levels of turbidity and particle counts, the experimental approach was to conduct a series of challenge runs whereby the same influent was used for both filtration systems and spiked with elevated levels of turbidity and Bacillus spores. The challenge water was spiked with material extracted from Manchester's Lake Massabesic sediment according to procedures employed by the National Sanitation Foundation's ETV protocol. The source water quality during the various challenges is summarized in Table 1.

Table 1. Water quality ranges during challenge runs--Jackson, NH (1/11/01)

Parameter						
Temp, °C	pH	TOC, mg/L	UV Abs, 1/cm	Turbidity, ntu	Total particles/mL (2-15 µm)	Bacillus spores, #/mL
1	6.28-6.36	1.26-1.47	0.042-0.050	2.27-2.89	$13.8\text{-}15.0 \times 10^3$	$2.33\text{-}3.25 \times 10^5$

The pilot filtration units were provided by the manufacturers. The rated hydraulic capacities for the precoat and ceramic media filters were roughly 16 gpm and 6 gpm, respectively. Specifications for each system are included in Table 2.

Table 2. Summary of Filtration Equipment Specifications

Manufacturer	Filter surface area, ft^2	Filter loading rate, gal/min-ft^2	Operating pressure differentials, psi Clean/Exhausted	Filter media	Media diameter, mm
Kinetico	0.55	10	10 20	ceramic balls	0.22
Separmatic	16	1	8 30	diatomaceous earth FW-50 Hyflo	 0.042 (median) 0.028 (median)

Each unit was self-contained and included in-line influent and effluent turbidimeters and particle counters. The precoat system included a sand pre-filter. The sand filter was thirty inches in diameter with approximately 4.9 square feet of surface area and held sand in the particle size range of 0.35 to 0.45 mm.

The filter variables evaluated during the abbreviated winter challenge study were limited. Each filtration unit was evaluated under two different operational conditions as shown in Table 3. The ceramic media filter was evaluated with and without a coagulant addition. The precoat filter was evaluated with two different diatomaceous earth sizes (Hyflo Supercel and FW-50). The precoat filter was operated with only a precoat to provide a maximum challenge to the system. In normal operation a body feed would be added during operation.

Table 3. Summary of variables used in pressure filtration challenges - Jackson, NH

Manufacturer	Challenge	Pre-treatment	Pre-coat	Body Feed	Coagulant
Kinetico	1	None	N/A	N/A	None
	2	None	N/A	N/A	1.5 ppm cationic polymer[A]
Separmatic	1	Pressure sand filter	FW-50[B] Grade DE, 0.2 lb/ft^2	Not used	N/A
	2	Pressure sand filter	Hyflo[C] Grade DE, 0.2 lb/ft^2	Not used	N/A

A: diethylamine epichlorohydrin polyquartenary amine in water, Aquamark Inc., Cleveland, Ohio
B: Eagle Picher, Reno, Nevada
C: World Minerals, Lompoc, California

Results

A summary of the collected data from the two challenges of both pressure filtration systems is shown in Table 4. At the request of Kinetico, Bacillus spore analysis was not performed on the ceramic media effluent.

The challenges were performed in cold New Hampshire winter weather conditions with temporary treatment installations that provided unusual challenges. The following observations were made after review of the data.

- It was difficult to distinguish between the performances of the two systems given the short-term nature of the challenges. Log removals were just less than 1 log for Cryptosporidium sized particles (2-5 microns) and just less than 2 logs for Giardia sized particles (7-15 microns).

- The addition of a coagulant improved the particle log removal performance of the Kinetico pressure filter.
- Particle count data indicated that there was no difference in the performance of the FW-50 and Hyflo DE used during the two short challenges. The Bacillus spore data favored the Hyflo, which has a smaller median particle size (28 µ) compared to FW-50 (42 µ). The results should be verified with additional challenge runs.
- The sand pre-filter used in conjunction with the Separmatic pressure filter did not influence the removal of Bacillus spores.
- The effluent turbidity recorded by the Kinetico filter did not agree with the particle count results which suggest the data may not accurately represent system performance. The turbidities achieved should be verified.

Table 4. Summary of Kinetico and Separmatic Pressure Filter Challenges--Jackson, NH (1/11/01)

Location	Temp, °C	pH	TOC, mg/L	UV absorbance, cm^{-1}	Bacillus spores, spores/mL *Log spores/mL*	Bacillus spores Log removal	Particle counts Log removal- **2-5 microns** 7-15 microns
Feed-Challenge #1	1	6.36	1.47 ± 0.01	0.050 ± 0.000	325,000 ± 2357 *5.51 ± 3.37*		
Kinetico effluent w/o coagulant			1.33 ± 0.05	0.042 ± 0.001	Not performed[A]		**0.84 ± 0.05** 1.91 ± 0.07
Separmatic effluent - FW-50 grade DE			1.31 ± 0.02	0.042 ± 0.000	160,000 ± 18,856 *5.20 ± 4.28*	0.31	**1.04 ± 0.13** 1.84 ± 0.15
Feed-Challenge #2	1	6.28	1.26 ± 0.00	0.042 ± 0.001	233,333[B] 5.37[C]		
Kinetico effluent with coagulant			1.42 ± 0.03	0.040 ± 0.000	Not performed[A]		**1.14 ± 0.06** 2.08 ± 0.07
Separmatic effluent - Hyflo grade DE			1.29 ± 0.01	0.041 ± 0.001	14,050 ± 71[D] *4.15 ± 1.85*	1.22	**1.19 ± 0.27** 1.95 ± 0.15

Notes:
A: Not performed at the direction of the manufacturer.
B and **D**: Quantification of Bacillus spores in samples indicated that the Feed-Challenge #2 and the Separmatic effluent sample containers were switched. Samples were taken from an instrument board where sample ports could be easily confused. The feed concentration was verified by a sample taken from the sand filter effluent prior to the pressure filter, which indicated 5.29 logs of spores/mL to be present in the challenge water.
C: The duplicate sample exceeded the countable limit in the dilution performed and the data was not available.

- As expected, neither filtration system removed total organic carbon or UV254 absorbance causing substances.
- The cold water temperature and conditions presented challenges to the feed lines and the instruments that may have influenced the challenge results.
- The challenges were too short to impact filter operation as no headloss development was observed.

Conclusions

The side-by-side challenges were not able to distinguish between the overall treatment performance of ceramic media and precoat pressure filtration systems. In general, the smaller DE grade the better the treatment performance of the precoat filter. The addition of a coagulant polymer enhanced the performance of the ceramic media filter. The integrity of the precoat filters were known to be problematic in previous studies but were not evaluated during this study.

Recommendations

Treatment comparison challenges should be performed at various times of the year to assess seasonal influences especially during periods of high run-off and turbidity conditions. In addition, the challenges performed in this study were too short to impact filter operational characteristics as little head loss development was observed. Consequently, challenges should be extended to at least several filter cycles so that performance monitoring at more critical periods of a filter run such as start-up, and immediately after cleaning may be evaluated.

Publication

A final report providing more extensive information was prepared by the NE-WTTAC at UNH. Copies of the report are available from the NE-WTTAC.

Disclaimer

This project was funded by the U.S. Environmental Protection Agency grant number X827736-01-0. Mention of specific trade names herein does not imply endorsement on the part of the U.S. EPA or the University of New Hampshire.

Principal Investigators

Mark Arenberg
Peter Dwyer
Larry Brannaka, Ph.D.
M. Robin Collins, Ph.D., P.E.
New England Water Treatment Technology Assistance Center
University of New Hampshire
Durham, NH