# A COMPARATIVE PERFORMANCE STUDY OF TWO TYPES OF CLOTH FILTER MEDIA APPLIED IN MUNICIPAL WASTEWATER TREATMENT

Hui Lin, P.E., Matthew Castillo, Lloyd W. Johnson, P.E., MPD
Aqua-Aerobic Systems, Inc., 6306 N. Alpine Road, Rockford, IL 61111, USA

## Introduction

Cloth Media Disk Filter (CMDF) technology, a tertiary filtration technology utilizing synthetic cloth media mounted in a circular disk configuration, has been widely employed in advanced wastewater treatment to remove particulate matter remaining in secondary effluent. Many published pilot and field studies (T. Knapp & D. Tucker, 2006; N. Slater, 2006; L. Nemeth, *et. al.*, 2006; H. Lin & L. Johnson, 2007; H. Lin, *et. al,* 2008) on CMDF performance with PA-13 pile cloth, constructed of nylon fabric fibers woven into a polyester support backing, have demonstrated that the technology can consistently produce high quality effluent under various operating conditions. However, it appears that the performance of the PA-13 cloth can be compromised in some situations where the cloth is exposed to free chlorine. A new pile cloth material, designated OptiFiber® PES-13, has been developed to overcome this issue. Both the pile fibers and the support backing of the PES-13 cloth are made of polyester which is resistant to free chlorine and other strong oxidants. The materials of construction for the two types of media are summarized in Table 1. The main objective of this study was to investigate and compare the performance characteristics such as total suspended solid (TSS), turbidity, particle removal efficiencies and backwash rates of the PES-13 and PA-13 pile cloth under various operating conditions.

## Materials and Methods

The study was conducted with two (2) identical single-disk AquaDisk® CMDF production units manufactured by Aqua-Aerobic Systems, Inc. One unit was equipped with OptiFiber® PA-13 nylon pile cloth media and the other with OptiFiber® PES-13 polyester pile cloth media. Secondary effluent from the Belvidere (IL) WWTP was used as the filter influent. The Belvidere WWTP's treatment scheme consists of a bar screen, a grit chamber, a primary clarifier, aeration basins, secondary clarifiers, traveling bridge sand filters, and a chlorine contact tank prior to discharge to the nearby Kishwaukee River. The study lasted about one (1) month. Multiple hydraulic loading rates were evaluated at varying influent TSS values to determine their effect on the media performance with regard to TSS, turbidity, and particle removal efficiencies as well as on corresponding backwash rates. "Stress tests" for high influent solids conditions were simulated by adding concentrated mixed liquor suspended solids (MLSS) from the WWTP's return activated sludge (RAS) line. Test runs during the stress tests normally ranged from two (2) to six (6) hours, however the filter units were operated continuously. A summary of operating conditions is presented in Table 2. Influent flow was monitored by in-line flow meters while backwash flow was calculated by multiplying the amount of backwash time by the backwash pumping rate in each test run. All TSS, turbidity, and particle size distribution (PSD) analyses were conducted in accordance with guidelines set forth in the 21st Edition (2005) of *Standard Methods for the Examination of Water & Wastewater*.

## Results and Discussion

TSS and turbidity values generated during the study indicate that both filter media produced almost identical filtrate quality of 1– 2 mg/L TSS and less than 2 NTU turbidity under hydraulic loading rates of 3.0 – 6.5 $gpm/ft^2$ and influent turbidity values of up to 60 NTU. The PES-13 polyester pile media did however perform slightly better in terms of TSS and turbidity removal efficiencies. PSD results also indicate that the PES-13 polyester pile media removed more influent particles than did the PA-13 nylon pile media in all measured size ranges. The removal efficiencies for particles measuring less than 20 microns decreased with increasing hydraulic loading rates for both media. Comparison of backwash rates at hydraulic loading rates of 3.0 – 6.0 $gpm/ft^2$ shows that both media generated similar volumes of backwash water. Filtrate turbidity readings indicate that there was less breakthrough after each backwash event for the PES-13 than that for the PA-13 (Figure 2). This may be attributable to the much tighter support backing construction of the PES-13.

## References

Tiffany Knapp and David Tucker (2006) "Side-By-Side Pilot Testing of Two Disk Filter Manufacturers at the City of Merced Wastewater Treatment Plant," *WEFTEC 2006 Proceedings*, Dallas, TX, Oct. 21-25, 2006, Water Environmental Federation, pp. 3378-3386.

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(a) (b)

Figure 1. (a) OptiFiber® PA-13; (b) OptiFiber® PES-13.

Table 1. Comparison of Media Materials of Construction

| Cloth Media | Pile Material | Backing Material | Construction | Nominal Pore Size (μm) |
|---|---|---|---|---|
| OptiFiber® PES-13 | Polyester | Polyester | Woven | 10 |
| OptiFiber® PA-13 | Nylon | Polyester | Woven | 10 |

Table 2. Summary of Test Conditions

| Test Run | Flow Rate (gpm) | Hydraulic Loading Rate (gpm/ft$^2$) | Influent Turbidity (NTU) | Test Duration (hrs) |
|---|---|---|---|---|
| 1 | 160 | 3.00 | 0 - 10 | 440 |
| 2 | 240 | 4.50 | 0 - 10 | 120 |
| 3 | 320 | 6.00 | 0 - 10 | 65 |
| 4 | 175 | 3.25 | 10 - 20 | 30 |
| 5 | 175 | 3.25 | 20 - 30 | 70 |
| 6 | 175 | 3.25 | 30 - 40 | 12 |
| 7 | 175 | 3.25 | 40 - 60 | 7 |
| 8 | 350 | 6.50 | 0 - 10 | 25 |
| 9 | 350 | 6.50 | 10 - 15 | 45 |
| 10 | 350 | 6.50 | 15 - 30 | 7 |

Table 3. Comparative Summary of Turbidity Removal Efficiencies

| Test Run | Influent Turbidity (NTU) | Effluent Turbidity (NTU) | | Turbidity Removal (%) | |
|---|---|---|---|---|---|
| | | PA-13 | PES-13 | PA-13 | PES-13 |
| 1 | 7.29 | 1.38 | 1.27 | 81.13 | 82.57 |
| 2 | 6.32 | 1.20 | 1.18 | 81.00 | 81.27 |
| 3 | 7.18 | 1.40 | 1.25 | 80.49 | 82.58 |
| 4 | 18.37 | 2.07 | 1.03 | 88.75 | 94.37 |
| 5 | 23.95 | 2.39 | 1.21 | 90.03 | 94.94 |
| 6 | 36.30 | 1.75 | 0.90 | 95.18 | 97.52 |
| 7 | 53.95 | 1.20 | 0.70 | 97.78 | 98.70 |
| 8 | 8.50 | 0.90 | 0.63 | 89.41 | 92.55 |
| 9 | 12.47 | 0.73 | 0.47 | 94.12 | 96.26 |
| 10 | 20.40 | 0.95 | 0.65 | 95.34 | 96.81 |

Table 4. Comparative Summary of TSS Removal Efficiencies

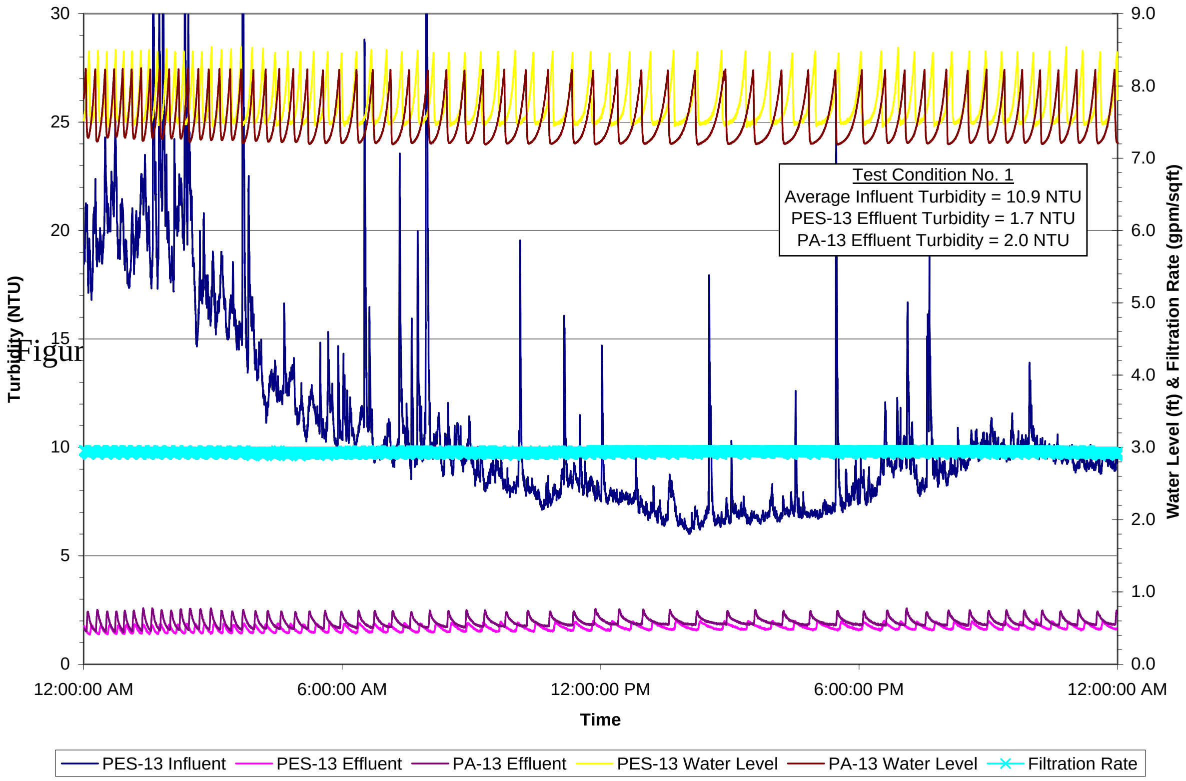
| Test Run | Influent TSS (mg/L) | Effluent TSS (mg/L) | | TSS Removal, % | |
|---|---|---|---|---|---|
| | | PA-13 | PES-13 | PA-13 | PES-13 |
| 1 | 16.23 | 1.66 | 1.96 | 89.80 | 87.95 |
| 2 | 11.37 | 1.43 | 1.30 | 87.39 | 88.56 |
| 3 | 15.10 | 2.05 | 1.78 | 86.42 | 88.25 |

Table 5. Comparative Summary of Particle Removal Efficiencies

| Test Run | Cloth Type | Particle Removals, (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2 - 4 µm | 4 - 6 µm | 6 - 10 µm | 10 - 15 µm | 15 - 20 µm | 20 - 25 µm | 25 - 30 µm | > 30 µm |
| 1 | PA-13 | 10 | 24 | 43 | 75 | 83 | 83 | 85 | 94 |
| | PES-13 | 9 | 24 | 45 | 79 | 87 | 87 | 89 | 95 |
| 2 | PA-13 | 12 | 16 | 32 | 61 | 72 | 72 | 79 | 93 |
| | PES-13 | 12 | 17 | 37 | 74 | 85 | 83 | 87 | 95 |
| 3 | PA-13 | -1 | 4 | 16 | 48 | 64 | 67 | 74 | 89 |
| | PES-13 | -1 | 5 | 21 | 64 | 82 | 85 | 88 | 96 |

Table 6. Comparative Summary of Backwash Requirements

| Test Run | Backwash Rate (% of Forward Flow) | |
|---|---|---|
| | PA-13 | PES-13 |
| 1 | 1.95 | 1.97 |
| 2 | 1.55 | 1.50 |
| 3 | 2.58 | 2.41 |


Turbidity (NTU)
Water Level (ft) & Filtration Rate (gpm/sqft)
Time
12:00:00 AM
6:00:00 AM
12:00:00 PM
6:00:00 PM
12:00:00 AM
Test Condition No. 1
Average Influent Turbidity = 10.9 NTU
PES-13 Effluent Turbidity = 1.7 NTU
PA-13 Effluent Turbidity = 2.0 NTU
PES-13 Influent
PES-13 Effluent
PA-13 Effluent
PES-13 Water Level
PA-13 Water Level
Filtration Rate