An Innovative Energy Saving Primary Filtration Using Cloth Media Technology

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Product Manager – Filtration
Agenda

• Introduction to Aqua-Aerobic Systems
• OptiFiber® Pile Cloth Media Filtration
• Primary Filtration at Rock River Water Reclamation District, IL
• Summary
Aqua-Aerobic Systems, Inc.
Loves Park, IL

- Founded in 1969, Privately Held Company
- 130 Employees (Office and Manufacturing)
- Applied Engineering Focus
- > 10% of Profits Back to R&D
- Manufacture Key Components
- > 24 Patented Products and Processes
Technology Timeline

1969: Aqua-Jet® Aerator
1975: Aqua MixAir® System
1984: Aqua DDM® Mixer
1986: Aqua MSBR® System
1991: AquaABF® Filter
1993: Aqua MixAir® System
1999: Aqua SBR® System
2003: Aqua SBR® System
2004: Aqua SBR® System
2005: Aqua Diamond® Filter

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Technology Timeline

2006
AquaPASS® System

2008
AquaJet® TTHM Approval

2009
Flow Characterization Intellipro®

2010
AquaBioMax™

2011
OptiFiber PES-14 MicroFiber

2012
UltraFiltration™

2013
Aqua MegaDisk™

Continued Innovation

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Filtration Experience
Over 3,000 Units Installed
OptiFiber® Pile Cloth Media Filtration
OptiFiber Pile Cloth Media

- Pile Construction
- Polyester Support Backing
Filtration Goals

➢ Maximize
  • Removal of TSS
  • Hydraulic throughput

➢ Minimize
  • Chemical
  • Backwash
Filtration Particle Removal Mechanisms

- Straining
- Sedimentation
- Impaction
- Interception
- Adhesion
- Flocculation

Surface Mechanism

Depth Filtration
L/D Ratio

Rapid Sand Filter

\[ L = 300-600 \text{ mm} \]
\[ D = d_{10} = 0.6 \text{ mm} \]
\[ L/D = 500-1000 \]

PES-14 Microfiber

\[ D \approx 0.007 \text{ mm} \]
\[ L = 3-5 \text{ mm} \]
\[ L/D = 425-715 \]

So, what does all this mean?
Filtration Particle Removal Mechanisms

Surface Mechanism

Depth Filtration
AquaDisk® Cloth Media Filter

- Cloth Media Disks
- Drive Motor
- Backwash Shoe
- Effluent Port
- PLC Control System
- Influent Weir
- Backwash Solids Pump
- Solids Collection Manifold
- Backwash Valve
How AquaDisk® Cloth Media Filter Works
How AquaDisk® Cloth Media Filter Works

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How AquaDisk® Cloth Media Filter Works
Primary Filtration
Rock River Water Reclamation District

April 8 – July 13 2014
Testing Objectives

- Hydraulic and solids loading capabilities
- Relative cloth performance (PA2-13 vs. Microfiber vs. Clarifier)
- Energy savings
- BW/SW volume and frequency (% of applied flow)
Research & Technology Center

- Located at Rock River Water Reclamation District
- 80ft by 60 ft x 14 ft (tall)
- Inputs: primary influent and effluent, secondary effluent, RAS
Testing Equipment

- Raw Sewage
- Screen (¼ inch openings)
- Grit removal
  - Primary
  - Filtration

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Testing Conditions

- 24/7 operation
- Side-by-side testing with primary clarifier
- Flux rates 3.25 – 4.0 gpm/sf-day, mostly 3.25 gpm/sf-day
- Filter influent TSS averaged 236 mg/L (104 – 526 mg/L)
- Solids loading rates approximately 9 – 10 lb/sf-day
- No chemical addition
OptiFiber® Pile Cloth Media Tested

OptiFiber PA2-13®
(April 8 – May 9, 2014)

OptiFiber PES-14®
(May 9 – July 13, 2014)
## Results:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average Influent</th>
<th>Average Effluent</th>
<th>Average Removal (%)&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Average Influent</th>
<th>Average Effluent</th>
<th>Average Removal (%)&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BOD (mg/L)</strong></td>
<td>220</td>
<td>95</td>
<td>54.2</td>
<td>169</td>
<td>59</td>
<td>64.2</td>
</tr>
<tr>
<td><strong>COD (mg/L)</strong></td>
<td>501</td>
<td>233</td>
<td>51.7</td>
<td>417</td>
<td>147</td>
<td>62.8</td>
</tr>
<tr>
<td><strong>TSS (mg/L)</strong></td>
<td>253</td>
<td>44</td>
<td>80.4</td>
<td>221</td>
<td>26</td>
<td>87.5</td>
</tr>
<tr>
<td><strong>VSS (mg/L)</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td>130</td>
<td>24</td>
<td>81.5</td>
<td>116</td>
<td>36</td>
<td>69.0</td>
</tr>
<tr>
<td><strong>Turbidity (NTU)</strong></td>
<td>211</td>
<td>110</td>
<td>48.2</td>
<td>143</td>
<td>37</td>
<td>73.5</td>
</tr>
<tr>
<td><strong>UVT (%)</strong></td>
<td>22.6</td>
<td>33.8</td>
<td>51.0</td>
<td>28</td>
<td>44</td>
<td>59.9</td>
</tr>
<tr>
<td><strong>FOG (mg/L)</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td>16</td>
<td>10</td>
<td>37.5</td>
<td>14</td>
<td>10</td>
<td>28.6</td>
</tr>
<tr>
<td><strong>TKN (mg/L)</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td>35</td>
<td>31</td>
<td>11.4</td>
<td>39</td>
<td>36</td>
<td>7.7</td>
</tr>
</tbody>
</table>

<sup>1</sup>Represents the average of daily removals $\Sigma\text{(inf-eff)}/\Sigma\text{inf}$, not removal of overall averages $(\Sigma\text{inf} - \Sigma\text{eff})/\Sigma\text{inf}$

<sup>2</sup>Results represent one grab sample per medium

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Results – TSS & BOD Removal:

- Primary: 66.4%
- PA2-13: 80.4%
- PES-14: 87.5%

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Results – TSS Removal:

- **Primary**
  - Influent TSS: 187 mg/L
  - Effluent TSS: 63 mg/L

- **PA2-13**
  - Influent TSS: 253 mg/L
  - Effluent TSS: 44 mg/L

- **PES-14**
  - Influent TSS: 221 mg/L
  - Effluent TSS: 26 mg/L

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Results – TSS Trending

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Results – TSS Trending
Results – BOD Removal:

<table>
<thead>
<tr>
<th>Location</th>
<th>Influent BOD</th>
<th>Effluent BOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>192</td>
<td>107</td>
</tr>
<tr>
<td>PA2-13</td>
<td>220</td>
<td>95</td>
</tr>
<tr>
<td>PES-14</td>
<td>169</td>
<td>59</td>
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</table>

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Results – BOD Trending

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Results – BOD Trending
Results – UVT Improvement:

![Graph showing UVT Improvement]
Results – UVT Trending
Results – UVT Trending

![Graph showing UVT Trends](image)
Summary
Implications:

Performance

- Consistently high effluent for the variable influent conditions

Filters in lieu of Primary Clarification

- Better removal of TSS and BOD$_5$
- More VSS (~25-38%) to the anaerobic digester
- More energy recovery (gas production)
- Less energy (~30-45%) use in the downstream aeration process

Primary Effluent Disinfection Systems

- Reduced Energy/Improved performance
Implications:

➢ Backwash

  • Ranged from 12 to 13% of the applied flow
  • Optimization was not an objective of this study
  • Improvement can be achieved by BW set-point adjustment and filter basin re-design

➢ Fats, Oils and Grease (FOG)

  • Did not affect the operation or removal performance
Implications:

Settling Basin

Aqua MegaDisk Filter

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Potential Applications:

• Replacement of primary clarifier for better removals and smaller footprint
• Carbon reduction to reduce energy in the activated sludge process
• Carbon diversion to improve gas production in anaerobic digestion
• Treatment of combined and sanitary sewer overflows (CSO & SSO) for TSS and BOD reduction
• Stormwater treatment
• Other high solids treatment process