Full Scale and Demonstration Primary Filter Projects Demonstrate Great Promise

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Acknowledgements

• California Energy Commission
• Full scale installation - Linda County Water District
• Pilot / Demonstration Sites - Los Angeles County Sanitation District, City and County of Honolulu, Rockford (IL), Oak Hill (WV)
• Peer Review - Prof. Emeritus George Tchobanoglous / UC Davis
• Primary Filter System: Aqua Aerobics Systems, Inc.
• Thickening System: Process Wastewater Technologies, Inc.
• Third party verification - Base Energy
• Kennedy Jenks CA and HI offices
Topics

• Primary Filtration for Carbon Diversion
  • Background
  • Objectives
  • Pilot and Demonstration Projects
  • First Full Scale Installation

• Conclusions

• Questions / Discussion
Primary Filtration

Primary filtration is another emerging technology based on successful demonstration of primary effluent filtration for 2 years

• Similar objectives (as PEF) for energy savings and plant capacity increase

• Replaces primary clarifiers with primary filters
  • 50 – 60% higher TSS/VSS removal efficiency
  • 40 – 50% higher BOD/COD removal efficiency
  • 70 – 80% reduction in footprint
Primary Filter Comparison

Scum Zone

Filtration Zone

Solids Zone

Tertiary Filter

Primary Filter
What is the most important criteria for design and operation of a primary treatment system?

A. Operational simplicity / flexibility

B. Treatment performance

C. Footprint

D. Capital and operational costs

E. Carbon management / diversion
Primary Filtration Main Objectives and Advantages

✓ Higher removal of organic load (BOD):
  Secondary treatment capacity $\uparrow$
  Aeration power consumption $\downarrow$
  Secondary treatment volume requirement $\downarrow$

✓ Reduction in primary treatment area $\downarrow$

✓ Higher removal of volatile suspended solids (VSS)
  Digester biogas energy production $\uparrow$

✓ Particle size modification: biological treatment efficiency $\uparrow$
City and County of Honolulu
Sand Island Primary Filtration Testing
(August 2016 – May 2017)

Average Flow Design Capacity: 90 MGD

Testing of Filtration for 3 MGD Sidestream Treatment System

Testing of Primary Filtration
City and County of Honolulu Sand Island Sidestream Filtration Testing Results

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Sidestream, mg/L</th>
<th>Filtered Sidestream, mg/L</th>
<th>Typical Average Removal Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSS</td>
<td>100-510</td>
<td>10-140</td>
<td>66%</td>
</tr>
<tr>
<td>TSS</td>
<td>240-590</td>
<td>81-170</td>
<td>62%</td>
</tr>
<tr>
<td>COD</td>
<td>400-820</td>
<td>130-500</td>
<td>46%</td>
</tr>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>142-360</td>
<td>89-210</td>
<td>43%</td>
</tr>
<tr>
<td>CBOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>170</td>
<td>99</td>
<td>42%</td>
</tr>
<tr>
<td>Soluble BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>81</td>
<td>71</td>
<td>13%</td>
</tr>
<tr>
<td>Ammonia</td>
<td>49-81</td>
<td>28-83</td>
<td>6%</td>
</tr>
<tr>
<td>TKN</td>
<td>64-110</td>
<td>35-91</td>
<td>21%</td>
</tr>
</tbody>
</table>
## Primary Influent Filtration System Concentration Ranges and Average Removal Performances

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Primary Filter Influent, mg/L</th>
<th>Primary Filter Effluent, mg/L</th>
<th>Constituent Average Removal Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td>VSS</td>
<td>110-190</td>
<td>155</td>
<td>17-40</td>
</tr>
<tr>
<td>TSS</td>
<td>120-260</td>
<td>188</td>
<td>24-62</td>
</tr>
<tr>
<td>COD</td>
<td>230-1000</td>
<td>389</td>
<td>67-270</td>
</tr>
<tr>
<td>$\text{BOD}_5$</td>
<td>110-210</td>
<td>154</td>
<td>55-86</td>
</tr>
<tr>
<td>Soluble $\text{BOD}_5$</td>
<td>47-63</td>
<td>55</td>
<td>38-56</td>
</tr>
<tr>
<td>Soluble COD</td>
<td>100</td>
<td>100</td>
<td>96</td>
</tr>
<tr>
<td>TKN</td>
<td>22-27</td>
<td>24</td>
<td>20-26</td>
</tr>
</tbody>
</table>
City and County of Honolulu - Sand Island Primary Filtration Particle Size Distribution Results

<table>
<thead>
<tr>
<th>Date</th>
<th>Sample Type</th>
<th>2 µm</th>
<th>5 µm</th>
<th>10 µm</th>
<th>20 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/4/2017</td>
<td>Influent</td>
<td>1.3</td>
<td>2.2</td>
<td>5.2</td>
<td>12.8</td>
</tr>
<tr>
<td>5/4/2017</td>
<td>Effluent</td>
<td>12.4</td>
<td>17.2</td>
<td>30.2</td>
<td>52.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Mean particle size (volumetric), Influent (µm)</th>
<th>Mean particle size (volumetric), Effluent (µm)</th>
<th>Relative change, percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/4/2017</td>
<td>96.6</td>
<td>20.4</td>
<td>79%</td>
</tr>
</tbody>
</table>

Mean particle size reduced by approximately 80 percent
Los Angeles County Sanitation District - City of Lancaster Primary Filtration Demonstration Project (November 2016 - November 2017)

Tertiary Treatment – 18 MGD

Serves approximately 160,000 people
Los Angeles County Sanitation District - City of Lancaster - Primary Filtration Demonstration Project

Lancaster Primary Filter Daily Average TSS

- Avg Inf TSS: 392 mg/L
- Avg Eff TSS: 56 mg/L
- Avg Removal: 86%

- Filter Influent TSS
- Filter Effluent TSS
- Avg Influent TSS
- Avg Effluent TSS
- Avg Removal (%)
Los Angeles County Sanitation District - City of Lancaster - Primary Filtration Demonstration Project

Lancaster Primary Filter Waste Ratios

Average Volumes
- Effluent: 35,527 gal
- BW: 3,713 gal
- SW: 1,852 gal
- BW+SW: 5,430 gal
First Full Scale Installation
Linda County Water District WWTP

Average Flow: 1.2 MGD (2016-2017)
2.5 MGD (2018-2019)

Downstream Process:
Nitrogen Removal, Tertiary Filtration

LCWD WWTP
Sacramento
First Full Scale Installation
Linda County Water District WWTP

Primary Filter Capacity:
Average Flow - 1.5 MGD
Peak Flow - 3 MGD
First Full Scale Installation – Linda County Water District WWTP

Design Completed in June 2016
Construction Started in October 2016
Started-up in August 2017
First Full Scale Installation
Linda County Water District WWTP
First Full Scale Installation
Linda County Water District WWTP

Primary Clarifier – average flow capacity 5 MGD

Primary Filter – average flow capacity 1.5 MGD
First Full Scale Installation
Linda County Water District WWTP
First Full Scale Installation
Primary Filter – Cloth Depth Filter
First Full Scale Installation
Primary Filter – Cloth Depth Filter
First Full Scale Installation
Thickening System - Volute Thickener
First Full Scale Installation
Thickening System – Phase Separator
Primary Filter System Initial Performance
Linda County Water District

LCWD Primary Filter Daily Average TSS

Avg Inf TSS: 276 mg/L
Avg Eff TSS: 48 mg/L
Avg Removal: 83%

TSS Removal (%)  
Filter Influent TSS  
Filter Effluent TSS  
Avg Influent TSS  
Avg Effluent TSS  
Avg Removal (%)
## Summary of Average Wastewater Characteristics (Linda County Water District)

<table>
<thead>
<tr>
<th>Parameter</th>
<th><strong>Primary Clarifier</strong></th>
<th><strong>Primary Clarifier</strong></th>
<th><strong>Primary Filter</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Influent</td>
<td>Effluent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avg Value (mg/L)</td>
<td>% Removal *</td>
<td>Avg Value (mg/L)</td>
</tr>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>220</td>
<td>26%</td>
<td>106</td>
</tr>
<tr>
<td>Soluble BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>51</td>
<td>0%</td>
<td>51</td>
</tr>
<tr>
<td>COD</td>
<td>501</td>
<td>24%</td>
<td>254</td>
</tr>
<tr>
<td>TSS</td>
<td>200</td>
<td>50%</td>
<td>40</td>
</tr>
<tr>
<td>VSS</td>
<td>188</td>
<td>47%</td>
<td>38</td>
</tr>
<tr>
<td>TKN</td>
<td>46</td>
<td>0%</td>
<td>41</td>
</tr>
</tbody>
</table>

* Based on historical data at LCWD WWTP
Conclusions

Primary filtration is an emerging advanced primary treatment technology for increased carbon diversion

Replaces primary clarifiers with primary filters:

- **TSS/VSS removal efficiency**: 50-70 percent
- **BOD/COD removal efficiency**: 40-55 percent
- **Footprint**: 80 to 85 percent
Conclusions

Actual performance/feasibility will be site specific

• Plant size
• Influent characteristics
• Efficiency of existing aeration system
• Available capacity
• Power cost
• Use of digester gas
Conclusions

Observed/expected side benefits:
- Response to upset conditions
- Load equalization
- Overall improvement in downstream biological treatment

Other considerations:
- Impact on denitrification
- Comparison with other technologies with similar concept
- Material/enclosure considerations compared to tertiary filters
- Digester design considerations
Conclusions
Primary Filtration Potential Benefits

25-30% ↓ in aeration costs

20-25% ↑ in secondary treatment capacity

30-40% ↑ in digester gas energy production

80 - 85% ↓ Primary treatment footprint
Estimated Savings

Assuming a 10% implementation of the (primary filtration technology) in US, the estimated present value of the savings will be approximately $5B

**Wastewater Treatment System Cost Savings Resulting from Primary Filtration**

<table>
<thead>
<tr>
<th></th>
<th>Savings Per MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Cost Saving</strong></td>
<td>$600,000</td>
</tr>
<tr>
<td><strong>Annual O&amp;M Costs Saving</strong></td>
<td>$30,000</td>
</tr>
<tr>
<td><strong>Net Present Value</strong></td>
<td>$1,100,000</td>
</tr>
</tbody>
</table>
QUESTIONS & COMMENTS

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