Fine Bubble Retrofit Does It Again

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La Crosse, WI
October 12, 2016

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What do we plan to cover?

- Background
- Process Review
- New Process
- Focus on the Aeration
- Design Parameters
- Construction
- Results
- Can we do more?
- Next Steps
- Summary
- Questions
Background
Background - Grande Whey - Juda, WI
Process Review
Project goal

- Expand capacity
- Provide redundancy
- Reduce chemical consumption

- Can capacity increase without increasing HP and power consumption?
New process
Focus on aeration

Current per aeration tank
- 75 HP pump
- 75 HP blower

Proposed (3 tanks)
- 2 - 75 HP blowers

<table>
<thead>
<tr>
<th># of Tanks</th>
<th>Current</th>
<th>Vs.</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>150 HP</td>
<td>Vs.</td>
<td>&lt; 75 HP</td>
</tr>
<tr>
<td>2</td>
<td>300 HP</td>
<td>Vs.</td>
<td>&lt; 150 HP</td>
</tr>
<tr>
<td>3</td>
<td>450 HP</td>
<td>Vs.</td>
<td>150 HP</td>
</tr>
</tbody>
</table>
Other Potential Reductions

- Clarifier vs. DAF
- RAS pump vs. Jet pump
- Diffused post air vs. mechanical aerator
Aeration Calculations

- Start with calculating the actual oxygen requirement (AOR)
  - SRT = 20 days, 1.2 lb O$_2$/lb BOD
  - Assume 100% removal of BOD
  - Assume nitrification, 4.6 lbs O$_2$/lbs NH$_3$
  - Assume all TKN converts to NH$_3$

\[
\text{AOR} = 1.2 \times \text{BOD} + 4.6 \times \text{NH}_3
\]
Calculations - Continued

- Next, convert to standard oxygen requirement

\[
AOR = SOR(\alpha) \left[ \frac{\beta \left( \frac{P_i}{P_{MSL}} \right) C_{sat_i}}{C_{sat_{20}}} \right] - DO \text{ field} \theta \left( T - 20 \right)
\]

The terms in the formula are:
- AOR = actual oxygen requirement (field conditions)
- SOR = standard oxygen requirement (standard conditions)

Alpha = 0.55
Beta = 0.95
Site elevation = 700’
D.O. = 2 mg/L

Temp = 80°F

Copied from Sanitaire *Diffused Aeration Design Guide*
- Calculate air required and horsepower
  - Air based on 1.8%/ft
    \[
    SCFM = \frac{SOR}{0.25056 \times SOTE}
    \]
  - Estimates between 1,650 and 3,200 SCFM
  - Horsepower
    \[
    BHP = \frac{0.23 \times SCFM}{Mech\ Eff} \times \left[ \left( \frac{14.7 + P}{14.7} \right)^{0.283} - 1 \right]
    \]
  - Estimates between 80 and 155 HP
Construction Sequence

- Build new aeration & clarifier
- Retrofit aeration tank 1
- Retrofit aeration tank 2
Results

- The aeration basins are operating as anticipated.
- Verified that the plant could operate with 2 tanks.
- Two blowers were able to supply air to three tanks maintaining DO > 4 mg/L.
Can we do more?

- Turbo to the rescue?
- Close fit, but not perfect.
- Horsepower dropped
GRAPHE

TB150-0.6S

SPEED
23000

P
9.1

FLOW
2183

ERROR
0

SPEED

Basin 3 DO Level
Current: 2.3
Alarm: 2.0

Basin 2 DO Level
Current: 2.8
Alarm: 3.1

Basin 1 DO Level
Current: 2.0
Alarm: 4.0

4872 Hrs
EAST BLOWER

5249 Hrs
WEST BLOWER

SWING BLOWER
1994

0 GPM
TO RAS
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>ΔP filter</td>
<td>0.022</td>
<td>psi</td>
<td>T1</td>
<td>50</td>
<td>°F</td>
</tr>
<tr>
<td>P</td>
<td>9.0</td>
<td>psi G</td>
<td>T2</td>
<td>158</td>
<td>°F</td>
</tr>
<tr>
<td>Q</td>
<td>2060</td>
<td>cfm</td>
<td>N</td>
<td>23200</td>
<td>rpm</td>
</tr>
<tr>
<td>RUNTIME ON-OFF</td>
<td>13652</td>
<td>Hr</td>
<td>POWER</td>
<td>81</td>
<td>kW</td>
</tr>
<tr>
<td>DCLink</td>
<td>642</td>
<td>V</td>
<td>ERROR CODE</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Mode: Current Set | Site: REMOTE | Status: Loaded | 2016/03/10 09:44:14
Actual vs. Initial Estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>ΔP, filter</td>
<td>0.022 psi</td>
</tr>
<tr>
<td>P</td>
<td>9.0 psi G</td>
</tr>
<tr>
<td>Q</td>
<td>2060 cfm</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number Diffusers in Plant</td>
<td>1392</td>
</tr>
<tr>
<td>Total Number Grids in Plant</td>
<td>3</td>
</tr>
<tr>
<td>Total Number Trains in Operation</td>
<td>3</td>
</tr>
<tr>
<td>Total Aerated Volume</td>
<td>169,304 ft³</td>
</tr>
<tr>
<td>Total AOR</td>
<td>4,680 lbs-O2/plant-d</td>
</tr>
<tr>
<td>AOR/SOR</td>
<td>0.346 lbs-O2/plant-d</td>
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<tr>
<td>Total SOR</td>
<td>13,536 lbs-O2/plant-d</td>
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<tr>
<td>Total Air Rate</td>
<td>1,506 SCFM/plant</td>
</tr>
<tr>
<td>Diffuser Air Rate</td>
<td>1.08 SCFM/diff</td>
</tr>
<tr>
<td>SOTE</td>
<td>35.88%</td>
</tr>
<tr>
<td>Max Dropleg Pressure</td>
<td>8.26 Psig</td>
</tr>
<tr>
<td>Est. Blower Pressure</td>
<td>8.56 Psig</td>
</tr>
<tr>
<td>Est. Blower Efficiency</td>
<td>0.7</td>
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<tr>
<td>Est. Blower Power</td>
<td>69.1 BHP</td>
</tr>
<tr>
<td>Est. Motor Load</td>
<td>56.1 KW</td>
</tr>
<tr>
<td>Est. SAE</td>
<td>10.1 lbs-O2/KWH</td>
</tr>
<tr>
<td>Oxygen Transfer Safety Factor</td>
<td>0.0%</td>
</tr>
<tr>
<td>Year</td>
<td>Organic loading to Aeration (#/Day BOD)</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>2013</td>
<td>2,140</td>
</tr>
<tr>
<td>2016*</td>
<td>2,780</td>
</tr>
<tr>
<td>2016***</td>
<td>2,780</td>
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</tbody>
</table>

*Based on using the existing PD blowers
**Aeration basin DO > 4 mg/L
***Based on using the Turbo blower

- 30% increase in organic load
- 110% increase in nitrogen load
- 50% reduction in HP
- 60% reduction in HP/BOD
## Energy Comparison – Turbo Blowers

<table>
<thead>
<tr>
<th>Year</th>
<th>Organic loading to Aeration (#/Day BOD)</th>
<th>Nitrogen loading to Aeration (#/Day TKN)</th>
<th>Estimated HP</th>
<th>Energy Consumption (HP/BOD/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>2,140</td>
<td>155</td>
<td>270</td>
<td>0.126</td>
</tr>
<tr>
<td>2016*</td>
<td>2,780</td>
<td>330</td>
<td><strong>135</strong></td>
<td><strong>0.049</strong></td>
</tr>
<tr>
<td>2016**</td>
<td>2,780</td>
<td>330</td>
<td><strong>110</strong></td>
<td><strong>0.040</strong></td>
</tr>
</tbody>
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*Based on using the existing PD blowers
**Aeration basin DO > 4 mg/L
***Based on using the Turbo blower

- 18% reduction in HP
- 18% reduction in HP/BOD
Some additional savings

- **Current**
  - Using 7.5 HP for post air instead of 25 HP mechanical aerator.
  - Using 4 HP RAS pump instead of 75 HP Jet motive pump

- **Future**
  - Use turbo blower to aerate sludge tank
  - Use turbo blower to aerate post Air
Summary

- Grande completed improvements that:
  - Increased capacity of WWTP
  - Provided redundancy to the aeration basins
  - Improved coagulant usage efficiency and reduced polymer consumption

- In doing so, Goals Met
  - Power consumption has been reduced while providing a 30% increase in loading
  - High efficiency turbo blower reduced power consumption an additional 18%
Thank you!

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