Maximize Oxidation Ditch
Bio-P Performance

By
Jack Wendler/Ripon WWTF
## Design 1.8 MGD

### Discharge Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Week Average Limit</th>
<th>Monthly Average Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD, mg/l (Varying based on time of year)</td>
<td>8.2-16</td>
<td>8.2-16</td>
</tr>
<tr>
<td>TSS, mg/l</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Ammonia, mg/L (Varying based on time of year)</td>
<td>2.2-5.1</td>
<td>2.2-5.1</td>
</tr>
<tr>
<td>Total Phosphorus, mg/L</td>
<td>--</td>
<td>1.0</td>
</tr>
</tbody>
</table>
• 1 Manager and 3 Operators
• Onsite Laboratory
  – BOD/TSS/TP/NH3-N/pH
  – Various process control testing to optimizing system
• 2003-2004 Upgrade
  – Fine Screen
  – 2 parallel oxidation ditches
  – 2 new final clarifiers
  – Biological Phosphorus Removal anaerobic zones ahead of ditches
  – UV Disinfection
  – Upgrade tertiary filtration – installed different media
Major Contributors
Staff started phosphorus optimization moves in 2012 in anticipation of its upcoming DNR discharge permit.

New permit was issued in 2014.

Permit requires compliance with a 0.075 mg/l TP limit in 2023.
Starting Point - BEFORE Optimization

Put Ugraded Facility Online

Start the Phosphorus Optimization Process
• Focus on Bio-P and Final Filtrate vs. Chemical Optimization

• The following questions came up as staff looked in Bio-P optimization....

  ➢ How can we reduce the impact of side stream nitrates\((\text{NO}_3^{-}\text{N})\) and ortho-phosphorus \((\text{PO}_4^{3-}\text{P})\) on Bio-P system?

  ➢ How can we improve the anaerobic and anoxic zones in the Bio-P system?
Possible Options for Changes in Operations

• Reduce $\text{NO}_3$-N and $\text{PO}_4$-P in GBT filtrate
  ➢ Holding tank operation
  ➢ General GBT maintenance
Possible Options for Changes in Operations

• Ways to improve anaerobic and anoxic zones in Bio-P system
  ➢ RAS Control
  ➢ ORP and D.O. control in ditches

• Review effluent tertiary filter operation for possible improvement in performance
For every lb. of NO$_3$-N in the side stream you will use up 4 lbs. of influent BOD denitrifying the NO$_3$-N in the anaerobic zone.

For every lb. of PO$_4$-P in the side stream you need an additional 20 lbs. more of influent BOD to biologically treat the P.
Why explore the side streams?

• Jun ‘12 noticed difference in GBT filtrate PO₄-P concentrations, mg/l
  ➢ Holding tank #1 – 3.3
  ➢ Holding tank #2 – 14.1 - blower was offline

• Jul ‘12
  ➢ GBT filtrate – 28.4 and 34.6
• Jul ‘12 in the GBT filtrate the NO$_3$-N concentration was an average 80 mg/l

• These high concentration of NO$_3$-N & PO$_4$-P have an adverse affect on the Bio-P
Efforts to reduce GBT NO$_3$-N and PO$_4$-P concentration

• Maintain adequate D.O. in holding so P does not release in holding tank

• Decreased Hydraulic Retention Time (HRT) by reducing operating level in holding tank

  ➢ Reduces conversion of organic nitrogen to ammonia and then NO$_3$-N
Efforts to reduce GBT NO₃-N and PO₄-P concentration

• Staff experimented with GBT maintenance to reduce PO₄-P
• Changed rubber seals and scrapers more often
• Staff cleaned belt more often
• Together both have improved the quality of the GBT filtrate resulting in less PO₄-P being recycled. It also resulted in lower polymer consumption
Efforts to Improve Anaerobic Zone

• Experimted with slowing the RAS flow rate
• Rational - reducing RAS flow will increase RAS sludge retention time in the final clarifier blanket helping to reduce ORP. When RAS sludge arrives in anaerobic zone it has a lower ORP improving the anaerobic zone quality
• Controlled as % of Influent – initial setting 70%
• After months of adjustment setting now at 55%
• Aeration Control – Inline ORP Probe with set point
• Any inline probe needs routine maintenance/cleaning
• Oxidation Ditch D.O. are measured 7 days/week
• 2012 D.O. was 1.0 ppm at the tail end of oxidation just before the secondary aerator.

• In 2012 the ORP control set point for the aerator’s was 170 mV this would achieve the desired 1.0 ppm D.O.

• Over the course of time staff experimented with a lower D.O. and ORP in the ditch.

• Present D.O. target is 0.7 ppm and ORP aerator set point control is 93 mV.
Effectives of Reduced ORP Set Point

- Oxidation Ditch #1 ORP Setpoint, mV
- Oxidation Ditch #1 D.O. ppm
- Oxidation Ditch #1 D.O. @ ORP Probe
Rational – Reducing the D.O. (ORP) in the ditch accomplishes two things;

1. Help to create a condition (lower ORP) for the DENITRIFYING organisms to act on NO$_3$-N

2. Bring the overall ORP lower in BPR system (oxidation ditch/final clarifier sludge blanket/anaerobic zones). This helps provide better performance in the anaerobic zone – PUSHING IT MORE ANAEROBIC
Before 2012 staff experimented with effluent tertiary filter backwashing to reduce effluent TSS and in turn reduce effluent TP.

Through experimentation staff found back washing each filter (there are 4 filters) everyday (manual mode vs. auto) improved effluent TSS and in turn effluent TP.

Staff also found out that organisms growing in the filters can effect the activated sludge - filaments.
Results of Operational Changes

• A combination of the following items all attributed to an improved Bio-P performance
• Reducing HRT in holding tank
• Increased levels of maintenance on GBT
• Reduce RAS flow rate
• Decrease both D.O. and ORP levels in the oxidation ditches – This option seemed to have the largest impact on increasing Bio-P performance
• Increase effluent tertiary filter backwashing
Total Phosphorus
5-5-2015

Reagent Blank
0.10 mg/l Std.
0.50 mg/l Std.
1.0 mg/l Std.
0.75 mg/l LCS
Influent
Effluent
<table>
<thead>
<tr>
<th>Sample</th>
<th>Sample Size (mls)</th>
<th>Absorbance</th>
<th>Conc. (mg/l)</th>
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</thead>
<tbody>
<tr>
<td>Standard 0.10 mg/l</td>
<td>25</td>
<td>0.034</td>
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</tr>
<tr>
<td>Standard 0.50 mg/l</td>
<td>25</td>
<td>0.173</td>
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<tr>
<td>Standard 1.00 mg/l</td>
<td>25</td>
<td>0.360</td>
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</tr>
<tr>
<td>Blank</td>
<td>25</td>
<td>0.001</td>
<td>0.01</td>
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<tr>
<td>LCS 0.75 mg/l</td>
<td>25</td>
<td>0.264</td>
<td>0.74</td>
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<tr>
<td>Raw</td>
<td>25</td>
<td>0.20</td>
<td>0.06</td>
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<tr>
<td>Final</td>
<td>25</td>
<td>0.20</td>
<td>0.06</td>
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</table>
T.S.S.
5-5-2015

Distilled Water Blank

Influent

Effluent
<table>
<thead>
<tr>
<th>NUMBER/SIZE ml</th>
<th>TYPE</th>
<th>SAMPLE LOCATION</th>
<th>PAPER GRAMS</th>
<th>INT. PAPER SAMPLE - GRAMS</th>
<th>REPEAT PAPER SAMPLE GR.</th>
<th>INT. S.S. mg/l</th>
<th>REPEAT S.S. mg/l</th>
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</thead>
<tbody>
<tr>
<td>1/100</td>
<td>D.W.</td>
<td>ROUND 3</td>
<td>1.4551</td>
<td>1.4651</td>
<td>1.4551</td>
<td>2.0</td>
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<tr>
<td>3/500</td>
<td>FINAL/DUP</td>
<td>SAMPLER</td>
<td>1.3761</td>
<td>1.3823</td>
<td>1.3823</td>
<td>124</td>
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<tr>
<td>5/50</td>
<td>RAW/DUP</td>
<td>SAMPLER</td>
<td>1.4536</td>
<td>1.4607</td>
<td>1.4605</td>
<td>142</td>
<td>138</td>
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<tr>
<td>6/100</td>
<td>MLSS-1</td>
<td>DITCH-1</td>
<td>0.5928</td>
<td>0.9204</td>
<td>3.276</td>
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<tr>
<td>7/100</td>
<td>MLSS-2</td>
<td>DITCH-2</td>
<td>0.5970</td>
<td>0.9019</td>
<td>3.049</td>
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<tr>
<td>8/50</td>
<td>RAS</td>
<td>BLDG 45</td>
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<tr>
<td>9/250</td>
<td>FCL 1</td>
<td>BLDG 45</td>
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<tr>
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<tr>
<td>11/50</td>
<td>DIG 1</td>
<td>5W-8W</td>
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AFTER Optimization

Put Upgraded Facility Online

Start the Phosphorus Optimization Process

Eff. TP, mg/l


0.66  0.64  0.62  0.63  0.53  0.35  0.38  0.14  0.17  0.46  0.21  0.26  0.25  0.31  0.11  0.14
Anglers & Effluent
City of Ripon, WI

"Cookietown USA" faced the strictest effluent limits in the State. Ripon, population 7,630, is supported by 2,300 industrial jobs. Earth Tech saved the City approximately $1.5 million with a first-of-its-kind technologically sophisticated yet easy-to-operate automated ORP probe system. This supercharged activated sludge process averted costly installation of pretreatment facilities by local industries. Sewer rates are now 25% below the state average. Treatment is affordable for industries. Jobs have been saved. Quality effluent flows into Silver Creek, a sensitive tributary to pristine Green Lake. Phosphorus reduction of 2,000+ lbs annually is restoring health to the waterways. Trout are now splashing in Silver Creek, and the air in "Cookietown" is sweet.

Enhanced nutrient removal and high performance final clarifiers exceed the strict effluent limits of 6 mg/L BOD, 10 mg/L suspended solids, 0.5 mg/L ammonia, and 1 mg/L phosphorus.
Ripon’s staff found that through a variety of operational changes they were able to drive the *Biology* and have noticeable impact on the Bio-P performance of their system.

Educated experimentation in an orderly fashion with your Bio-P system can have positive effects on Bio-P performance.