Can a POTW Receiving Industrial Loads Comply with Future TP Limits?

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“According to the latest research, the average human body is 20% water and 80% stress.”

“I wasted all day today worrying about yesterday that nobody will remember tomorrow.”
Safety Moment – Stress Management

- Stress is our body's reaction to any change that requires an adjustment/response.
- Stress can affect your body, your thoughts, and your behavior.
- Health impacts: high blood pressure, heart disease, obesity, and diabetes.
- Physical symptoms include: headache, muscle tension, chest pain, fatigue, stomach upset, insomnia, etc.
- Manage stress by
  - Practicing relaxation techniques e.g. deep breathing.
  - Keeping a sense of humor
  - Spending time with family and friends
  - Setting aside time for hobbies
  - Getting plenty of rest, eating healthily, avoiding excess caffeine and alcohol, etc.
Presentation Outline

- Safety Moment
- Newark WWTP & Anomatic Corporation
- Problem Statement
- Study Objectives & Approach
- Findings
- Conclusions
Newark WWTP

1948: Originally constructed as a primary plant
1961: Upgraded to secondary treatment
1968: Added incineration & sludge dryer
1988: Major upgrades: A2O BNR process, chlorination
1998: Added UV disinfection
2011: Added high rate wet weather treatment facility: Actiflo® & UV disinfection

Flow: 8 mgd (design); 9 mgd (average)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Weekly</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBOD$_5$, mg/L</td>
<td>23/40</td>
<td>15/25</td>
</tr>
<tr>
<td>Summer/Winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSS, mg/L</td>
<td>23/45</td>
<td>15/30</td>
</tr>
<tr>
<td>Summer/Winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia-N, mg/L</td>
<td>3.3/15.8</td>
<td>2.2/10.5</td>
</tr>
<tr>
<td>Summer/Winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total P, kg/d</td>
<td></td>
<td>331.5</td>
</tr>
<tr>
<td>Summer (1$^{st}$ May – 31$^{st}$ Oct.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Anomatic Corporation

- Has been in operation for about 30 years
- Provides key benefits to the City:
  - One of the largest employers (≈ 600)
  - One of the largest users of water and wastewater services
- Stamping and anodizing aluminum parts
- The bright dip process uses sulfuric, nitric, and phosphoric acids
- Wastewater relatively high in: NO\textsubscript{x}, Sulfate, & Phosphorus
- Average flow: 0.45 mgd
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## Problem Statement

<table>
<thead>
<tr>
<th>Cause</th>
<th>Observation</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>High influent NO\textsubscript{X}</td>
<td>Denite. in the primary clarifiers</td>
<td>• Floating sludge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Poor thickening</td>
</tr>
<tr>
<td></td>
<td>Denite. in the secondary clarifiers</td>
<td>• Effluent TSS violation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• E. coli violation</td>
</tr>
<tr>
<td>High influent TP</td>
<td>Poor P removal</td>
<td>• Permit violation</td>
</tr>
<tr>
<td>High Influent SO\textsubscript{4}</td>
<td>Poor VS reduction</td>
<td>• Does not meet Class B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Poor gas production</td>
</tr>
<tr>
<td></td>
<td>High H\textsubscript{2}S in biogas</td>
<td>• Poor gas quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Corrosion</td>
</tr>
</tbody>
</table>
Study Objective

• The study was not initiated to tell Anomatic to clean-up or get out! If Anomatic relocated it can have serious & far-reaching consequences to the City

• Overarching objective:
  – Assess current plant loadings
  – Develop an understanding of sulfur transformation in the digester
  – Identify future P removal approaches
  – Work collaboratively with Anomatic to arrive at an acceptable resolution of the issue
Approach

• Discussed operations & plant performance with plant staff
• Reviewed plant data
• Identified data gaps and initiated special sampling campaigns
  – Collection system
  – Treatment plant
• Developed a high-level whole plant process model
• Developed SUMO 2S model incorporating sulfur chemistry
• Shared findings with the City & Anomatic staff
Sampling Campaigns

- **1\textsuperscript{st} sewer sampling (Aug. 2016):** To determine the extent of denitrification between Anomatic and the WWTP
- **2\textsuperscript{nd} sewer sampling (Nov – Dec 2016):** To determine the extent of denitrification after the Anomatic stream was rerouted to increase contact time with high BOD dairy waste (Tamarack)
- **WWTP profiling (Oct. 2016 – Feb. 2017):** To determine NO\textsubscript{x} and SO\textsubscript{4} transformation in the treatment process.
- **WWTP influent sampling (Nov. 2017 – Feb. 2018):** To characterize WWTP influent with & without Anomatic operation
- **WWTP influent monitoring Nov. 2017 – May 2019:** To update plant influent SO\textsubscript{4} and TP loadings
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Historic Plant Loading – Influent NO$_2$ + NO$_3$

influent NO$_2$&NO$_3$, lbs/day

- 2015
- 2016
- 2017
- 2018
Key Observations From Sampling Efforts and Plant Data Review

• Collection system denitrification is unreliable & inconsistent

• The WWTP influent NO$_x$ and SO$_4$ loads far exceed typical municipal levels.
  – Anomatic contributes 50 to 100% of the WWTP NO$_x$ & SO$_4$ loads

• TP loads have decreased significantly over the last 2 yeas; it is now at typical municipal levels.

• P fractionation suggests most of the influent P is reactive and therefore removable.
## Summary of Current WWTP Influent Concentrations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Period</th>
<th>Count</th>
<th>Average, mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfate</td>
<td>1 Nov. 2018 – 31 May 2019</td>
<td>40</td>
<td>290.0</td>
</tr>
<tr>
<td>Total P</td>
<td>1 Jan. – 31 May 2019</td>
<td>22</td>
<td>5.9</td>
</tr>
<tr>
<td>NOx</td>
<td>1 Jan – 31 Dec. 2018</td>
<td>195</td>
<td>21.2</td>
</tr>
<tr>
<td>cBOD</td>
<td>1 Jan. – 31 May 2019</td>
<td>58</td>
<td>74.3</td>
</tr>
</tbody>
</table>

The A2O configuration can not sustain bio-P removal because of:

1. Loss of anaerobic zone due to high nitrate ($\approx 10$ mg/L)
2. Carbon limitation ($c\text{BOD}:\text{TP} \approx 12.6$)
Fate of Sulfate
We Worked with Dynamita to Incorporate Complex Sulfur Chemistry into SUMO 2S
Conditions that Allow Sulfur Reducing Organisms (SROs) to Outcompete Methanogens

1. Higher growth rates
2. Higher affinity for VFA & hydrogen
3. Low substrate ratio (COD:SO₄ <10)
4. pH < 7
5. Gaseous H₂S produced by SROs is inhibitory to methanogens:
   - H₂S concentration for 50% inhibition: 50 -125 mg/L at pH 7-8
   - Operational target appears to be < 300 ppm H₂S
Mitigation of Digester $\text{H}_2\text{S}$ Formation

1. Before the fact:
   - Eliminate Anomatic $\text{SO}_4$ load (pipe dream!)
   - Increase digester pH & shift dissociation to the right:
     \[ \text{H}_2\text{S} \rightleftharpoons \text{HS}^- \rightleftharpoons \text{S}^{2-} \]
     May also inhibit methane production

2. After the fact: Ferric addition
   - To digester:
     Soluble S species $\rightarrow$ Particulate form
   - Future: Add to primaries for future P compliance
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<thead>
<tr>
<th>Issue</th>
<th>Recommendations</th>
</tr>
</thead>
</table>
| High influent NO\textsubscript{x} | • Eliminate co-settling (DONE!)  
• Evaluate bioaugmentation to enhance sewer denitrification  
• Monitor infl. NO\textsubscript{x} & work with Anomatic to control NO\textsubscript{x} load  
• Update Sewer Ordinance for system-wide control |
| High influent SO\textsubscript{4} | • Implement digester ferric addition  
• Monitoring infl. SO\textsubscript{4} & work with Anomatic to control SO\textsubscript{4} discharge  
• Update Sewer Ordinance for system-wide control |
| Influent total P       | • Not an issue anymore due to tight control by Anomatic.  
• Monitoring infl. TP & work with Anomatic to avoid future increase. |
Conclusion

• Options for achieving future TP permit compliance
  1. Bio-P removal: not a viable approach due to
     • Nitrate interference in the anaerobic zone
     • Insufficient carbon (cBOD:TP ≈ 12)
  2. Chemical P removal (with ferric)
     • Add to primary clarifier
     • Digester ferric addition to control H₂S will also provide sidestream ortho-P treatment
     • Tight dose control to minimize impacts on UV disinfection
  3. Use existing Actiflo units: May need regulatory coordination

Every case involving an industrial discharger and a POTW may be likened to a marriage!
Acknowledgement

• Roger Loomis, PE, Utilities Superintendent
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• Scott Knighton, Assistant Wastewater Facilities Manager
• Nancy Taylor, Pretreatment Coordinator
Thank You for Your Interest!
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