Troubleshooting Activated Sludge

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Outline of Presentation

• Background
• Triggers
• Monitoring
• Case Studies
  • Dispersed Throughout
Evolution of Cleaning Chemicals May Be Difficult for Activated Sludge Systems

- Pre WWII
  - Soap made using animal fats
  - WWII created shortage in animal fats

- Post WWII
  - Soaps give way to detergents
  - Detergents based on petrochemical or synthetic formulations
  - Detergents evolve to potentially include:
    - Enzymes
    - Bleaches
    - Hydrophobic or hydrophilic properties
    - Biocidal components
    - Other…..
  - Market pressures and regulations prompt continued change
Water Conversation Is Good!  
(Except If Used To The Dilution)

**Figure 14.** Trends in total water withdrawals by water-use category, 1950–2010.

*Source - USGS*
Rapid Settling and Miscellaneous Stress

Background
Stable Conditions are Required for Proper Floc Formation

• “The following factors can adversely affect floc formation:
  • Sludge Age
  • Slug Discharges
  • Toxicity
  • Surfactants
  • Excessive Shearing”

• Toni Glymph, *Wastewater Microbiology: A Handbook for Operators*
Strategic Responses Require Well Structured Steps

1. Recognize Issue
   - Confirm Inside Fence
   - Process Control
     - RAS
     - WAS
     - Aeration
     - Other

2. Determine Potential
   - Additional Monitoring
     - SOUR
     - Microscopy
     - Sulfides
     - Other

3. Act on Information
   - Visit Industry
   - Change Operation
   - Supplement/Treat

4. Communicate, communicate, communicate!
Description of Treatment Stress

• Potential Observations
  • Influent
    • Increased Sulfides
    • Foam/Odd Colors/Odors
    • pH Changes
  • Mixed Liquor
    • Appearance/Odor
    • Settling Characteristics
    • Mixed Liquor Concentration
    • Clarifier Surface
  • Effluent
    • TSS Spike
    • BOD Spike
    • Ammonia Spike
    • Nitrite (NO₂) Spike
    • WET Test Failure
BOD – Toxic Substances

• Confirmed through serial dilutions
  • BOD bottles with greatest amount of sample that have the lowest BOD might indicate presence of toxic substances

<table>
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<th>Source</th>
<th>Bottle</th>
<th>Sample Vol (ml)</th>
<th>Initial DO</th>
<th>Final DO</th>
<th>Depletion</th>
<th>Dilution Factor</th>
<th>BODs</th>
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<td>1</td>
<td>5</td>
<td>8.9</td>
<td>4.6</td>
<td>4.3</td>
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<td>10</td>
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<td>4.3</td>
<td>4.6</td>
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<td>3</td>
<td>20</td>
<td>8.9</td>
<td>3.9</td>
<td>5.0</td>
<td>15</td>
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</tbody>
</table>

• Laboratory Testing for BOD and CBOD – Brake and Raynovic
Description of Treatment Stress

• Nitrification stress might be defined as:
  • Effluent ammonia concentrations are not as low as typical or expected
  • Nitrite is present in effluent when not typical

• 12.9 lbs of Cl\(_2\) consumed per mg/L NO\(_2^-\) per MGD
Description of Treatment Stress

- Process Observations
  - Automation Changes
    - Less Air Required
    - More Air Required
    - Lower Residuals Detected; More Chlorine Required
  - Oddities in Optical Measurements
Underlying Triggers
Underlying Triggers

• Loss of Dilution
  • Chemicals
  • Metals
  • Organic Loads
• Change in Hydraulic Detention Times
  • Sewer
  • Process Tanks
• Change in Temperature
  • Less volume, more time, warm ambient conditions = Warm Activated Sludge

The gradual changes associated with droughts makes identification of stresses difficult.
Chemicals of Interest Include:

- **Quaternary Amines**
  - Used in cleaning chemicals
  - Accumulate through adsorption
  - Degrade slowly

- **Anionic Surfactants**
  - Used in cleaning chemicals
  - Coats bacteria surface causing deflocculation
  - Foam may be associated with these wastewaters

*Note: Portable Toilets Frequently Include Quaternary Amines*

If your industries use a chemical to kill bacteria at their facility, they should understand what it does at yours.
Wastewater Characteristic Changes of Interest Include:

- Sulfide Toxicity
  - Very pH Dependent
    - Monitor daily
  - May indicate new or greater sources of H$_2$S
    - Develop Baseline

“Sulfide toxicity to activated sludge is more common than currently recognized.” Michael Richard Ph.D. *Activated Sludge Microbiology Problems and Their Controls*

@ a pH of 7.0 s.u., 1 mg/L H$_2$S decreased oxygen uptake by 50 %
@ a pH of 8.0, 100 mg/L H$_2$S was required to get the same response
Midge Fly Infestation

Where Have All the Solids Gone?

By Ron Trygar, CET  |  Lab Detective  |  June 2012
Proactive Observations
Keys To Gaining Value From Information Include

- Collect information in good times to provide a baseline
- Organize information to provide trending and other review opportunities
- Communicate findings with appropriate parties
  - Suspected contributors
  - Management
  - Operators/Team
- Isolate information when possible
Microscopy Can Indicate if Toxicity may be a Factor

- Microscopy Evaluations
  - Changes in indicator organisms
    - More Flagellates
    - More amoeba
    - Testate or shelled indicator organisms
    - Fewer higher life forms or inactive higher life forms
    - Stress to filamentous bacteria
    - Stress to floc formation
  - Get trusted sources for reference
  - Do in-house and do so consistently
Regular SOUR or OUR Analysis May Identify Meaningful Changes in Characteristics

![Respiration Rate Diagram]

- **Abnormally High** – Check for Increased Load
- **Normal**
- **Abnormally Low** – Check for Toxicity

**mg/hr/g**

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**Resp. Rate mg/hr/g**

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**SOUR**
Influent pH Monitoring May Date/Time Stamp Trigger
Industrial Pretreatment May Avoid Issues

- Communicate with pretreatment coordinator – In House
- Gain political will if necessary
  - Respectfully proceed
- Discuss Cause and Effect Relationships with Industry
  - Raw Materials
  - Cleaning Chemicals
  - By-Products
  - Products
Adenosine Triphosphate (ATP) Indicates Viable Organisms

- ATP analysis measures the light following the introduction of reagents creating a luminescing reaction.
- Data Provides Information
  - Total ATP
  - Dissolved ATP
  - Cellular ATP
  - Active Biomass Ratio
  - Biomass Stress Index
Operator Intuition!

Facility Identifies Toxicity Source by Opening Manholes

- Community of 1400
- Flow of ~ 60,000/day
- 43 gpd per person
- Treatment stress identified
- Collected samples, opened manholes
- Found paint being dumped
Settling Characteristics May Indicate Timing of Initial Issue
Trends of Key Information Such as Settling Characteristics Provides Timely Information

Database shortcuts to meaningful trends

**Trend of Settling Characteristics**
Comparison of Information from Multiple Sources Provides Detailed Trends

2010 WWTP TSS vs Industry Ammonia (or Amines)

Ammonia Later Determined to Be Amines

Concentration (mg/L)


Industry Eff NH3  WWTP Eff TSS
Track Anecdotal Information With Data to Build on “Hunches”

Historically Operators Note Difficulties Operating Less than 12 mgd
Closing Thoughts
Remedies May Require Multiple Adjustments

- Adjust Conventional Controls
  - Adjust RAS
  - Adjust WAS
  - More Air
- Reduce Industrial Stresses
- Reduce Hauled in Stresses
- Supplement – Bio augmentation
- Add Coagulant or Flocculent
- Add Seed

Identifying and eliminating the trigger is the best remedy.
Additional Closing Thoughts

• Developments to cleaning chemicals, biocides, and other important products may have a negative impact on wastewater treatment

• Environmental conditions may allow hidden stresses to reveal themselves

• Monitoring and proactive responses can improve performance

• Industrial pretreatment may be improved through simple communications
Questions and Answers