INTRO TO PANEL PRESENTATIONS ON

WWRF OPTIMIZATION

CASE STUDIES OF WHAT WORKS AND WHAT DOESN’T

Overview of Panel Discussions

- Goal of presentations
- Mix of small and large systems
- Presented by municipal staff
- Focused on activated sludge

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<thead>
<tr>
<th>Location</th>
<th>Capacity, mgd</th>
<th>Optimizations/Investigations</th>
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What is the Goal of Optimization?

- Minimize $$$
  - Life cycle costs and operating costs
- Improve process reliability
  - Minimize permit violations
- Reduce stress for superintendents & operators
Overview Topics

- Aeration System Energy Optimization
- Enhanced Biological Phosphorus Removal
- Probes for Automation
Typical Energy Usage in WRRFs

- **Aeration**: 40-60%
- **Influent Pumping**: 15-20%
- **Sludge Processing**: 15-20%
- **Miscellaneous**: 7-10%
- **Primary Treatment**: 3-5%
Aeration System Energy Optimization

- Starts with blower efficiency
- Fine bubble and clean diffusers
- Automatic DO and/or ammonia control
Newer, Energy Efficient Blowers Reduce Power Usage

- Rotary Screw (PD)
- Centrifugal – Single Stage
- High Speed Turbo
Typical Secondary Treatment in Michigan WRRFs

Activated Sludge Processes with:

- Nitrification
- Enhanced Bio-P Removal (EBPR)
- Chemical P Removal
Enhanced Biological Phosphorus Removal

![Diagram of Enhanced Biological Phosphorus Removal process]

- **Primary Effluent**
  - **Anaerobic (with Nitrification)**
    - Air
  - **Aerobic**
  - **Clarifier**
    - **Ferric chloride for P precipitation**
    - **Secondary Effluent**
      - BOD < 25 mg/L
      - TSS < 25 mg/L
      - NH₄ < 0.5 mg/L
      - TP < 1 mg/L

![Graph of Ortho-P Concentration](Ortho-P Conc. vs Time)
Enhanced Biological P Removal (EBPR) Mechanism

- **Anaerobic Zone**
  - Rapidly Biodegradable Substrate (VFAs)
  - PHB
  - Polyphosphate
  - Energy
  - P Release
  - Cell Synthesis

- **Aerobic Zone**
  - Polyphosphate
  - Energy
  - CO₂ + H₂O
  - Cell Synthesis
  - Excess P Uptake

- **DO, NO₃⁻**
EBPR Mechanism

Anaerobic

Feed condition or Battery charging

Aerobic

Starved condition or Battery discharging

Waste Sludge Loaded with P
VFAs Play a Central Role in EBPR

- VFA = Food for PAOs
  - VFA:P removed = 4:1 to 16:1

- Rapidly biodegradable COD is another estimate of VFA formation potential
  - rbCOD:P removed = 15:1 (minimum)

- Potential sources VFAs
  - Fermentation in sewer system
  - Fermentation in anaerobic zone of the bioreactor
  - Primary sludge fermentation
Requirements for Reliable EBPR

1. Consistent and adequate supply of VFAs
   - Variable supply of VFAs appear to stress the PAOs
   - Wet weather flows & high infiltration cause low VFAs
   - Recycle loads can impact VFA:TP ratio

2. Preserve integrity of the anaerobic zone
   - Critical for P release – No P release, no PAO selection

3. Maximize solids capture
   - Solids = Particulate P
     - Optimize clarifier & filter operation
     - Maximize thickening & dewatering solids capture
Aeration and the (bio-chemical) environment

- Anaerobic
- Anoxic
- Oxic

- Nitrification
- BOD removal
- ‘P’ uptake
- Denitrification
- ‘P’ release
- Fermentation

ORP, mV
Probes for Process Control

Types of Probes:

▪ Dissolved Oxygen
▪ Oxidation Reduction Potential
▪ Ammonia

Key O&M Issues:

▪ Instrument reliability
▪ Maintenance requirements (calibration, cleaning)
▪ Frequency of replacement
▪ Cost (per analyzer, SCADA)
▪ What happens to process if instrument fails?
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