Activated Sludge Process Control Made Easy
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Presentation

1. Project overview—Harry
2. Why—Eric
3. Project status—Harry

Key Abbreviations

1. FST—Final settling tank
2. MCRT—Mean cell residence time
3. SRT—Solids residence time
Northeast Ohio Regional Sewer District

• Who we are...
  • Regional wastewater utility created in 1972 by court order
  • Separate and distinct from the City of Cleveland and Cuyahoga County

• What we do...
  • Servicing all or part of 62 member communities
  • 1 million customers
  • 90+ billion gallons wastewater treated each year
Project Overview: Rehab FSTs 1-10, New FST 11, Wasting Clarifier FST 5
## Existing FST Configurations

<table>
<thead>
<tr>
<th></th>
<th>FSTs Nos. 1-6</th>
<th>FSTs Nos. 7-10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Circular</strong></td>
<td><strong>Dimensions (ft)</strong></td>
<td><strong>Gould Type II Rectangular</strong></td>
</tr>
<tr>
<td>110</td>
<td><strong>Side Water Depth (ft)</strong></td>
<td>110 x 294</td>
</tr>
<tr>
<td>12.6</td>
<td><strong>Energy Dissipating Inlet</strong></td>
<td>12.6</td>
</tr>
<tr>
<td><strong>Weir Length (ft)</strong></td>
<td><strong>RAS per tank (MGD)</strong></td>
<td>1600</td>
</tr>
<tr>
<td>937</td>
<td><strong>RAS per tank (MGD)</strong></td>
<td>Perforated Baffle Wall</td>
</tr>
<tr>
<td>25 foot dia. x 5 foot deep floc well</td>
<td><strong>Launders</strong></td>
<td>8 x 144-foot long dual-weir length launders</td>
</tr>
<tr>
<td>in-board and peripheral launders / dual weirs</td>
<td><strong>Collector Type</strong></td>
<td>(2) Traveling bridges with hydraulic siphon</td>
</tr>
<tr>
<td><strong>Organ pipe hydraulic suction removal</strong></td>
<td><strong>Collector Type</strong></td>
<td><strong>RAS per tank (MGD)</strong></td>
</tr>
<tr>
<td>5.7</td>
<td><strong>Collector Type</strong></td>
<td>19.0</td>
</tr>
</tbody>
</table>
SRT Control

• All FST 5 settled solids pumped to GBTs

• All other FST settled solids (RAS) pumped to Pass 1 at ATs

Control ML flow to FST 5: Waste all settled solids from this FST only
SRT Control

- All FST 5 settled solids pumped to GBTs
- All other FST settled solids (RAS) pumped to Pass 1 at ATs
The Prospect of Direct Discharge from Southerly’s First Stage is a Game Changer

1. Consistent effluent quality a must – therefore, sludge quality
2. Need to prevent nitrification
Growth Rate, $\mu$, Controlled by MCRT/SRT

$\mu = \frac{1}{MCRT} + \gamma + b$

Because $\gamma$ and $b$ are small

$\mu \approx \frac{1}{MCRT}$
Controlling Growth Rate in Activated Sludge is Paramount

1. Controls sludge quality—How the sludge flocculates, settles and compacts

2. Controls whether or not nitrification will occur
MCRT Controls Sludge (and Effluent) Quality and the Number of Rotifers

Relative Number of Microorganisms vs. Sludge Quality
Growth Rate of Nitrifiers Changes with Temperature
This is Reason Controlling MLSS Can Lead to Nitrification in Summer

![Graph showing the relationship between Nitrification (%) and SRT (days) for Summer, Spring/Fall, and Winter seasons. The graph indicates that the rate of nitrification increases with increasing SRT, with a steeper increase observed in the summer season.]
Calculating MCRT Can be Tedious (note there are many ways to calculate clarifier mass)

\[ \text{MCRT} = \frac{V_a \cdot \text{MLSS} + V_{\text{blanket}} \cdot TSS_{\text{blanket}}}{Q_{\text{WAS}} \cdot TSS_{\text{WAS}} + Q_{\text{EFF}} \cdot TSS_{\text{EFF}}} \]
Simplifies if $V_{\text{blanket}} \approx 0$ and $TSS_{\text{EFF}} < 10 \text{ mg/L (} \approx 0\text{)}$

$$SRT = \frac{V_a \cdot MLSS}{Q_{\text{WAS}} \cdot TSS_{\text{WAS}}}$$
Waste Mixed Liquor Instead of RAS
($TSS_{WAS} = MLSS$) ...

$$SRT = \frac{V_a \cdot MLSS}{Q_{WAS} \cdot TSS_{WAS}}$$
Wow! Greatly Simplified!

\[ SRT = \frac{V_a}{Q_{WAS}} \]

If this is so easy, why don’t we do it more often?
For the Simple Reason that the RAS is More Concentrated

\[ TSS_{RAS} = \left( \frac{Q}{Q_{RAS}} + 1 \right) \cdot MLSS \]
The Wasting Clarifier is Born!

Control ML flow to FST 5: Waste all settled solids from this FST only
Rearranging Equation to Determine $Q_{\text{WAS}}$ Needed for Target SRT

For example, if a 2-day SRT is targeted, this equation says that $Q_{\text{WAS}}$ has to be set equal to $1/2$ the on-line aeration basin volume per day.

$$Q_{\text{WAS}} = \frac{V_a}{SRT_{\text{target}}}$$
SRT Control is Easy and Elegant

1. How many aeration basins are on line?

2. What SRT is needed to not nitrify and give best sludge and effluent quality.

3. Set mixed liquor flow to $V_a/SRT_{target}$ to wasting clarifier (FST No. 5).

4. Waste all solids in underflow from wasting clarifier to GBTs

5. Return all solids from other FSTs to aeration basins; maintain low blankets
Opportunity for GBT Optimization as Well

4. Waste all solids in underflow from wasting clarifier to GBTs
Project Status
Thank you!

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Kevin Zebrowski, Southerly WWTC Asst. Superintendent
Brian Flanagan, Southerly WWTC Unit Process Manager
Mark Citriglia, NEORSD Manager of Analytical Services
Questions

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