Process Considerations for Implementation of Side Stream Short Cut Nitrogen Removal at Neuse River RRF

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Topics for Today’s Presentation

1. Bioenergy Recovery Project overview
2. Drivers for side stream treatment at NRRRF
3. Process considerations for treating high strength filtrate
4. Side stream treatment system considered
5. LIFT SEE IT Site Visits of Short-Cut Nitrogen Removal Systems
6. Next Steps
Neuse River Resource Recovery Facility

- 60 mgd, expanding to 75 mgd
- Centralized biosolids processing for all three RRFs
  - Lime stabilization, composting, and some Class B liquid land application
- Enhanced nutrient removal
- Converting to advanced digestion with Thermal Hydrolysis Pretreatment (THP)
  - Includes biogas utilization
  - Includes side stream short-cut nitrogen removal
Proposed Biosolids Process

- PRIMARY CLARIFIERS
- PRIMARY SOLIDS
- TWAS THICKENING
- BLEND TANK
- SCREENED SLUDGE
- PRE-DEWATERING
- THERMAL HYDROLYSIS
- PASTEURIZATION
- FOG RECEIVING
- SCREENINGS
- STEAM FROM BOILERS
- GAS CLEAN UP
- SIDESTREAM NITROGEN REMOVAL
- EQ
- LOW PRESSURE GAS STORAGE
- RNG PIPELINE INJECTION
- BOILERS
- FLARE
- BIOGAS
- ANAEROBIC DIGESTERS
- SLUDGE STORAGE
- FINAL DEWATERING
- CLASS A CAKE STORAGE
Visualization of the New Residuals Handling Complex (60-Percent Design Concept)
Side Stream Treatment - Drivers
Drivers for Side Stream Nitrogen Removal

- Improved VSR across digestion increases nutrient mass loadings in the sidestream. (+20%)
- Deammonification offers a reduced energy and reduce carbon pathway for nitrogen removal.
  - ~$600,000 additional O&M costs to treat in main stream process at current flows and loads

✓ No Carbon
✓ 60% less air
Side Stream will use Deammonification

- **Short-Cut Nitrogen Removal**
- **Ammonia Oxidizing Bacteria (AOB)**
  - Aerobically convert $\frac{1}{2}$ of ammonia to nitrite
- **Anaerobic Ammonia Oxidizing Bacteria (annamox)**
  - Oxidize ammonia under anoxic conditions
  - Utilize nitrite as oxygen source
- **No carbon needed**
- **Some residual NO$_3$-N**
Process Considerations for Treating High Strength Filtrate
### THP Digestate Challenges

#### High TKN
- Potential to inhibit AOBs (high free ammonia)
- Alkalinity and NH$_3$-N balance

#### High COD
- Potential to inhibit AOBs
- Increased competition between annamox and heterotrophs

#### High TP
- Increased risk for struvite formation
- Potential to react with iron (micronutrient deficiency)

#### Other Potential Challenges
- Elevated TSS, Elevated Polymer
- Diffusion Limitations
- Limited U.S. Experience
### Example Short-Cut Nitrogen Removal “Process Enhancement” Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>Dilute filtrate (≥1:1)</td>
<td>• Reduce AOB inhibition to high ammonia and COD (Figdore et al, 2011)</td>
</tr>
<tr>
<td>AOB in suspension; annamox on media (ANITA™ Mox IFAS configuration)</td>
<td>• Improve substrate diffusion (Zhao et al)</td>
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<tr>
<td>Higher operating DO</td>
<td>• Reduce oxygen diffusion limitation (Zhang et al, 2016)</td>
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<tr>
<td>Better annamox selection</td>
<td>• Increase annamox retention (Zhang et al, 2016)</td>
</tr>
<tr>
<td>Pretreat filtrate</td>
<td>• Reduces struvite potential; reduces annamox competition (Remy et al, 2016); Improves TIN removal</td>
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Proposed Side Stream Treatment Systems for NRRRF
General Process Flow Diagram – Side Stream Nitrogen Removal

1. **Anaerobic Digester**
2. **Heated Dilution Water for Dewatering (approximately 1X)**
3. **Dewatering**
   - **(Solids)**
4. **Equalization Tank**
5. **Side Stream Influent Pump Station**
6. **Heated Dilution Water (if necessary)**
7. **Side Stream Equalization Pump Station**
8. **Sidestream Bioreactor**
9. **To RAS Channel**
Deammonification Technologies Considered

- Two Recommended from PER
  - World Water Works conDEA™
  - Kruger ANITA™ Mox IFAS

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<th>WWW conDEA™</th>
<th>Kruger ANITA™ Mox IFAS</th>
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<tr>
<td>Reactor configuration</td>
<td>Flow Through</td>
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<tr>
<td>Biomass characteristic</td>
<td>Flocs and granules</td>
<td>Biofilm on media and flocs (IFAS)</td>
</tr>
<tr>
<td>Proprietary retention strategy</td>
<td>Micro-Screen and Lamella Plate Settlers or internal clarifier</td>
<td>Plastic carriers, screens, and clarifier</td>
</tr>
</tbody>
</table>

**Process Diagram**

![Process Diagram](image)
World Water Works conDEA™

- Continuous flow through process
- Annamox bacteria suspended in granular form
- MicroScreen is used to retain anammox and waste NOB
  - Selects for large anammox granules
  - 100% of flow goes through screen if clarifier upset
- Messner Panel Aeration (Fine bubble)
- Lamella clarifier or in-tank clarifier for solids separation
- Strass is running with MicroScreen configuration
- No US installations yet using revised configuration
Kruger ANITA™ Mox IFAS

- Continuous flow through process
- Anammox bacteria colonized on plastic media carriers
- Medium Bubble Aeration System
- Majority of AOBs are in the suspended phase (Zhao et al)
- Clarifier used for solids return, waste from RAS line to maintain design liquid phase SRT
- No US installations of sidestream IFAS system
New to US Marketplace: Ovivo-Paques AnammoPAQ™

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<tr>
<th>Design Info</th>
<th>AnammoPAQ</th>
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<td>Granules</td>
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<td>Proprietary retention strategy</td>
<td>Inclined Plate Settlers – weight-based selection</td>
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Figures courtesy of PAQUES / Ovivo
“The LIFT Scholarship Exchange Experience for Innovation & Technology Program (SEE IT) is an initiative spearheaded by WE&RF, WEF, and NACWA to provide scholarships for utility personnel to visit other utilities with innovations of interest and to share experiences with their peers”

http://www.werf.org/lift/LIFTSEE_IT.aspx
Technologies Visited

- **Part 1: Side Stream Short-Cut Nitrogen Removal Systems**
  - Treating high strength filtrate from anaerobic digestion process
  - Technologies incorporating recent process enhancements

- **Part 2: Biosolids Handling Processes using THP with Mesophilic Anaerobic Digestion**
  - Focus on similar sized systems
  - Using newer, modular THP reactors
conDEA™ Process at Amersfoort WWTP, NL

- Continuous flow through process
- Utilizes cyclone separator to separate / retain annamox granules
- One tank design (clarifier in middle)
- One of earliest flow-through DEMON® systems
  - Installed in 2012
  - THP, WASSTRIP, and OSTARA Processes added 2015/2016
conDEA™ Process – Key Take Aways

- Flow-through process is an attractive alternative to SBR.
- All-in-one tank configuration is a space-efficient option.
- Very important to manage filtrate quality!
  - Common take-away for all three systems.
AnammoPAQ™ Process, Olburgen, NL

- Treats potato processing + biosolids recycle streams
- Upstream phosphorus recovery process
- Continuous flow through process
- Completely granular system
- Anammox and AOB bacteria co-exist on granules (1 - 5 mm dia.)
- No RAS; Single pass operation
- Granules retained in system through inclined plate separator in tank
- Occasional “sluicing” of excess granules
AnammoPAQ™ Process – Key Take Aways

- Simple system
- Control system individualized for each application
- Higher N loading rates, but phosphorus pretreatment achieves significant sCOD reduction
ANITA™ Mox IFAS Process in Boras, Sweden

- New treatment plant under construction
- Will treat leachate + filtrate
- Filtrate will be diluted 1:1
- Continuous flow through process
- Anammox bacteria colonized on plastic media carriers
- Majority of AOBs are in the suspended phase (Zhao et al)
- Clarifier used for solids return, waste from RAS line to maintain design liquid phase SRT
• Very similar to MBBR configuration, except for:
  • Secondary Clarifier
  • RAS / WAS Pumping

• IFAS system provides some additional process control
  • SRT control
  • Lower operating DO
Next Steps for Side Stream Treatment System

- Shared LIFT SEE IT Site Visit Findings with Design Team
  - Utilized side stream site visits to assist with technical evaluation of systems being considered
- Finalized selection criteria (cost and non-cost)
- Developed weighted scoring system
- Obtained updated proposals
- Evaluated using selection criteria and weighted scoring system
- Finalized selection and moving forward with final design of side stream treatment system
Thank You!