ANITA™ Mox

The Simple, Robust Anammox Process Solution for High Strength Ammonia Streams and Deammonification

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Glenn Thesing, Kruger Inc.

Today’s Presenters

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Cary, NC

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AnoxKaldnes
Sweden

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Cary, NC
Value of ANITA™ Mox

- With fifteen (15) installations sold for sidestream treatment, ANITA Mox has proven its value:
  - **Simple**
    - MBBR \( \Rightarrow \) Flow In = Flow Out
      - No recycle streams to manage
      - No MLSS or SRT to control
      - No Separate Sludge System Needed
  - **Robust**
    - Bacteria Retained by Media and Screens
      - Variations in Dewatering Schedules and Dewatering Starts/Stops
      - High TSS and Swings in TSS
      - High Polymer Residual
      - High NO₂⁻N Residual
      - Variability in pH
  - **Reliable**
    - Process Performance Guarantees
  - **Flexible Layout**
    - Can be installed in existing tanks

Introduction to Deammonification

- Deammonification is a “short cut” nitrogen removal process
- Utilizes Anammox = ANaerobic Autotrophic AMMonia OXidizer bacteria
  - Requires both oxic and anoxic environments
- Deammonification has achieved industry acceptance as a sidestream treatment technology, treating:
  - Municipal WWTP – Liquor (centrate, pressate, etc.) from dewatered anaerobic sludge
  - Industrial process effluents
  - Landfill leachate
Sidestream ANITA™ Mox

- Reject water from sludge digestion in municipal WWTPs

- ~1-2% of WWTP influent
- 15-20% of N load
- N-NH₄⁺: 500-1500 mg/L

Sidestream ANITA™ Mox

- Nitritation
- NH₄⁺ + NO₂⁻ → AOB
- Anammox
- N₂
- Aerobic
- Simultaneous in Biofilm

- Anoxic
- Media
- Biofilm
- Liquid
- NH₄⁺
Sidestream ANITA™ Mox

- When compared to conventional ammonia removal in the mainstream WWTP
  - **Energy Savings**
    - 60% less O₂ required
  - **Capital Cost Savings**
    - Compact footprint
    - MBBR & IFAS → small tanks
    - Re-use existing tanks
  - **Operational Ease and Cost Savings**
    - No external carbon needed
    - Reduced sludge production
  - **Robust Process**
    - MBBR & IFAS media protects anammox bacteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ANITA™ Mox</th>
<th>Conventional Nitrogen Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen Requirement (lb O₂ / lb N)</td>
<td>1.9</td>
<td>4.6</td>
</tr>
<tr>
<td>Methanol Consumption (lb / lb N)</td>
<td>0</td>
<td>3.0</td>
</tr>
<tr>
<td>Sludge Production (lb VSS / lb N)</td>
<td>0.1</td>
<td>0.5 – 1.0</td>
</tr>
</tbody>
</table>

Sidestream ANITA™ Mox – MBBR Criteria

<table>
<thead>
<tr>
<th>ANITA™ Mox Influent</th>
<th>Optimal</th>
<th>Possible</th>
<th>Challenging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, °C</td>
<td>20-35</td>
<td>15-20</td>
<td>&lt;15 or &gt;35</td>
</tr>
<tr>
<td>Ammonia-N, mg/L</td>
<td>200-2,000</td>
<td>50-200</td>
<td>&lt;50 or &gt;2,000</td>
</tr>
<tr>
<td>sbCOD/N ratio</td>
<td>&lt;0.5</td>
<td>0.5-1.0</td>
<td>&gt;1.0</td>
</tr>
<tr>
<td>TSS, mg/L (avg.)</td>
<td>&lt;1,000</td>
<td>1,000-2,000</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Alkalinity, mg/L CaCO₃: NH₄-N, mg/L</td>
<td>&gt;5</td>
<td>4.5</td>
<td>&lt;4</td>
</tr>
</tbody>
</table>

* - With ANITA™ Mox only. If conditions are outside of Optimal, Possible or Challenging, treatment is still very likely possible with supplemental treatment.
Sidestream ANITA™ Mox

- ANITA Mox Configurations:
  - **Moving Bed Biofilm Reactor (MBBR)**
    - Flow In = Flow Out
    - No Downstream Clarification
    - Biological Treatment in Biofilm
  - **Integrated Fixed Film Activated Sludge (IFAS)**
    - Downstream Clarification and RAS
    - Biological Treatment in Biofilm and Mixed Liquor

- **MBBR**
- **IFAS**

Sidestream ANITA™ Mox

- **Startup of Systems**
  - Facilities are seeded with seed media (~5%) to jump start the biological process
  - Full flow achieved in two (2) to four (4) months typically
  - Multiple seed sources available
James River Treatment Plant – Newport News, VA

- Centrate Characteristics
  - $Q = 0.075$ MGD
  - $NH_3-N = 890$ mg/L
  - Temperature = 30 °C
- Retrofit of existing tank
- Startup seeded from Malmö BioFarm
- Plant has existing Hybas™ (IFAS) treatment
- Facility serves as BioFarm

James River Treatment Plant – Newport News, VA

- Process Startup Period – 30 Day Performance Test

*Source: Hampton Roads Sanitation District (HRSD)
South Durham Water Reclamation Facility – Durham, NC

- Influent Characteristics
  - $Q = 0.080 \text{ MGD}$
  - $\text{NH}_3-N = 1000 \text{ mg/L}$
  - $\text{Temperature} = 24 \degree \text{C}$
- Retrofit of existing tank
- Startup seeded from James River TP
- Facility will serve as BioFarm

South Durham Water Reclamation Facility – Durham, NC

- South Durham WRF Construction:
Egan Water Reclamation Plant – Chicago, IL

- **Details**
  - Starting in Q3 2016
  - Four (4) MBBR Reactors
  - Flow = 0.23 MGD
  - NH₃-N Load = 1,080 mg/L

- **Project Drivers**
  - Egan WRP currently pumps centrate to the O’Brien WRP
  - Energy-efficient method of treating centrate at the Egan WRP

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MBBR Pilot – Sanitation Districts of L.A. County

- **Joint Water Pollution Control Plant (JWPCP)**
  - Currently no effluent nitrogen limits

- **Nitrogen removal may be necessary in the future**
  - Regulatory (MLPA)
  - Reuse demand

- **Centrate is a nitrogen rich stream**
  - 2% of the hydraulic loading
  - 28% of the N-loading

- Targeting centrate for nitrogen removal would reduce the overall process size and cost

*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County*
MBBR Pilot – Sanitation Districts of L.A. County

Simulate a 24-hr Power Outage event

*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County

MBBR Pilot – Sanitation Districts of L.A. County

- **DMP (Dilute Mannich Polymer) in feed**
  - 13 ppm (3X typical dose)  e.g., Centrifuge startup condition
  - 44 ppm (10X typical dose)  e.g., Worst-case scenario

*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County
### Summary of Robustness and Perturbation Testing

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Scenario</th>
<th>Perturbation Period</th>
<th>Recovery Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Process power outage</td>
<td>24 hr</td>
<td>&lt; 8 hr</td>
</tr>
<tr>
<td>2</td>
<td>System underfeed mode 2</td>
<td>24 hr</td>
<td>&lt; 8 hr</td>
</tr>
<tr>
<td>3</td>
<td>System overfeed (2X)</td>
<td>24 hr</td>
<td>16 hr</td>
</tr>
<tr>
<td>4</td>
<td>Under aeration (No Air)</td>
<td>24 hr</td>
<td>32 hr</td>
</tr>
<tr>
<td>5</td>
<td>Over aeration (+23%)</td>
<td>24 hr</td>
<td>&lt; 8 hr</td>
</tr>
<tr>
<td>6</td>
<td>Mannich polymer in feed</td>
<td>Various</td>
<td>~24-32 hr</td>
</tr>
</tbody>
</table>

*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County*
Mainstream ANITA™Mox Pilot – Paris

C-stage:
- MBBR -> 500 gal (2m³), 30% fill
- Drumfilter -> 0.4m², 40μm

N-stage:
- IFAS -> 500 gal (2m³), 40% fill
- Clarifier -> 400 gal (1.5m²)
- Temp = 13-23°C

Mainstream ANITA™Mox Pilot – Paris

- NH₄ in, NH₄ out, TN out (mg/L)
- % NO₃/NH₄

Sequenced aeration:
- TNₖ = 10 mgN/L
- 80% TN removal
- % NO₃/NH₄ < 10%

Lost MLSS - Aeration issue - Sequenced Aeration
ANITA Mox has demonstrated excellent value in sidestream deammonification:

- **Simple**: Flow In = Flow Out
- **Robust**: Bacteria Retained by Media and Screens
- **Flexible Layout**: Can be installed in existing tanks at plants seeking efficient NH$_3$N and TN removal
- **Reliable**: Process Performance Guarantees

Third party testing has proven ANITA Mox’s robustness with regard to a variety of process upsets – important on the dewatering side of the WWTP
Summary and Questions

- Kruger, as a subsidiary of Veolia, brings US-based and worldwide expertise, patents, and financial stability to all of our projects.

- Veolia’s Mainstream ANITA Mox research is producing stable TN removal in multiple ongoing piloting efforts.

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Summary and Questions

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