REMOVING ORTHOPHOSPHATE AND IMPROVING DEWATERABILITY OF DIGESTED SLUDGE BY POST-DIGESTION AIRPREX® PROCESS

OWEA Biosolids Workshop
December 7, 2017

Josh Gable – Regional Sales Manager
Discussion Outline

• Quick History on CNP
• Phosphorus in WWTPs
• AirPrex Deep Dive
  • How it works
  • Review of data
  • Review of key benefits
• Bonus – CalPrex Pre-digestion recovery
• Summary
History of CNP and AirPrex

AirPrex®
Sludge Optimization
and P-Recovery
Phosphorus Flows in WWTPs - For Plants with BNR
**Phosphorus Accumulating Organisms (PAOs)**

**AEROBIC Biological Zone**

- Increased PO$_4$ uptake due to the formation of polyphosphates

**ANAEROBIC Zone / Digester**

- PO$_4$ release due to the hydrolysis of polyphosphates
Much of P either chemically bound or soluble.

P contained with PAOs
Nuisance Struvite Formation
AirPrex®
Sludge Optimization and P-Recovery
Where AirPrex Plugs In

Diagram showing the integration of AirPrex in a wastewater treatment process, including preliminary treatment, biological treatment, and final water production.
So Why There?

1. Dewatering is always the problem area for nuisance struvite formation
   - Get it to form before dewatering and eliminate the issue

2. We want to mitigate sidestream phosphorus

3. Removing the soluble P upstream of dewatering improves the cake dryness and reduced the polymer requirement
Denver Metro, CO - RWHTF

So Why There?

MAP precipitation area

Mg\(^{2+}\) in solution
How it Works

Raw Sludge (WAS & PS) → Biogas

Digester

AirPrex® Reactor

CO₂ Out, pH ↓

Magnesium-Dosage

Air stripping

Dewatering

Struvite output
How it Works

Sequestration - OPTIONAL

Struvite
## Notable Pilot Tests

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Location</th>
<th>Date</th>
<th>MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fond du Lac WWTP</td>
<td>Fond du Lac, Wisconsin</td>
<td>October 2015</td>
<td>4</td>
</tr>
<tr>
<td>Fox River Water Reclamation District</td>
<td>Elgin, Illinois</td>
<td>November 2015</td>
<td>25</td>
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<tr>
<td>Miami-Dade South District Plant</td>
<td>Miami, Florida</td>
<td>April 2016</td>
<td>128.5</td>
</tr>
<tr>
<td>Stevens Point WWTP</td>
<td>Stevens Point, Wisconsin</td>
<td>May 2016</td>
<td>3</td>
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<tr>
<td>RWH Treatment Facility at Metro WWRD</td>
<td>Denver, Colorado</td>
<td>June 2016</td>
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<tr>
<td>Sun Prairie WWTP</td>
<td>Sun Prairie, Wisconsin</td>
<td>October 2016</td>
<td>4</td>
</tr>
<tr>
<td>Tres Rios Water Reclamation Facility</td>
<td>Tucson, Arizona</td>
<td>January 2017</td>
<td>50</td>
</tr>
</tbody>
</table>
What to Expect as a Result

- Improvement Cake Dryness
  2 to 5 percentage points
- Reduction in Polymer
  10 to 40% reduction

Data Collected during Denver Metro Pilot Test, Summer 2016
What to Expect as a Result

- 90% Reduction of Sidestream OP

Data Collected during Sun Prairie, WI Pilot Test, Fall 2016

Struvite sample collected during Airprex Pilot in Miami-Dade
What to Expect as a Result

- 90% Reduction of Sidestream OP
- Subsequent Reduction in Digester TP

![Struvite sample collected during Airprex Pilot in Miami-Dade](image)

![Graph showing Concentration PO4-P (mg/L) vs Date](graph)

Data Collected during Sun Prairie, WI Pilot Test, Fall 2016
What to Expect as a Result

– Reduction in Digester influent Phosphorus as Observed at the SunPrairie, WI Pilot Test

Modeling completed by MWH based on Denver Metro Pilot

➤ Suggests 30% Reduction in Digester TP Concentration when System Reaches Steady State.
# Pilot Testing Summary

<table>
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<tr>
<th>Plant Name</th>
<th>Location</th>
<th>Date</th>
<th>MGD</th>
<th>Orthophosphate Reduction (%)</th>
<th>Dry Cake Solids Increase (%-points)</th>
<th>Polymer Reduction (%)</th>
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</thead>
<tbody>
<tr>
<td>Fond du Lac WWTP</td>
<td>Fond du Lac, Wisconsin</td>
<td>October 2015</td>
<td>4</td>
<td>&gt;90</td>
<td>+2</td>
<td>-15</td>
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<td>Denver, Colorado</td>
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<td>50</td>
<td>&gt;90</td>
<td>+4</td>
<td>-30 to -50</td>
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</table>
Example Installation

• Amsterdam, Netherlands – Installed 2014
AirPrex® - Amsterdam WWTP (Netherlands)
AirPrex® - Savings for Amsterdam
AirPrex Installations

As of June 2017 – Denver Metro Announced AirPrex Selected as Technology of Choice for their Nutrient Recovery Project

<table>
<thead>
<tr>
<th>Wastewater Treatment Plant</th>
<th>Location</th>
<th>Year Built</th>
<th>Plant Size MGD</th>
<th>Orthophosphate Reduction (%)</th>
<th>Dry Cake Solids Increase (%-points)</th>
<th>Polymer Reduction (%)</th>
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<tr>
<td>Mönchengladbach-Neuwerk (Niersverband) WWTP</td>
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<td>Wieden-Echten (Reest &amp; Wiedn) WWTP</td>
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<td>Amsterdam-West (Waternet) WWTP</td>
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<td>2014</td>
<td>170</td>
<td>&gt;90</td>
<td>+3</td>
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<tr>
<td>ASG Salzgitter North WWTP</td>
<td>Salzgitter, Germany</td>
<td>2015</td>
<td>20</td>
<td>&gt;90</td>
<td>+2</td>
<td>-15</td>
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<tr>
<td>Jing Nan Tianjin WWTP</td>
<td>Tianjin, China</td>
<td>2016</td>
<td>120</td>
<td>&gt;90</td>
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<td>Uelzen WWTP</td>
<td>Uelzen, Germany</td>
<td>2017</td>
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<td>Pending Start-Up</td>
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<td>Wolfsburg, Germany</td>
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<td>Pending Start-Up</td>
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<td>Liverpool WWTP</td>
<td>Medina, Ohio</td>
<td>2017 Start-up</td>
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<td>Pending Start-Up</td>
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<td>Little Patuxent Water Reclamation Plant, Howard County</td>
<td>Savage, Maryland</td>
<td>2017 Start-up</td>
<td>29</td>
<td>Pending Start-Up</td>
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</tr>
</tbody>
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Key Benefits of AirPrex

• Reduction of OP recycle by > 90%
• Improved Dewatering
  • 3-5% point improvement in cake DS
  • Up to 40% reduction in polymer
• Low hanging fruit, easier to implement than pre-digestion recovery technologies.
CNP CalPrex for Pre-Digestion Recovery
What is Brushite?

*Distinction of Phosphorus Minerals*

Brushite is a higher value product. Commercial value = $250 - $300 / ton versus $75 - 100 / ton for Struvite.
What is Brushite?

Distinction of Phosphorus Minerals

Brushite (dicalcium phosphate or dical) forms in slightly acidic conditions of pH 4.5 – 6.5 and is a good fertilizer. 
\[ \text{Ca}^{2+} + \text{H}_2\text{PO}_4^{-} + 2\text{H}_2\text{O} \rightleftharpoons \text{CaHPO}_4\cdot2\text{H}_2\text{O} + \text{H}^+ \]

Struvite (magnesium ammonium phosphate) forms in slightly alkaline conditions of around pH 8 and is a good fertilizer. 
\[ \text{NH}_4^+ + \text{Mg}^{2+} + \text{HPO}_4^{2-} + 6\text{H}_2\text{O} \rightleftharpoons \text{NH}_4\text{MgPO}_4\cdot6\text{H}_2\text{O} + \text{H}^+ \]

Hydroxylapatite forms under alkaline conditions of pH 9 and is NOT a good fertilizer. 
\[ 3\text{Ca}^{2+} + 2\text{HPO}_4^{2-} + x\text{H}_2\text{O} \rightleftharpoons \text{Ca}_3(\text{PO}_4)_2\cdot2x\text{H}_2\text{O} + 2\text{H}^+ \]
CNP CalPrex for Pre-Digestion Recovery
Why Acid Phase Digestion –

Soluble Ions During Anaerobic Digestion

Sample from 8 Aug 2007

Flow

Acid

Thermo

Meso

GBT Filtrate

Phosphorus precipitated with calcium and magnesium.
Phosphorus Recovery Potential

Recovery Potential (% Total P) vs. % Total P solubilized for CNP AirPrex®, Ostara Pearl®, and CNP CalPrex™.

- Post Digestion Filtrate Max
- WAS Max
- Acid Digest Max

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
CNP CalPrex Pilot
CNP CalPrex Pilot
CNP CalPrex Pilot
Key Benefits of CalPrex

• Lower chemical cost for Ca(OH)$_2$ versus MgCl$_2$
  • ~ $0.06 per lb
  • Roughly 10-20% the cost of MgCl$_2$ on a per lb. of P-removed basis

• Where acid digester used
  • Can remove highest amount of TP of currently available technologies

• Brushite has higher commercial value than Struvite
Summary

• Implementation of AirPrex
  • Reduce sidestream OP by 90%
  • Reduce digester influent TP by estimated 30% at steady state
  • Improve Cake DS by 3 to 5 percentage point
  • Reduce polymer requirement by 10 to 40%

• Implementation of CalPrex
  • TP removal rates of over 50% possible as a separate stream
  • Key to success is good P-release, best achieved via acid phase digester
  • Produce higher value fertilizer

• Combined Solution
  • Maximize TP diversion and fertilizer production while maximizing solids dewaterability