Nitrogen and Phosphorus Harvesting and Reuse

MWEA – Sustainable Energy Seminar

October 19, 2017
Agenda

- What is struvite and why recover it?
- Technologies for struvite recovery
- AirPrex piloting case studies
- Evaluation and design for St. Cloud, MN
Background
What is Struvite?

- Magnesium-Ammonium-Phosphate – MgNH₄PO₄*6H₂O
- Slow release fertilizer

Mg, NH₄ and PO₄ are present in high concentrations in certain flow streams within WWTPs.
Why Struvite Recovery?

Potential Improvement to Biosolids Dewatering

Prevent Struvite Accumulation Maintenance

Low WWTP Effluent Phosphorus Limits
Why Struvite Recovery?

Phosphorus Demand

Phosphorus Supply

Phosphorus Agronomic Application Rates
Struvite Harvesting from Sidestreams

- Ostara, Multiform Harvest, NuReSys
- Forms and removes struvite from sidestreams

Diagram showing the process flow for struvite harvesting.
Struvite Harvesting from Biosolids

- AirPrex, NuReSys
- Forms and removes struvite prior to dewatering
Nutrient Harvesting

- More technologies on the market...

- CalPrex (CNP)
- Struvia (Veolia)
- Phosphaq (Paques)
- Crystalactor
- Phosphogreen (Suez)

QuickWash
Piloting for Improved Biosolids Dewaterability
Piloting Case Study
Sun Prairie

- Major plant upgrade with startup in 2007

Pilot Test = 22% TS

Full Scale = 18% TS

%TS Cake
Currently 12-14%TS

Theories:

- Bio-P Affects Sludge Extra Polymeric Substance Characteristics (Soluble P Theory, Dr. Kopp)

- Bio-P with Anaerobic Digestion Change Makeup of Multivalent Cations in the Sludge (Divalent Cation Bridging Theory)
Piloting Case Study
Sun Prairie

- AirPrex piloted with plant’s belt filter press and with pilot centrifuge
Piloting Case Study
Stevens Point

AirPrex

NuReSys
Piloting Case Study
Stevens Point

3-5% TS Cake Increase
AND
33% Polymer Reduction
Piloting Summary

- Dewatered Cake Improvement of 2-5% TS
- Decreased Polymer Requirement
- Decreased Sidestream Phosphorus & Nitrogen Loadings
- Decreased Biosolids P Content
  - If sequestered
Site Investigations and Design for St. Cloud, MN
St. Cloud, MN

- Primary Clarifiers
- Secondary Clarifiers
- Thickening
- Anaerobic Digestion
- PSD
- WAS
- Aeration
- DSD to Liquid Storage
Nutrient Removal and Recovery Project
- Anaerobic digestion improvements
- Installation of dewatering centrifuge
- New biosolids cell lysis process

Primary Goals for nutrient recovery
- Produce valuable resource
- Reduce biosolids phosphorus content
- Reduce phosphorus recycle load
St. Cloud, MN
Biosolids or Sidestream Recovery?

Biosolids Struvite Recovery
- Reduces biosolids and recycle phosphorus concentration
- Soluble phosphorus lower than anticipated
- Product not as high value
- Product difficult to recover from biosolids
St. Cloud, MN
Biosolids or Sidestream Recovery?

- Primary Clarifiers
- Secondary Clarifiers
- Aeration
- Thickening
- Anaerobic Digestion
- Dewatering (in Construction)
- PSD
- WAS
- DSD
- Centrate
- Filtrate

Sidestream Struvite Recovery
- High value product
- Reduces biosolids and recycle phosphorus concentration
- Soluble phosphorus lower than anticipated
St. Cloud, MN
Biosolids or Sidestream Recovery?

- Lower than anticipated soluble phosphorus due to alum in primary sludge
  - Primary sludge and WAS are co-thickened and digested
  - Phosphorus is bound with alum
- Solution: Install WAS phosphorus release process to separate soluble phosphorus prior to thickening

Pre-Thicken WAS
St. Cloud, MN
Biosolids or Sidestream Recovery?

- Sidestream struvite recovery with WAS phosphorus release preferred
  - High value product
  - Maximum struvite production
  - Minimize biosolids phosphorus and recycle phosphorus

- Which sidestream struvite vendor best suits St. Cloud?
Donohue visited multiple Ostara and Multiform Harvest installations to obtain detailed information on design, operation and performance.
Struvite Precipitation

- Influent phosphate concentration, magnesium dosage and pH critical to struvite formation

- Ostara reactor has recycle to enhance production of high value pellets

- Ostara reactor requires periodic reseeding to maintain struvite pellet size

- MHI reactor designed to produce struvite without control over pellet size
Struvite Processing

- Struvite harvested from the reactors is processed and bagged into supersacks

- Ostara package typically includes dewatering, drying, sorting, storage and bagging

- Ostara has offered the City of St. Cloud bulk storage and transport (no sorting required)

- Multiform Harvest package typically includes dewatering, drying (optional) and storage
Summary

- St. Cloud found advantages and disadvantages to each process
- Request for proposal sent to Ostara and Multiform Harvest
- Vendors were competitively evaluated based on capital and life cycle costs
- Ostara selected and designed, now in construction
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