Thermal Hydrolysis Process - Pretreatment for Anaerobic Digestion, Overview and Current Status

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Objectives of today’s presentation:

• Provide overview of Thermal Hydrolysis Process (THP)
  • How does it work
  • Benefits to digestion

• Describe process, considerations

• Implementation strategies

• Status of technology implementation

• Review recent performance

THP tanks and digesters at DC Water, Blue Plains WWTP
What is thermal hydrolysis?
Definition: Pretreatment of solids to enhance hydrolysis step in anaerobic digestion

Rate limiting step for sludge digestion
Where does THP fit in the solids treatment train? Class A configuration:
Class B process configuration:
Cambi™ THP – Batch process operated with continuous flow

Foul Gas Processing, Then to Digesters

Recycled Steam

Flash Line

Dilution Water

Hydrolyzed sludge to digestion (8-12%)

Steam ~150-175 psi

Raw Solids (15-18%)

Variable Level

PULPER TANK (Pre-heat)

REACTOR STEPS
1. Reactor Fill Cycle
2. Add Steam to Reach 90 psi
3. Batch Hold Time (Class A)
4. Flash (steam explosion) to Flash Tank

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Cambi™ THP – Batch process operated with continuous flow, continued
How does THP improve digestion?

- Reduces digester size = cost and footprint savings:
  - Digester feed ~ 10% TS, compared to conventional ~ 5% TS
  - Allows for digestion at higher total solids concentrations
  - Quickly break down (hydrolyzes) solids into more digestible components
  - Stable digestion at 10 – 12 days HRT

- Produces a Class A product under specific circumstances

- Digested solids highly dewaterable – 30+% TS

- Improves visual, aesthetic appeal of dewatered, digested product
THP Process Considerations – What’s required to make this work?
Key processes to optimize THP

- Raw sludge screening
- Solids pre-dewatering ahead of THP
- Continuous and reliable steam production
- Post dilution of hydrolyzed solids
- Post THP cooling
- Foul gas management
- Final dewatering dilution
Raw sludge screening removes debris; protects THP auto valves, avoids plugging
Pre-dewatering delivers consistent feed to THP

- Output target: typically 16 – 17% TS
- Centrifuges typically used; BFPs also used
- Typical operation: Over-dewater, then “trim” TS with plant water or raw solids (thin sludge)
Continuous, reliable steam supply required for solids treatment with THP

- Frequent metric ~ 1 lb of steam required per lb of dry solids throughput (at 16 - 17 % solids feed)
- Newer systems may achieve less than 1.0 due to greater energy recycling.
- Supply steam at 175 psig
- Reactors set-point – 90 psig
Steam Production: Co-generation of steam and power

CHP at Crawly Plant, UK

Solar 50 turbines (3) at DC Water
Steam production: Boilers

• As cogen back-up
• As primary source of steam

• Consideration: Some jurisdictions require certified boiler operators for steam boilers
Post-THP dilution serves two functions

- Lower temperature to be compatible with pumping equipment
- Lower solids concentration to manage digester ammonia concentration (9 – 10%TS)
- Dilution water must be pathogen free
  - Disinfected plant water (effluent)
  - Potable water
Post-THP cooling to mesophilic temperature

- Tube-in-tube HEXs preferred
- Recirculate digesting solids (DS):
  - Mix with Thermally hydrolyzed solids (THS)
  - 3:1 DS to THS ratio
- Turbulent velocity through sludge tubes is critical
Foul gas from THP reactors must be managed

- Small leakage from reactors, pipes, pumps is expected
- Odor potential is very high
- Management through –
  - Containment and collection
  - Condense
  - Pump to digesters
Final dewatering produces desirable biosolids product
Final dewatering - considerations

- Belt filter presses (BFPs) most common; centrifuges also used
- Relatively high concentration of DS to dewatering (5 - 6% TS) –
  - Impacts polymer mixing and flocculation
  - Dilution of BFP feed improves polymer effectiveness
  - Dilution water may be filtrate or other pathogen free source
- Belt wash water must be pathogen free
- Filtrate high in ammonia content –
  - Collect separately from wash water
  - Send to recycle treatment where effluent nitrogen limits apply
How do I get one of these?

- Status of the technology
- Who are the vendors?
- THP projects in North America
- Procurement methods

Cambi Thermal Hydrolysis Facilities at Cardiff, UK
As of 2017, 6900 dry tons/day THP capacity in some phase of implementation
Vendors offering thermal hydrolysis processes

• Cambi:
  • by far the most installations operating and/or in design/construction
  • Wide range of capacities and feedstock

• Veolia
  • Exelys – continuous flow; Not yet certified as a Class A process
  • Biothelys – batch

• Others with few and/or small installations; none in North America
Cambi systems represent 85–90% of installed THP systems worldwide

- Norwegian firm
- Independent; not a subsidiary
- THP developed through application of science and lessons learned
- BC’s experience with Cambi – collaborative, but . . .
- Mark II is standardized product line
Cambi Mark II, B6 system

• Uses 6 cubic meter reactors
• B6-3 (70 dtpd capacity)
• B6-4 (93 dtpd capacity)
• Modular construction – built at Cambi’s fabrication facility in UK
## Thermal hydrolysis status in North America

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<th>Agency / Owner</th>
<th>Year THP Selected</th>
<th>Cambi System (# of trains)</th>
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DC Water Performance

• 4 years continuous, full-scale operation
• Average 65% VSR
• Average 300 – 330 dtpd throughput

10MW power production
DC Water Performance, continued

- Approximately 60% reduction in biosolids truck traffic
- Eliminated lime usage/delivery
- DC Water marketing biosolids product as Bloom™

Biosolids Facilities, DC Water
Procurement of THP technology

• THP is a process, not an equipment item
• If desired, sole source procurement can be justified on experience, installed systems, capacity
• Limited opportunity to customize:
  • Capacities vary as step function with number of reactor vessels
  • Can accommodate Owner standards for controls, electrical, and some mechanical components
• Vendor scope of supply may be tailored to needs of project
Summary

- Thermal hydrolysis is an established process for pre-treatment solids to enhance anaerobic digestion
- Significant digestion benefits achieved through THP:
  - Greater VSR and digester gas production via smaller digesters
  - Class A digested solids via appropriate process configuration
- Improved cake product:
  - Higher cake solids
  - Low cake odor
  - Debris free
- Support systems for THP are significant
- Cambi has by far the most THP installations
- Growing list of applications in North America
Questions?

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Belt presses produce high quality product
How does it work? Combination of temperature and pressure (Cambi™)

1. Solids are dewatered to ~17%, then sent to Pulper

2. Solids mixed with return steam and Water

3. Solids are heated by direct steam addition to 320°F and 90 psi for 30 minutes

4. Pressure in reactor is reduced to 60 psi.
   - Steam is returned to Pulper

5. Reactor pressure is rapidly released, flashing solids to the flash tank.

To Cooling and anaerobic digestion

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Source of supplemental digester heat is required

• During Start-up, while THS feed is low (ramping up) and digester shell losses are constant

• During periods when THS feed is suspended (process reasons, maintenance/repair, etc.)

• Steam injection provides supplemental heat:
  • Inject into recirculating digested solids loop
  • Special steam injector is required