Overview

• How are Biosolids Used?
• What are End Use Considerations?
• Intro to thermal hydrolysis
• Case Studies:
  • DC Water
  • San Francisco PUC
• Conclusions
Biosolids Products and Markets

Biosolids Products:
- Cake (Class A or Class B)
- Dried Product
  - Pellets
  - Granules
- Compost
- Soil Blends
- Char
- Ash

Biosolids Markets:
- Bulk Agriculture
- Landscaping/horticulture
- Municipal projects
- Golf courses
- Fertilizer blending
- Redevelopment
- Energy
How are Biosolids Used?

EPA Regions

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

1 2 3 4 5 6 7 8 9 10

Othe Incineration Surface Disposal Land Application

Courtesy: Robert Bastian, US EPA
End Use Considerations

• Product vs. technology
• Accessible markets
• Degree of flexibility and diversity desired
• Risk perception
• Product consistency

“Cake production decreased to less than half, from a total of 19,600 tons in 2004 to 9500 tons in 2006”
Different Processes Generate Different Product Quality

Example: Cambi Thermal Hydrolysis

- Granular, Class A biosolids
- Easily stored and land-applied
- Low odor
- Higher value products are possible

Bottom line: Working with an end product that can access more markets can stabilize product costs long-term
Cambi™ Thermal Hydrolysis Process (Mark II)

1. In-Reactor Fill Cycle
2. Add Steam to Reach 90 psi, 320°F
3. Batch Hold Time (Class A)
4. Flash (steam explosion) to Flash Tank

Foul Gas Processing, Then to Digesters

Raw Solids (15-18%)
Variable Level

Recycled Steam
Flash Line

Dilution Water

Flash Tank
Variable Level

Hydrolyzed sludge to digestion (9-12%)

REACTORS

1. In-Reactor Fill Cycle
2. Add Steam
3. Batch Hold Cycle
4. Flash Cycle

Flash Line
Steam ~150-175 psi

PULPER TANK
(Pre-heat)

Dilution Water
Why the Attention on the Thermal Hydrolysis?

• Extensive research showing TH Benefits (Haug et al, 1978 and others)
  • Greater digestion performance - more biogas/energy and less solids for disposition
  • Improved dewatered cakes
  • Allows thick digester feed, with low viscosity slurry
  • <half typical digestion tankage is required

• Easily meets EPA Class A time/temp if batch/plug-flow
  • 140° to 180° C for 20 to 30 minutes
  • This is “sterilization”, not pasteurization
THP Vendors and Offerings are Expanding

**Cambi™**
- 1995 initial plant (Hias Norway)
- Most systems are batch (Class A)
- Currently, 29 plants operating world-wide and additional plants are in design and construction
- World’s Largest THP/digestion at DC Water (370 mgd) was started in Fall 2014, operating well
- Reactor sizes: 2, 6, and 12 cubic meters
- Sole-sourced at DC Water and HRSD, and won Franklin, TN competitive selection process

**Veolia - BioThelys™**
- Batch THP system – installed at a few plants in Europe (LD configuration)
- Two larger systems are now in startup in the UK
- Not being marketed in the US

**Veolia/Krüger - Exelys™**
- Uses plug flow arrangement – i.e., “continuous” flow reactor
- Installed at a few small or demonstration plants in Europe (DLD configuration)
Thermal Hydrolysis Digested Dewatered Products from the UK

- 30% solids
- Very stable
- Class A
- No debris
- Low odor
TH/Digestion Cake Odor from Field Sites

Mean Headspace Detection Threshold (dilutions to threshold)

- THP with Centrifuge Dewatering
- THP with BFP Dewatering
- Conventional MAD with Centrifuge Dew

Thermal Hydrolysis Processes

Conventional Mesophilic
Case Study: DC Water

- Class B lime stabilized biosolids, spread and stored across Virginia
- Public opposition to biosolids land application
- Potential for regulatory changes to biosolids land application
- High energy and disposal/reuse costs
- Earlier digestion project cancelled due to high capital costs
Re-Evaluation of Biosolids Alternatives in 2007 used Updated Research/Information

- DC Water recognized the need for biosolids product improvement and diversification over time

- 12 Alternatives developed/evaluated
  - Various anaerobic digestion processes
  - Digestion pretreatment including TH
  - Thermal drying options
  - Many options used existing lime stabilization capacity to handle peak/abnormal events

- Employed expert panel as part of the evaluations
Biosolids Program Drivers

**DC Water**

- Reestablish a digestion/energy program at Blue Plains that has long term sustainability
- Greatly reduce biosolids volumes
- Produce a low odor, well dewatered biosolids product with potential for “beyond-ag” uses
- Produce renewable power to offset plant energy needs
- Achieve Class A biosolids

Brown and Caldwell
Preserving Cake Quality - Belt Filter Presses Selected over Centrifuges

• Detailed business case evaluation of BFPs vs. centrifuges

• Both technologies achieve ~30% solids

• BFPs use less energy

• Net present value of options was similar - space requirements also similar

• No regrowth with either, but odor regrowth potential with centrifuge

• BFP pilot testing in U.K. on Cambi/digested feed – to determine parameters for design
Preserving Cake Quality - Minimizing Cake Conveyance

- A mantra at DC Water!
- Cake drops directly into cake bins
- Pre-dewatered cake pumped minimum distance to THP trains
- Final Dewatering (BFP) cake—single belt conveyor to loadout

![Diagram](image.png)
Win-Win Project: DC Water

- Thermal hydrolysis (Cambi) facilities on-line
- Produce 13 MW electricity through combined heat and power
- Anticipate further program savings through generation of a marketable soil blend
- Estimated 50,000 metric ton reduction in CO2e emissions

Savings on end use: No net impact on ratepayers
Case Study: San Francisco

- Class B biosolids through anaerobic digestion, used in land application and landfill cover
- Regulatory and public pressure on both available outlets
- Rising end use management costs
- Vulnerable, aging solids handling infrastructure
Case Study: San Francisco

• Upgrades at two treatment plants to Class A processes

• Diversification of end uses through planned product marketing within the Bay Area

• Near-term exploration of regional collaborations for Class A and biosolids-to-energy interim options
Summary: Higher Value Products Can Reduce Program Costs

- Cambi or other Class A processes can be the basis for a higher value product (e.g. DC Water soil blend)

- Marketable products can introduce diversity to your biosolids portfolio, decreasing end use risk
Summary: How Does Upgrading Biosolids Treatment Help?

Improve process reliability
• Produce a higher quality, potentially less odorous product
• Perception of decreased public health risk
• Potential to decrease overall program management costs (e.g. improved dewatering, decreased product quantity, reliable access to end use sites)

Class A products allow access to a broader range of markets

Creating opportunities for diversification can help control long-term risks and costs

Introduction of new/different product in the biosolids marketplace can create a “niche” and create a unique market advantage
Questions?

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

2. Solids mixed with return steam

3. Solids are heated by direct steam addition to 320° F and 90 psi for 30 minutes
   - Class A time vs temp.
   - Organic compounds are solubilized

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

5. Reactor pressure is rapidly released, flashing solids to the flash tank.
   - Flushing causes cells to rupture
   - Steam is returned to Pulper Tank
   - Hydrolyzed solids have reduced viscosity

Class A biosolids
Reduced volume
- 30% solids cake
- 60% V.S. destruction

~10% solids digester feed at 100° F

Methane

Dewatering

Anaerobic Digester