How to Participate Today

• Audio Modes
  • Listen using Mic & Speakers
  • Or, select “Use Telephone” and dial the conference (please remember long distance phone charges apply).
• Submit your questions using the Questions pane.
• A recording will be available for replay shortly after this webcast.

Today’s Moderator

Fred Edgecomb
Gilbert Neely Wastewater Reclamation Facility Project Manager
Today’s Speakers

Matthew Higgins, Ph.D.  
Professor, Civil and Environmental Engineering  
Bucknell University

Matt Van Home, P.E.  
Hazen and Sawyer

Peter Loomis, P.E.  
CDM Smith

Dave Parry, Ph.D.  
C2HM

Anaerobic Digestion 101

Matthew Higgins, Ph.D.  
Claire W. Carlson Chair in Environmental Engineering  
Bucknell University  
Lewisburg, PA 17837
Why Anaerobic Digestion?

One of the approaches to meeting EPA 503 Requirements for biosolids:

1. Vector Attraction Reduction (VAR) requirements
   - reduces the organics in the sludges so it is ‘stable’

2. Reduces pathogens
   - Meets EPA Requirement as
     “Process to Significantly Reduce Pathogens”
**Why Anaerobic Digestion?**

3. Produces a renewable energy source – biogas (55-70% methane) uses:
   - Combined heat and power systems (CHP)
   - Digester heating
   - Vehicle fuel
   - Put into natural gas grid

4. Produces an excellent soil amendment product, rich in:
   - Carbon
   - Nitrogen
   - Phosphorus
   - Micronutrients

---

**Big Picture of Anaerobic Digestion Process**

1. Organics In
2. Microbial Degradation of Organics
3. Biogas Out (CH$_4$ + CO$_2$)
4. Organics Out
Organics In

<table>
<thead>
<tr>
<th>Feed Stocks</th>
<th>Typical Feed Total Solids Concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Activated Sludge (WAS)</td>
<td>4-6%</td>
</tr>
<tr>
<td>Primary Sludge (PS)</td>
<td>4-6%</td>
</tr>
<tr>
<td>Primary/Secondary Blends</td>
<td>4-6%</td>
</tr>
<tr>
<td>Food Wastes</td>
<td>5-15%</td>
</tr>
<tr>
<td>Fats, Oils and Grease (FOG)</td>
<td>Highly variable</td>
</tr>
<tr>
<td>Lots of other organic wastes</td>
<td>variable</td>
</tr>
</tbody>
</table>

Microbial Conversions

Particle Disintegration → Hydrolysis → Fermentation (acidogenesis)

Organic Particles (floc) → Complex Polymers Proteins, Carbohydrates and Lipids → Amino Acids, Sugars, Fatty Acids → Acetate, Propionate, Butyrate, Valerate, $H_2$ → Volatile Fatty Acids and Hydrogen Gas ($H_2$)
**Microbial Conversions**

Aceticlastic Methanogenesis:

\[ \text{CH}_3\text{COOH} \rightarrow \text{CO}_2 + \text{CH}_4 \]

Hydrogenotrophic Methanogenesis:

\[ \text{H}_2 \rightarrow 2\text{H}_2\text{O} + \text{CH}_4 \]

Typical Parameters for Expressing Degradation:

1. **Volatile Solids Reduction (VSR)**

\[ \text{VSR} = \left( \frac{\text{Mass of VS in} - \text{Mass of VS out}}{\text{Mass of VS in}} \right) \times 100^\circ \]

**Microbial Degradation**

- Volatile Solids Reduction (VSR)
- Chemical Oxygen Demand Reduction (CODR)
Microbial Degradation

**VSR by Van Kleek Equation**

- Van Kleek assumes inert solids are constant in and out of the digester, no settling of grit
- Inert Solids = TS – VS (also called 'fixed' solids or ash')
- Equation uses the volatile solids fraction (VSF) = $\frac{\text{VS}}{\text{TS}}$

\[
\text{VSF}_{\text{in}} = \frac{\text{VS}_{\text{in}}}{\text{TS}_{\text{in}}}

\text{VSF}_{\text{out}} = \frac{\text{VS}_{\text{out}}}{\text{TS}_{\text{out}}}
\]

**Volatile Solids Reduction by Van Kleek Equation**

\[
\text{VSR by Van Kleek} = 100 \times \left( \frac{\text{VSF}_{\text{in}} - \text{VSF}_{\text{out}}}{\text{VSF}_{\text{in}} - (\text{VSF}_{\text{in}} \cdot \text{VSF}_{\text{out}})} \right)
\]
Typical VSRs

<table>
<thead>
<tr>
<th>Feed Stocks</th>
<th>VSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Activated Sludge (WAS)</td>
<td>25-40%</td>
</tr>
<tr>
<td>Primary Sludge (PS)</td>
<td>40-65%</td>
</tr>
<tr>
<td>Food Wastes</td>
<td>75-85%</td>
</tr>
<tr>
<td>Fats, Oils and Grease (FOG)</td>
<td>80-95%</td>
</tr>
</tbody>
</table>

Operational Parameters Affecting VSR - SRT

Sols Retention Time (SRT) = average time a particle spends in the digester

\[
SRT = \frac{V}{Q}
\]

Primary Sludge

Waste Activated

Typical Design & Operation Range

SRT (d)
Operational Parameters Affecting VSR -
Temperature

Mesophilic Range: 25-45 °C
Thermophilic Range: 50-65 °C

Typical Mesophilic Operating Temperature
35-38 °C
Digester Operational Parameters

Organic Loading Rates

Volatile Solids Loading Rates = mass of VS fed per day per unit volume of digester.
Typical “Textbook” Values:

a. kg VS\textsubscript{in} per day per cubic meter of digester volume (1-3 kg VS/d-m\textsuperscript{3})
b. lb VS\textsubscript{in} per day per cubic ft of digester volume (0.06-0.30 lb VS/d-ft\textsuperscript{3})

OLR don’t consider:

a. What is in your digester
b. Nature of wastes
c. Operational conditions

Higher OLRs can be readily achieved with good operations

Digester Operational Parameters

Specific Organic Loading Rates

Specific Organic Loading Rate considers ‘biomass’ in digester

= grams of COD\textsubscript{in} per day, per gram of VS in digester

Current Guideline:

\[ \text{SOLR} = \frac{g \text{COD}_{\text{in}}}{d \cdot g \text{VS in digester}} < 0.3 \]
Anaerobic Digestion Operational Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Importance</th>
<th>Stable Operating Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Master variable for digester operation</td>
<td>6.7-7.8</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>Helps buffer pH changes</td>
<td>&gt;1000 mg/L as CaCO₃</td>
</tr>
<tr>
<td>VFAs or VAs</td>
<td>Increase in concentrations an indicator of potential upset</td>
<td>&lt;300 mg/L</td>
</tr>
<tr>
<td>VA/Alkalinity Ratio</td>
<td>Ratio of Volatile Fatty Acids to Alkalinity Ratio, increases mean process changes</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Biogas Composition (CH₄/CO₂ Ratio)</td>
<td>Decreases in CH₄ content can mean process changes and inhibition</td>
<td>&gt;55%</td>
</tr>
</tbody>
</table>

Stoichiometry of Anaerobic Digestion

**Theoretical General Equation (Buswell, 1952)**

\[ C_{n}H_{a}O_{b}N_{c} + H_{2}O \rightarrow xCH_{4} + yCO_{2} + zHCO_{3}^{-} + zNH_{4}^{+} \]

- Organic Feedstock
- methane production
- biogas production
- digester pH
- digester alkalinity
- potential inhibition

x, y and z are a function of n, a, b, and c
### Stoichiometry of Anaerobic Digestion

<table>
<thead>
<tr>
<th>Type</th>
<th>Formula</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Activated</td>
<td>$C_{6.6}H_{12}O_{2.4}N$</td>
<td>Bucknell Data (average of 8 plants)</td>
</tr>
<tr>
<td>Primary Sludges</td>
<td>$C_{17}H_{31}O_{7.2}N$</td>
<td>Bucknell Data (average of 5 plants)</td>
</tr>
<tr>
<td>Food Waste</td>
<td>$C_{17}H_{30}O_{6}N$</td>
<td>Bucknell Data (average of 3 different FWs)</td>
</tr>
<tr>
<td>Fats</td>
<td>$C_{16}H_{32}O_{2}$</td>
<td>Rittman and McCarty</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>$C_{6}H_{10}O_{5}$</td>
<td>Rittman and McCarty</td>
</tr>
<tr>
<td>Protein</td>
<td>$C_{16}H_{24}O_{5}N_{4}$</td>
<td>Rittman and McCarty</td>
</tr>
</tbody>
</table>

### Biogas Production

<table>
<thead>
<tr>
<th>Feed Stock</th>
<th>Methane Yield (\frac{L \text{ CH}<em>4}{kg \text{ VS}</em>{\text{destroyed}}})</th>
<th>Methane Yield (\frac{L \text{ CH}<em>4}{kg \text{ VS}</em>{\text{feed to digester}}})</th>
<th>VSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Sludge</td>
<td>660</td>
<td>360</td>
<td>55%</td>
</tr>
<tr>
<td>Waste Activated</td>
<td>625</td>
<td>250</td>
<td>40%</td>
</tr>
<tr>
<td>Food Waste</td>
<td>650</td>
<td>560</td>
<td>80%</td>
</tr>
<tr>
<td>FOG (Fats, Oil, Grease)</td>
<td>980</td>
<td>880</td>
<td>90%</td>
</tr>
<tr>
<td>Sugars</td>
<td>440</td>
<td>400</td>
<td>90%</td>
</tr>
<tr>
<td>Protein</td>
<td>580</td>
<td>520</td>
<td>90%</td>
</tr>
</tbody>
</table>
Notes on EPA Regulatory Requirements

Class B Biosolids:
- assumes pathogens are present
- site restrictions are used for land application to ensure public safety
- product is stable, vector attraction reduction is met

Several Options for Demonstrating Class B Requirements
1. VSR > 38% for vector attraction reduction
2. Monitor fecal coliforms: < 2 million per gram dry solids
3. Demonstrate digestion meets time and temperature requirement = 15 days at > 35 °C

Notes on EPA Regulatory Requirements

Class A Biosolids:
- pathogens levels below detection
- no site restrictions for beneficial reuse
- stable product that meets vector attraction reduction

Several Options for Demonstrating Class B Requirements
1. >38% VSR for vector attraction reduction
2. Monitor fecal coliforms: < 1000 per gram dry solids
3. Monitor Salmonella: < 3 MPN/gram dry solids
Summary

Anaerobic digestion is a sustainable approach to treating organic wastes:
• produces renewable energy
• produces a product that recycles organics and nutrients
• can be used to meet EPA requirements for biosolids
• stable operations require regular monitoring and good practices

Matt Van Horne, PE

• 14 years experience
• Specializes in biosolids, energy management and wastewater treatment facilities
• Principal Investigator for WE&RF project on the operational impacts of co-digestion
Agenda

• What is co-digestion?
• Why consider co-digestion?
• System configuration
• System control
• Lessons learned

What is Co-Digestion?
Co-Digestion at a WRRF

Primary Sludge → Anaerobic Digester → Waste Activated Sludge → External Organic Materials

What Are Possible External Sources of Material?

- Fats/oils/grease (FOG)
- Pre-consumer food waste
- Post-consumer food waste
- Industrial waste organics
What Are Possible External Sources of Material?

Why Consider Co-Digestion?
First Let’s Take a Step Back…

Digester feedstocks → Digester gas

- Carbohydrates
- Fats
- Proteins

Hydrolysis Stage

- Sugars → Fatty Acids → Amino Acids

Acidogenesis

- Hydrogen Acetic Acid
- Carbon Dioxide
- Ammonium

Acetogenesis

- Methane

Methanogenesis

Increasing Gas Production

- More incoming organics can result in more digester gas produced
- More change the economics of beneficial utilization
Increase Utility Revenue

- Tipping fees
- More biosolids to sell
- More energy to sell externally

Collection System Benefits

- Remove problematic materials (FOG) from collection system with appropriate outlet
System Configuration

Overall System Components

- Truck Unloading
  - Depackaging and Slurrying
  - Screening and Debris Removal
  - Grinding and Macerating
- Heating
- Storage
Truck Unloading

Depackaging/Slurrying
Screening/Debris Removal

Grinding/Macerating
Heating

Storage
Feeding

Sample FOG Facility
Sample FOG Facility

Sample Food Waste Facility
Digester Considerations

- Increased solids content - mixing
- Increased organic loading - gas handling and foaming/RVE control
- Digested solids production

Key Points

- Can be many new steps
- Harsh characteristics of material
- Odor management
- Design for reliability
- Design for maintenance access
System Control

What Are We Really Trying to Control?

• Digester performance is key
  ▪ Loading rates
  ▪ Quality of materials for digestion
  ▪ Mixing system performance
How Do We Monitor and Control This?

• Feedstock monitoring
  ▪ pH
  ▪ Total solids
  ▪ Volatile solids
  ▪ Toxicity
• Take samples from each batch received!

How Do We Monitor and Control This?

• Digester monitoring
  ▪ pH
  ▪ Volatile acid concentrations
  ▪ Alkalinity
  ▪ Foaming
  ▪ Temperature
  ▪ Feed rates
  ▪ Volatile solids
But What Does This Really Mean?

• Continue normal digester monitoring and sampling
  ▪ Maybe small expansion of parameters
• Become familiar with received materials
  ▪ Understand how the digesters react to different materials
  ▪ Can be simple flow rate control

Lessons Learned
**WE&RF Has a Significant Research Program on Co-Digestion**

<table>
<thead>
<tr>
<th>Ongoing Projects</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Balance and Reduction Opportunities, Case Studies of Energy Neutral Wastewater Facilities and Topic Bottom Line (TBL) Research Planning Support</td>
<td>ENERGY112</td>
</tr>
<tr>
<td>Identification of Barriers to Energy Efficiency and Resource Recovery at WWTPs and Solutions to Process these Barriers</td>
<td>ENERGY113</td>
</tr>
<tr>
<td>Developing Solutions to Operational Side Effects Associated with Co-Digestion of High-Strength Wastewater</td>
<td>ENERGY114</td>
</tr>
<tr>
<td>Low Energy, Alternative for Aerated Sludge, Advancing Anaerobic Membrane Bioreactor Research</td>
<td>ENERGY112</td>
</tr>
<tr>
<td>Research to Advance Energy Production and Recovery from Wastewater and Solids</td>
<td>ENERGY120</td>
</tr>
<tr>
<td>State of the Science and Issues Related to Heat Recovery from Wastewater</td>
<td>ENERGY120</td>
</tr>
<tr>
<td>Guidelines for Utilities Wishing to Conduct Pilot Scale Demonstrations</td>
<td>ENERGY120</td>
</tr>
<tr>
<td>Co-digestion of Organic Waste - Addressing Operational Side-effects</td>
<td>ENERGY120</td>
</tr>
<tr>
<td>Co-digestion of Organic Waste - Addressing Operational Side-effects</td>
<td>ENERGY120</td>
</tr>
</tbody>
</table>

**Detailed Survey**

[Map of the United States with markers indicating survey locations]
What Do Plants Monitor?

How is Digester Feed Controlled?
**Additional Time Spent at Digestion**

![Bar chart depicting additional time spent at digestion](chart.png)

**Future Work Efforts for Co-Digestion**

- There is no standard approach to monitoring co-digestion systems;
- Operational impacts vary widely based on the type and quantity of material co-digested;
- Few major operational impacts were reported; and,
- The industry would benefit from additional guidance for how to best manage operations of co-digestion facilities.
Questions and Answers

Matt Van Horne, P.E.
mvanhorne@hazenandsawyer.com
703-267-2738

Thermal Hydrolysis Operating Considerations

Peter Loomis, PE
- 29 years experience in wastewater and biosolids
- Led commissioning, startup and 2 years of operations at Blue Plains for TH/Digestion
- Oversaw installation/commissioning of Ringsend TH/Digestion expansion in 2008
Thermal Hydrolysis Operating Considerations

Agenda
1. Thermal Hydrolysis - Background and History
2. Operations at DC Water
3. TH/Digestion Operating Results
4. Lessons Learned

Thermal Hydrolysis - Background and History

Thermal Hydrolysis (THP) is a process by which sludge is heated and pressurized with the purpose of reducing organic solids to make them more readily biodegradable....

In other words, it's a pressure cooker.
Why THP?

- Class A biosolids
- Increased downstream processing capacity
- Increased VSR biogas
  - Projected 10-15% VSR increase
  - Reduced digested solids production
  - Potential energy neutrality
- Increased cake solids content
  - 10% increase
- Reduced digester foaming
  …and reduced odor

Lower Odor of THP Biosolids Could Open Product Use Opportunities

Source: Murthy, 2012
THP System Overview

**THP Background - History**

- First full scale THP system commissioned in 1995 by Cambi
- HIAS plant Lillehammer, Norway
- Original vessels are still in operation
- Kruger/Veolia 1st pilot plant 2004 (Biothelys) full scale - 2009.
- Kruger/Veolia 1st Exelys plant 2014
- First US Installation - DC Water Operational October 2014 (Cambi)
- 8 US THP Facilities in planning/design/construction
**THP Background - Manufacturers**

- Cambi ~50 facilities. 1 in US. 8 Additional in US in next 3 years.
- Veolia/Kruger 2 types
  - Biothelys - continuous batch ~7 facilities + 1 US pilot
  - Exelys - continuous 2 facilities + 1 demonstration
- Sustec - 2 full scale, 3 pilot
- Haarslev - 2 pilot scale plants

**DC Water: First Operating THP Facility in North America**
DC Water: Operations

• Implemented THP/digestion with seeding beginning in October 2014
• Full throughput in February 2015
• Full acclimatization in late 2015
• Temporary approval for Class B land application February 2015
• Approval for Class A land application in May 2016

DC Water: Operations Controls

• Key Control Issues
  ▪ Feed Concentration
  ▪ THP Feed Rate
  ▪ Reactor Temperature
  ▪ Dilution Control
  ▪ Digester Temperature Control
  ▪ Steam Pressure
DC Water: Biosolids Operating Results

- VSR 65% to 70% (January to June 2016)
- SRT/HRT at ~20 days
- Fecal coliforms <5 MPN/Gram
- Approximately 500 wet tons per day produced
- Generating 8 to 10 MW of power
- Waste heat from power generation providing steam

DC Water: Daily Feed Rates

Average Mass Feed Rate = 303 DTPD
Average SRT = 21 days
DC Water: Volatile Solids Reduction

Average Feed VS = 81%
Average VSR = 68.5%

DC Water: Solids Concentration in Digesters

- Digester 1
- Digester 2
- Digester 3
- Digester 4
DC Water: Dewatered Solids Concentration

- Dewatered solids ~32%
- Polymer use ~20 to 22 lbs/ton

DC Water: Meeting and Exceeding Class A Requirements

- Average Fecal Coliform <5 MPN/gram
- Max Fecal Coliform 72 MPN/gram
Digester Ammonia

Digester Settling

1 minute 90 minutes 4 hours
Hydrolyzed Sludge Settling

1 minute 90 minutes 28 hours

Sludge Cooling

DC Water

• Approach
  ▪ 2 Cooling HEX & 1 Tuning HEX per digester
  ▪ Cooling HEX cools incoming solids
  ▪ Tuning HEX provides “trim” cooling of digesting solids

• Results
  ▪ Cooling HEX Maintain Digester Temperatures
  ▪ Tuning HEX loses significant heat in winter
Cooling Water

- DC Water
  - Plant Effluent (10 MGD Pump Station)
  - Maximum Water Temp. of 81°F
  - Chlorine addition to prevent bio-fouling
  - Apparent precipitate fouling of water side
  - Microbially Induced Corrosion

Lesson Learned:
Cooling water supply is critical for conceptual design

Digesters

- Draft Tube Mixing
- Rapid Rise Control via overflow to ground
- No supplemental gas storage
- No Field Analysis Capabilities
DC Water: Operating Issues

• Mechanical Issues
  ▪ Rotary Lobe Pumps
  ▪ Cake Bin Gates
  ▪ Centrifuge Solids Control
  ▪ Wear on Mechanical Equipment

• Process Issues
  ▪ Vivianite
  ▪ Grit
  ▪ Foam
  ▪ Odors

• Support Equipment Issues
  ▪ Steam Pressure
  ▪ Flare Exhaust Results
  ▪ Dilution Control

DC Water: Results and Observations Summary

Solids throughput approximately doubled standard mesophilic digesters
Concentration in digesters exceeds 5%
Little or no foam with reactors at 165°C
Digesters resilient to feed changes
At 50% Primary/50% Secondary Solids VSR improved by 20% to 30% (50% VSR to 65% VSR)
Gas yield proportionally higher with VSR
Digested solids release water better
Low odor from digested/dewatered solids after 24 to 48 hours
Questions?

Peter M. Loomis, PE
703.691.6442
loomispm@cdmsmith.com
Why Thermophilic Digestion?

- Increased digester capacity
- Class A Biosolids when time temperature requirement is met
- Cost savings from fewer digesters
- Meet site constraints

What is Thermophilic Digestion?

Mesophilic
95 to 98 °F (35 to 37 °C)

Thermophilic
125 to 140 °F (52 to 60 °C)
Single-Stage or Multiple-Stage

Continuous versus Batch Thermophilic Digestion
Temperature-Phased Anaerobic Digestion (TPAD)

Advantages                          Disadvantages
• Increased digester capacity
• Increased solids destruction
• Greater biogas production
• Possible decrease in hydrogen sulfide in biogas
• Improved biosolids quality
• Class A biosolids with batch process
• Higher operating temperatures
• Increased heat demand
• Requires more heat exchangers
• Possible increase in siloxanes in biogas
• Increased odor at dewatering
Converting from Mesophilic to Thermophilic

- Digesters must be able to structurally handle thermophilic temperatures
- Additional heat exchangers are required for sludge heating
- Heat recovery exchangers may be added for energy efficiency
- Digester heating system must be able to supply more heat at a higher temperature

Targeted Parameters for Digester Monitoring

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.8 to 7.7</td>
</tr>
<tr>
<td>Temperature</td>
<td>Mesophilic 35 deg C (95 deg F)</td>
</tr>
<tr>
<td></td>
<td>Thermophilic 55 deg C (130 deg F)</td>
</tr>
<tr>
<td>Volatile Solids Reduction</td>
<td>greater than 50%</td>
</tr>
<tr>
<td>Volatile Acids (VA)</td>
<td>less than 1,000 mg/L</td>
</tr>
<tr>
<td>Alkalinity (ALK) as CaCO₃</td>
<td>Mesophilic: greater than 1,000 mg/L</td>
</tr>
<tr>
<td></td>
<td>Thermophilic: greater than 2,000 mg/L</td>
</tr>
<tr>
<td></td>
<td>less than 2,000 mg/L NH₃-N</td>
</tr>
<tr>
<td>Ammonia</td>
<td>less than 2,000 mg/L NH₃-N</td>
</tr>
<tr>
<td>VA/ALK Ratio</td>
<td>less than 0.2 or declining</td>
</tr>
<tr>
<td></td>
<td>(preferred under 0.1)</td>
</tr>
<tr>
<td>CO₂ in Digester Gas</td>
<td>less than 40% by volume</td>
</tr>
<tr>
<td>CH₄ in Digester Gas</td>
<td>greater than 60% by volume</td>
</tr>
<tr>
<td>Specific Biogas Production</td>
<td>greater than 0.9 Nm³/kg_VSR</td>
</tr>
<tr>
<td></td>
<td>(15 scf/lb_VSR)</td>
</tr>
<tr>
<td>Foaming</td>
<td>little or none</td>
</tr>
</tbody>
</table>
Examples of Thermophilic Digestion Operations

- Los Angeles, CA
- Oakland, CA
- San Francisco, CA
- St Joseph, MO
- Duluth, MN
- Columbus, GA
- Vancouver, BC
- Tel Aviv, Israel

Dan Region WWTP (SHAFDAN)
Multi-Staged Thermophilic Digestion

- Primary Sludge
- Thickened WAS
- Sludge Blend Tanks
- Sludge Screens
- Digester Feed Tanks
- To Digester Feed Tanks
- Heat Recovery
- To Dewatering
- Digested Sludge Storage Tank
- To Dewatering
- Thermophilic Digesters
- (6)

Thermophilic Heat Supply: 11 MW Cogeneration System with Eight 1.4 MW Packaged Units

- Heat supply system designed for thermophilic temperatures and engine heat recovery
- Boilers provide heat for startup and backup heat

Dan Region Shafdan WWTP, Tel Aviv, Israel,
Thermophilic Digestion Summary

- Advantages for capacity, Class A, cost savings, tight site
- Anaerobic digestion at 125 - 140 degrees F (50 - 60 degrees C)
- Differences between thermophilic and mesophilic digestion
- Same key control variables as mesophilic digestion
- Mesophilic digesters can be converted to thermophilic digesters
- Examples of thermophilic digestion systems

Questions?

David L. Parry
Ph.D., PE, BCEE
dave.parry@ch2m.com
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