Trends and Technologies for Energy Management for Industrial and Municipal Projects

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Outline

- Introduction
- Anaerobic Digestion Overview
- Technology Choices
- Project Drivers and Trends
- Case Studies
- Lessons Learned
- Summary
Introduction

• WEF has the Energy Roadmap
• Industry has been doing Energy Recovery from WW for many years using AD
• Industry has Sustainability Goals on Energy, Water, Wastes etc.
• Land Bans are driving food waste to energy projects in CT, MA, CA and this will continue
• Municipal WWTPs are interested in co-digestion
• More P3’s evolving with industry and POTWs working together
Energy in Wastewater

- COD in the wastewater creates energy
- 5.6 cubic meters methane per pound COD removed
- Methane has 960 BTU per cubic feet versus natural gas at 1030 and propane at 2516
- Sanitary wastewater COD around 500 mg/l
- Industrial wastewater COD can be 50,000 mg/l or 100 times
- 40,000 tons per year food waste can generate 1.2 MW of electricity and 1 Million BTUs heat
## Number of Industrial Wastewater Installations

<table>
<thead>
<tr>
<th>Industrial Sector</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>Beverage</td>
<td>623</td>
</tr>
<tr>
<td>Food</td>
<td>310</td>
</tr>
<tr>
<td>Pulp and Paper</td>
<td>137</td>
</tr>
<tr>
<td>Chemical/Pharmaceutical</td>
<td>107</td>
</tr>
<tr>
<td>Dairy/Ice Cream/Cheese</td>
<td>67</td>
</tr>
<tr>
<td>Sewage</td>
<td>67</td>
</tr>
<tr>
<td>Meat/Poultry/Fish</td>
<td>23</td>
</tr>
<tr>
<td>Other</td>
<td>265</td>
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<tr>
<td><strong>Total</strong></td>
<td>1,599</td>
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</table>

Reference: Chemical Engineering, April 2003
Food Waste!

Pre/Post Consumer

Packaged Waste

Fats/Oils/Greases

Dairy/Beverages

Food Processor Waste
What is Anaerobic Digestion?

- Biological conversion process (oxygen free)
- **Organic feedstock** consumed by bacteria
- Feedstock material is stabilized
- Byproducts
  - Biogas: 50 – 75% methane, 25 – 50 % carbon dioxide, trace gases
  - Digestate
- Commodities
  - Power
  - Recoverable heat
  - Biomethane
  - Soil amendment
Digesters in the United States

- Digestion is widely used across the world as a recycling technology.
- 2,000 digester installations in the United States and growing rapidly.
- 7,000 digester installations in Germany and growing.

Orlando, FL  San Jose, CA  Sacramento, CA
Case Study – Facility Input/Output

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>577 US tons FW/day</td>
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<tr>
<td>2</td>
<td>48 US tons/day</td>
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<tr>
<td>3</td>
<td>72,000 gal/day</td>
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<tr>
<td>4</td>
<td>2.25 US Tons N/day</td>
</tr>
<tr>
<td>5</td>
<td>1.95 million ft3/day</td>
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</table>

Food Waste to Energy Facility

- Food Waste
- Biogas
- Treated Wastewater
- Fertilizer
- Finished Compost
Benefits of AD

• Lower power and sludge production
• Renewable energy produced
• Can reduce greenhouse gas emissions
• Soil amendment produced
• Increased landfill diversion
• Proven technology
Current AD Practices in the United States

- Municipal Wastewater Treatment Plants
  - ~1,500 municipal WWTP using AD for solids stabilization
- Industrial Wastewaters
  - ~200 AD facilities primarily food & beverage production
- Animal Manure Organics
  - ~190 AD facilities for animal manure
- Organics derived from MSW and other sources
  - < 10 AD facilities

Approximately 200 AD facilities in the US are used for digesting organics…
Anaerobic Digester Technologies
Many Choice for Reactor Configurations – Wet AD

Reference: R.E. Speece, 1996
Upflow Anaerobic Sludge Blanket (UASB)
Small Footprint
Anaerobic MBR Simplified Flow Diagram

- **Anaerobic Digesters 95 F to 100 F**
  - Digester Feed 60,000 mg/L COD
  - Membrane Return
  - Membrane Feed
- **Membrane Separation**
  - Biogas Cleaning
  - Permeate <300 mg/l COD
- **CHP Engines**
  - Electricity and Heat
- **Waste solids to solids handling**
Conceptual Total Solution PFD

**Client**
- Waste Stream

**Production Facility**
- Covered-Odor Control Mixing
- Equalization System Flow Management

**Energy Integration**
- Steam
- Electric
- Hot water
- Gas

**Chemical & Nutrient Addition**

**Pre-Conditioning Tank**

**Heat Exchanger**
- Heat

**Anaerobic Reactor**

**Post Treatment**
- Clarification
- Final polishing

**Water Reuse**
- Irrigation
- Non-contact
- Boiler make-up
- CIP

**Biogas**

**Emergency Flare**

Discharge to POTW

Direct Discharge
Thermophilic Digester Technologies

The Raptor® Process

- Pre-treatment (enzymatic, chemical, thermal, mechanical or biological) depending on your substrate
- Organic residue or substrate fed into storage tanks
- Rapid thermophilic digestion in an ANAMIX™ mixed digester
- Wastewater: Fed back into pre-treatment process
- Digestate centrifuged to wet sludge cake
- Biogas treatment & reuse as renewable energy (CHP/boiler)
- Sludge cake used as fertilizer in agriculture

GW&E/Ovivo
“Dry” Anaerobic Digestion

- Organic input remains stationary; solids concentration greater than 25%-35%
- No pretreatment of organic waste needed
- Material loaded into gastight building and saturated with percolate
- Batch operation and more labor intensive
Case Studies

- Ridgewood, NJ Co-Digestion of FOG and Biosolids
- Yogurt Whey, NY Co-Digestion and Industrial Pre-treatment
- Distillery Wastewater San Juan, Puerto Rico
- Food Waste to Energy, CT
Co-Digestion of FOG at Ridgewood NJ

- Co-Digestion of FOG and Biosolids
- 5 MGD Treatment Plant
- Two trucks per day average – 10,000 gallons FOG
- Increased gas production by two to three times
- 240 KV Engine plus solar panels
- Produces 100 % plant power with excess power to grid
- Reduced electrical costs to client over 20 years with no capital
- Financing at no cost to Ridgewood NJ client
- NSU lead DBOF project with HDR doing engineering
• Expand on current Co-Digestion of Whey at POTW
• Design-Build Anaerobic Pretreatment system for whey volumes in excess of the 25MM gallons per year
• Collect and utilize the produced biogas
• Selected Anaerobic MBR Technology
Biogas Utilization Options

- Local uses in facility (heating, boiler)
- Transfer to food processor: Boilers
- Conversion to Electricity (CHP engines or other)
• 342 mm BTU/day biogas energy available
• GE Jenbacher engines(2) with a power output of 848 kW each
• More than 5 times the electric power required for the whey treatment plant
• Excess electric power will be exported to the grid
• Heat recovered used to maintain (37 C) digester temperature
Rum Distillery Wastewaters

- CODs over 50,000 mg/l treated
- Anaerobic fixed film process
- Biogas has high sulfur (over 2-3%) requiring treatment for use in boilers
- Plant gets 50% of energy to run the distillery from the wastewater
Quantum Biopower is completing construction of a 40,000 ton per year, 1.2 MW Digester – CoGen facility in Southington CT. Online NEXT MONTH Plans to initiate new 3-5 projects in 2016-2017
1. Food Waste Processing
   - 40,000 Tons/Year
   - Fats/Oils/Greases
   - Meats
   - Produce
   - Packaged products
   - Bakery Items

2. Methane Production
   - Natural process
   - Heat and Mixing
   - Methane created

3. Sustainable Energy
   - 1.2 MW of electricity
   - 1 MM BTU’s of heat
   - Southington, CT

4. Compost
   - 10,000 tons/year
   - Organic compost
   - Farms & Growers in CT
Wastewater Treatment – Nutrient Recovery

**Digester Facility Effluent Quality**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average Daily Limit</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>BOD</td>
<td>185 mg/l</td>
<td>370 mg/l</td>
</tr>
<tr>
<td>TSS</td>
<td>185 mg/l</td>
<td>370 mg/l</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>50 mg/l</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>5 mg/l</td>
<td>10 mg/l</td>
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Lessons Learned for All Projects

- Get a good waste and wastewater characterization.
- Consider need and benefits for treatability testing.
- Develop a good design basis with variability in loadings.
- Evaluate and select best technical solution first.
- Evaluate technology providers who can deliver the solution as well as project delivery models.
- Build in flexibility in design for production shutdowns and expandability.
Summary

- Anaerobic Digestion (AD) has been used for years for biosolids and high strength industrial wastewaters for energy value.
- The trend now is using AD more for co-digestion of FOG, food wastes and organics with biosolids and manure for energy.
- Municipal digesters with excess capacity are being used for FOG and Organics for energy.
- Source separated organics and industrial wastes residuals are also going to new AD systems for energy.
- There are other project drivers including landfill bans in some states.
Thank you for the opportunity to present.

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<tbody>
<tr>
<td>Joseph G. Cleary, P.E., BCEE</td>
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<td>201-940-7210 Office</td>
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<tr>
<td>201-841-1316 Mobile</td>
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<tr>
<td><a href="mailto:jcleary@geosyntec.com">jcleary@geosyntec.com</a></td>
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