Anaerobic Digestion
Post-consumer Food Scraps

NEWMOA Webinar
Tom Kraemer and Greg McCarron
October 8, 2015
Overview

• Introduction
• AD technologies
• AD facilities
  - Operational
  - Construction/permitting
• Technical feasibility considerations
• Financial feasibility considerations
Introduction

• Tom Kraemer, CH2M
  – 32 years in solid waste management, recently focused on organics

• Greg McCarron
  – SCS Engineers – New York
  – 29 years in solid waste management, SCS National Expert on Organics Management

• Focus on post-consumer food scraps
AD PROCESS OVERVIEW

FEEDSTOCKS DRIVE EVERYTHING
The Front End: Pre-Processing

- DON’T NEGLECT PRE-PROCESSING IN PLANNING THE PROJECT!
- Once the feedstocks have been inspected and unacceptable materials removed, they may need to be physically or chemically altered to provide optimal conditions for the digestion process.
- Common preparation steps includes grinding or shredding, and water addition.
- The level and type of preprocessing and preparation required is dependent on the feedstock and also on the specific AD technology used.
- Starter inoculums (e.g., recycled feedstock that has already gone through the digestion process or wastewater produced during digestate dewatering or percolation steps) might be added to initiate microbial activity at the mixing stage.
The AD Process: The Basic Technologies

- **Wet digesters** are designed to handle materials that are dissolved or suspended in water.

- In **High-solids digesters**, the materials are either pumped into a digester tank as a slurry or stacked in place (e.g. with front-end loaders). When stacked in place, water is percolated through the materials to distribute nutrients and microorganisms; they are not submerged in a tank.

- Digesters can be designed to operate in **thermophilic, mesophilic and psychrophilic** temperature ranges.

- Systems can have **multiple stages**. In single-stage systems, the entire biological digestion process takes place in a single vessel. In two-stage systems, hydrolysis occurs in one vessel and the subsequent stages occur in a different vessel. The vessels are optimized for the stage`s microorganisms.
Types of Anaerobic Digestion for Food Waste

• Wet AD
• High Solids AD
• Co-digestion with sewage sludge

Wastewater treatment plant digester

High Solids AD

Wet Digester
Co-Digestion in WW Sludge Digester

- Fork Lift
- SSO
- Conveyor
- Sorting
- Conveyor
- Shredder
- Conveyor
- Sorted and Shredded SSO
- Bottles, Cans, Plastics
- Debris Box
- Slurry Tank
- Rock Trap/Grinder
- Odour Scrubbers
- Fan

To Receiving/Processing Facility at WWTP

- Solids Content 25% SSO from Transfer Facility
- Dilution Water (Treated Effluent from WWTP)

10% Solids Content

Food Waste 10% Solids to Existing WWTP Digester

Drum Screen

Debris Box
## Digester Type by Moisture Content

<table>
<thead>
<tr>
<th>Digester Type</th>
<th>Digester Water Content</th>
<th>Feedstock Type</th>
<th>Net Energy Output</th>
<th>Digestate Treatment</th>
<th>Leachate Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>High solids stackable</td>
<td>Less than 60%</td>
<td>Stackable materials</td>
<td>Highest</td>
<td>Dewatering not required</td>
<td>Lowest</td>
</tr>
<tr>
<td>High solids slurry</td>
<td>Between 60% and 80%</td>
<td>Wet but not liquid</td>
<td>Intermediate</td>
<td>Dewatering may be required</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Wet</td>
<td>Greater than 80%</td>
<td>Liquid</td>
<td>Lowest</td>
<td>Dewatering is required</td>
<td>Highest</td>
</tr>
</tbody>
</table>
The Back End: Digestate Management

• DON’T NEGLECT THE BACK END! 80 - 90% OF THE INPUT TONNAGE BY WEIGHT COMES OUT THE BACK END

• Digestate is the solid or semi-solid material left over at the end of the digestion process.

• In wet (low-solids) and high-solids-slurry digestion systems, the digestate is the solid or semi-solid material extracted from the bottom of the digestion tanks. In high-solids-stackable digestion systems, digestate is the solid material removed from the digestion tunnels.

• A typical quantity of digestate for all digester types is 0.85 ton of dewatered digestate for each ton of wet SSO added to the digester.

• It is important to estimate digestate quantities, dewatering requirements (if any), and how much centrate will be generated from dewatering operations.

• Digestate is typically composted, but is sometimes land applied.
# Wet AD: Pros and Cons

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Handles wastes that are in a liquid or slurry condition upon arrival</td>
<td>• Cannot generally handle waste with contaminant material (e.g., plastic, metals, and rocks)</td>
</tr>
<tr>
<td>• Entirely contained system (high level of odour control)</td>
<td>• Requires significant pretreatment and operational care to avoid exceeding capacity or upsetting biosolids digestion</td>
</tr>
<tr>
<td></td>
<td>• Produces more effluent than the other two digester types</td>
</tr>
<tr>
<td></td>
<td>• Requires more energy consumption than high-solids digesters</td>
</tr>
</tbody>
</table>
### High-Solids Slurry: Pros and Cons

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Can process waste with contaminants (e.g., plastic, metals, and rocks)</td>
<td>• Slurry typically is not completely mixed, so can cause uneven digestion if not carefully managed</td>
</tr>
<tr>
<td>• Handles wastes that are in a liquid or slurry condition upon arrival</td>
<td>• Produces more effluent than high-solids-stackable digestion</td>
</tr>
<tr>
<td>• Produces less effluent than wet (low-solids) digestion</td>
<td>• Less energy-efficient than high-solids-stackable digestion</td>
</tr>
<tr>
<td>• More energy-efficient than wet (low-solids) systems</td>
<td>• May require water addition to make the feedstocks pumpable</td>
</tr>
<tr>
<td>• Entirely contained system (high level of odour control)</td>
<td></td>
</tr>
</tbody>
</table>
# High-Solids Stackable: Pros and Cons

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Can process waste with contaminant material (plastic, metals, rocks)</td>
<td>- Requires mixing with shredded L&amp;YW or other bulking materials</td>
</tr>
<tr>
<td>- Handles solid stackable wastes with little pretreatment</td>
<td>- Must operate as a batch system, requiring purging and opening the digester between batches</td>
</tr>
<tr>
<td>- Produces negligible effluents</td>
<td>- Odour potential when door is opened</td>
</tr>
<tr>
<td>- More energy efficient than other AD systems</td>
<td></td>
</tr>
<tr>
<td>- May require no water addition</td>
<td></td>
</tr>
</tbody>
</table>

Operational AD Facilities

• EREF Study, August 2015
  – Study focus on organic fraction of MSW (OFMSW); includes data as of 2013
  – 25 stand-alone AD facilities for OFMSW
  – 75 AD facilities at farms; co-digest OFMSW
  – 81 AD facilities at WWTP; co-digest OFMSW
  – 800,000 tons of OFMSW processed

• Update of EREF Data to Fall 2015
  – 5 additional AD facilities are operational
  – 2 additional AD facilities are in construction
Operational Facilities in the NEWMOA States

- **New York: Stand-alone facilities (EREF)**
  - Buffalo BioEnergy: quasar wet system; biosolids/FOG/manure/food; 40k tpy; 770 kW
  - Niagara BioEnergy: sister plant

- **MA: Stand-alone facilities (EREF)**
  - Agreen: quasar wet system; manure and liquid food; 15k tpy; 250 kW
  - BGreen: sister plant

- **NEWMOA region (EREF)**
  - On farm: 17
  - WWTP: 6
Construction/Permitting
NEWMOA States

• Construction
  – RI, BlueSphere: wet; food scraps; 250 tpd; 3.2 MW
  – MA, Stop & Shop: wet; food scraps; 35k tpy; 1.25 MW (secure feedstock and energy use)

• Permitting
  – CT, Anaergia/Bridgeport: wet; food/ biosolids/FOG; 10k tpy; 1.6 MW
  – MA, Harvest/Bourne: food scraps/biosolids; 5 MW
Notable West Coast Facilities

PRIVATE SECTOR “MERCHANT” FACILITIES:
• Harvest Power’s Energy Garden and Composting Facility in Richmond, BC
  – 20,000 tpy commercial food waste – high solids stackable - biogas to electric
• JC Biomethane in Eugene, Oregon
  – 12,000 tpy commercial food waste
  – 16,000 tpy food processing waste and manure – wet digester – biogas to electric
• CR&R Digester – Perris CA
  – 80,000 tpy commercial food and yard waste – high solids slurry – biogas to CNG

PUBLIC SECTOR FACILITIES
• San Jose HSAD Facility
  – 90,000 tpy organics from “wet/dry” ICI waste collection system – high solids stackable
• Marin County Co-digestion
  – 4,000 tpy municipal food scraps – biogas to electricity
Technical Feasibility Considerations

- Feedstock (see next slide)
- Technology
  - Pre-processing equipment
  - Digester equipment
  - Biogas processing and use
- Permitting requirements and timeline
- Digestate management and quality
- Contracts for construction and operation
- Developer and vendor guarantees
  - Throughput and energy
Feedstock Considerations

- **Quantity**
  - Tonnage available in service area?
  - Seasonality of feedstocks (e.g., leaves)?
  - Competing facilities?

- **Quality**
  - Contamination: plastic, grit
  - Effect on digester equipment
  - Effect on digestate processing and use
Financial Feasibility Considerations

• Tipping fee revenue
  – What is the competition in the service area?
  – How will feedstock be secured?

• Energy revenue
  – What is the energy product?
  – Preferred: offset or provide power on-site (e.g., WWTP/farm/factory)
  – Electric to the grid: price is usually set by natural gas price (see next slide)
  – RECs

• Grants and subsidies
U.S. Natural Gas Electric Power Price (Dollars per Thousand Cubic Feet)
Costs

• Project-specific cost estimate needed
  – Limited facilities processing OFMSW vs. farm or WWTP digesters

• Capital costs
  – Pre-processing system
  – Digester system
  – Biogas system

• Operating costs
  – Equipment O&M
  – Digestate management
Contact Information

- Greg McCarron/SCS Engineers
  New York
  GMcCarron@SCSEngineers.com
  1-845-357-1510