HIGH RATE ANAEROBIC DIGESTION WITH ENERGY RECOVERY

Annette M. Berger
KB BioEnergy, Inc.

OWEA
January 21, 2016
OVERVIEW

• What is High Rate Anaerobic Digestion?
• Akron Renewable Energy Facility
  • Schmack Biogas AD
• Operations
  • Solids
  • Biogas
• Challenges
HIGH RATE ANAEROBIC DIGESTION

• Operations based on recycling a concentrated bacterial biomass stream
  • Accomplished by pumping some of the effluent leaving the digester back to the front of the digester.
  • Digester size reduced to one third of the conventional size
  • Typically have higher loading rates
    • Conventional- 0.03 to 0.10 lbs of VS/CF/day
    • High rate-0.10 to 0.40 lbs of VS/CF/day
  • Uniform temperatures throughout system
  • Fed on a continuous basis
  • Steady mixing capacity
WATER RECLAMATION AND RENEWABLE ENERGY FACILITIES
WATER RECLAMATION AND RENEWABLE ENERGY FACILITIES

<table>
<thead>
<tr>
<th>Year</th>
<th>Million Gallons Processed</th>
<th>Dry Tons</th>
<th>Biosolids</th>
<th>Filter Cake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>65.90</td>
<td>14,819</td>
<td>4.86</td>
<td>29.10</td>
</tr>
</tbody>
</table>
RENEWABLE ENERGY FACILITY
RENEWABLE ENERGY FACILITY – OPERATIONAL DESIGN

- **Feed Rate**
  - 35,000 gal/day of 5% solids
  - ~120 WT/day of 28% solids

- **Digested Solids**
  - 65,000 gal/day of 9% solids

- **CHPUs**
  - 30,000 kWh/day produced
  - 5.37 MMBTU/hr produced

- **Dried Solids**
  - 35 to 40 yds/day of 92%+ pellet-like material
PROCESS FLOW
PROCESS FLOW - SOLIDS
Euco

- Plug Flow Digesters
  - Capacity of 286,000 gallons each
  - Continual mix
  - Blend of 5% solids and 28% solids are fed to unit
  - Retention time of 8-9 days
  - 50% biogas production
Euco – Upgrades

- Enhanced heating arrangement
  - Brugg tubing
- Dewatered solids delivery
  - Feed screw replaced hopper

January 21, 2016
Coccus

- Complete Mix Digesters
  - Capacity of 704,000 gallons each
  - Solids content of 12-15%
  - Retention time of 21 days
  - Wooden lattice structure for sulfide reducing bacteria to cultivate
  - Double membrane dome
**DRYER**

- Paddle Dryer
  - Feed rate of 10,000 wet lbs./hr.
    - 28% - 30% DS dewatered digested solids off of centrifuges
  - Discharge product solids ≥92%
  - Operational 5 days/week
Dewatering – Raw Solids

- Process Flow
  - Three holding wells
  - 225,000 gallon capacity total
  - Raw solids at 5-6%

- 2 meter Andritz Belt Filter Presses
  - 5 Units
  - 200 GPM/press
  - 28% to 30% dry solids
DEWATERING – DIGESTED SOLIDS

• Process Flow
  • Three holding wells
  • 225,000 gallon capacity total
  • Digested solids at 10% DS

• D5LL Andritz Centrifuges
  • 3 Units
  • 2500 dry lbs/hr per unit
  • 28% to 30% dry solids
**Solids Dewatering – Polymer Usage**

- **Raw Solids**
  - 1.62 gallons/DT
  - $13.80/DT

- **Digested Solids**
  - 5.33 gallons/DT
  - $45/DT

January 21, 2016
HIGH RATE ANAEROBIC DIGESTION

- Average Mix Ratio
  - 19 MG liquid
  - 50 MG dewatered
    - 9 MG volume
    - 70% overall
  - 42 MG recycled

January 21, 2016
**Final Product**

- Research
  - Ohio Agricultural Research Development Center (OARDC)
    - Turf applications
    - Sod farms
- Class A Exceptional Quality
- 10,000 cubic yards annually
• **Heavy Metals: Meets EQ Status** – < Avg. Monthly Concentration Limits

• **Pathogen Reduction: Particles** > 80ºC or 176ºF

• **Vector Attraction: Dry Solids** ≥ 90%

• **Fecal Coliform:** < 1,000 MPN

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Regulatory Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>9.99</td>
<td>41</td>
</tr>
<tr>
<td>Cadmium</td>
<td>3.87</td>
<td>39</td>
</tr>
<tr>
<td>Copper</td>
<td>353</td>
<td>1500</td>
</tr>
<tr>
<td>Mercury</td>
<td>.263</td>
<td>17</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>9.74</td>
<td>18</td>
</tr>
<tr>
<td>Nickel</td>
<td>25.5</td>
<td>420</td>
</tr>
<tr>
<td>Lead</td>
<td>50.8</td>
<td>300</td>
</tr>
<tr>
<td>Selenium</td>
<td>.903</td>
<td>100</td>
</tr>
<tr>
<td>Zinc</td>
<td>1560</td>
<td>2800</td>
</tr>
</tbody>
</table>
Final Product

- Twinsburg School System
  - Applied to the athletic fields in late Fall 2015
  - Photos taken on December 7, 2015
**Final Product**

- **OARDC Research**
  - Turf Plots
    - Conducted on OARDC ground
    - Noticeable greening due to nitrogen and micronutrients
  - Sod Farm
    - Results not in till Spring 2016
  - Potting Mix
    - Results not in till Spring 2016

January 21, 2016
**Feed Rates – Design vs. 2015 Performance**

<table>
<thead>
<tr>
<th></th>
<th>Liquid Sludge to ADS (Dry Tons)</th>
<th>Belt Filter Press Cake (Dry Tons)</th>
<th>Raw Liquid Solids (%)</th>
<th>Cake Solids (%)</th>
<th>Combined Sludge to ADS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design</strong></td>
<td>2,900</td>
<td>11,500</td>
<td>5.0</td>
<td>28.4</td>
<td>39.5</td>
</tr>
<tr>
<td><strong>2015</strong></td>
<td>4,043</td>
<td>10,537</td>
<td>5.0</td>
<td>28.0</td>
<td>40.2</td>
</tr>
</tbody>
</table>
SOLIDS –
DESIGN VS. 2015 PERFORMANCE

<table>
<thead>
<tr>
<th></th>
<th>Euco Dry Solids (%)</th>
<th>Coccus Dry Solids (%)</th>
<th>Retention Time (Days)</th>
<th>Volatile Solids Loading (lbs/day/1,000 ft³)</th>
<th>Volatile Solids Destruction (%)</th>
<th>Digested Sludge to Centrifuge (Gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>14.6</td>
<td>9.1</td>
<td>30</td>
<td>225</td>
<td>50</td>
<td>64,700</td>
</tr>
<tr>
<td>2015</td>
<td>9.6</td>
<td>7.8</td>
<td>25</td>
<td>241</td>
<td>55</td>
<td>68,649</td>
</tr>
</tbody>
</table>

January 21, 2016
2015 DRYER MATERIAL

- **TechnaGro Advanced**
  - 12,255 cubic yards produced
  - 11,063 cubic yards sold
**Biogas Utilization**

- Biogas End Use
  - Conditioned using Unison Solutions Package
    - H₂S removal
    - Siloxane removal
  - Three 600 kW MWM engines
  - Thermal boilers for dryer
    - 300 cfm full capacity
  - Flare with capacity for 600 cfms
**Biogas Production** – Design vs. 2015 Performance

<table>
<thead>
<tr>
<th></th>
<th>Biogas Production (cfm)</th>
<th>Biogas Conversion Rate (ft³/lb VS destroyed)</th>
<th>Biogas Energy Potential (BTU)</th>
<th>Methane (%)</th>
<th>Hydrogen Sulfide (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>373</td>
<td>17.9</td>
<td>560</td>
<td>52</td>
<td>83</td>
</tr>
<tr>
<td>2015</td>
<td>383</td>
<td>17.1</td>
<td>597</td>
<td>60</td>
<td>68</td>
</tr>
</tbody>
</table>

January 21, 2016
**BIOGAS UTILIZATION**

Total Biogas Production 120,200 MMBTU

- Engines 99,689 MMBTU (83%)
- Thermal Boiler 15,278 MMBTU (12.5%)
- Flared 5,233 MMBTU (4.5%)
Challenges

Solids

• Cleaner sludge
• Larger capacity to hold digested solids
• Scaling in dryer with non-potable water
• Dust in end product
THANK YOU