Using FOG and Foodwaste to Increase Methane Production

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National Pretreatment & Pollution Prevention Workshop

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Terms

- Co-digestion – two or more inputs to digester
- FOG - FATS, OILS, and GREASE
- IKG - Inedible Kitchen Grease or trap grease
- Brown Grease - trap grease and sewer grease
- Yellow Grease - Used cooking oil from restaurants
- SSO – source separated organic (preconsumer) such as fruit and vegetable scraps
- CHP – Combined Heat and Power
Introduction and Overview

Why accept FOG and Food waste?

FOG & Foodwaste will increase digester biogas production (more methane).
Key Points

• Fats, Oils, and Greases (FOG) are very high energy feedstock to digesters.
• Separating FOG can eliminate problems in sewer collection systems.
• SSO food waste also a high energy feedstock.
• Utilize excess digester capacity and generate more biogas.
Anaerobic Digestion Process

Anaerobic digestion (simplified)

- Complex Organics → Soluble Organics → Organic Acids (VFAs) → Methane + CO₂

- Hydrolysis → Acidogenesis → Methanogenesis

- Acid Producers

- Methanogens
## Biogas Production

<table>
<thead>
<tr>
<th></th>
<th>Gas yield per unit solids destroyed, m³/kg (cu ft/lb)</th>
<th>Methane content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>1.2–1.6 (19–26)</td>
<td>62–72</td>
</tr>
<tr>
<td>Scum</td>
<td>0.9–1.0 (14.4–16)</td>
<td>70–75</td>
</tr>
<tr>
<td>Grease</td>
<td>1.1 (17.6)</td>
<td>68</td>
</tr>
<tr>
<td>Crude fibers</td>
<td>0.8 (12.8)</td>
<td>45–50</td>
</tr>
<tr>
<td>Protein</td>
<td>0.7 (11.2)</td>
<td>73</td>
</tr>
<tr>
<td>PS + WAS blend (typical)</td>
<td>0.8–1.1 (13–18)</td>
<td>60–70</td>
</tr>
</tbody>
</table>

Source: Design of Municipal Wastewater Treatment Plants, WEF, 2009
Anaerobic Digestion of Biosolids

Egg-Shaped Digesters

Conventional Digesters
How Can We Increase Digester Gas Production?

- Alternative Digestion or Biosolids Conditioning
- FOG / Food Waste
- Primary Treatment
FOG Receiving Designed by HDR

Napa Sanitation District FOG
Designed in 2011

City of Watsonville, CA
Designed in 2002
Case Study
Watsonville, CA

- Produce more biogas to utilize excess digester capacity
- Accept grease hauler truck loads – restaurant grease traps and other sources
Plant Description

- **Average Daily Flow**
  - 12.1 mgd Design
  - 7.4 mgd for 2002
  - 7.1 mgd for 2003

- **Activated Sludge**

- **Cogeneration System**
  - One 600 kW engine generator, duel fuel digester gas/natural gas

- **Digester Gas Storage Sphere (32-foot-diameter)**

- **Digesterers**
  - Two 90-foot-diameter, 31.5 ft SWD, 1.5 MG each, primary/secondary operation
The Plan

- Feed grease to the primary digester to increase digester gas production and reduce natural gas purchases.

- Cogeneration historically fueled with DG/NG:
  - Fuels are blended at variable ratios, and adjusted one to two times daily.

- Will grease digestion work?
  - Survey of other plants doing similar.

- Watsonville has some similar experience with fruit waste digestion.
Design Considerations

- Volume of Grease Per Day
- Percent Grease/Water in Truck Load
- Evaluate Grease digestion capacity
- Grease Conversion to Digester Gas
- Location of Grease receiving station
- Capital Cost Estimate
- Existing gas utilization and estimated tip fee revenue
- Grease Metering to Digester
- Grease Holding Tank, Heating, and Mixing (Chopper Pump)
- Digester Mixing
## Design Criteria

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grease Holding Tank</td>
<td>11,000-gallon tank - Two 3,000 gallon loads/day</td>
</tr>
<tr>
<td>Grease Holding Tank Mixing Pump</td>
<td>Chopper Pump (300 gpm)</td>
</tr>
<tr>
<td>Digester Mixing Pump</td>
<td>Chopper Pump (5,000 gpm)</td>
</tr>
<tr>
<td>Grease Metering Pump</td>
<td>PD Pump (25 gpm)</td>
</tr>
<tr>
<td>Grease Holding Tank Heating System</td>
<td>Hot Water Piping Inside Tank (25 gpm)</td>
</tr>
<tr>
<td>Odor</td>
<td>Small Activated Carbon Canister at Top Manway</td>
</tr>
</tbody>
</table>
Design Criteria (continued)

- 6,000 gpd of grease mixture based on increase in digester gas production necessary to eliminate natural gas purchases
- Additional volatile solids loading to digester
- No increase in SRT in digester
Grease Holding Tank & Mixing Pump
Grease Feed Pump (25 gpm)
Digester Mixing Pump (5,000 gpm)
Hot Water Pump (25 gpm)
Grease Unloading
Grease Digestion Schematic

Grease Holding Tank
11,000 gal

Hot Water Heating
(25 gpm)

Digester Mix Pump
(5,000 gpm)

Grease Feed Pump
(25 gpm)

Grease Tank Mix Pump
(300 gpm)

Digester
1.5 MG
Project Economics

- Revenue is dependent upon natural gas avoided costs and grease tipping fees
- Maximum savings = Natural gas purchased for cogeneration plus tipping fees
- Capital cost = $270,000 actual
- Mixing energy savings – external pump mixing vs gas mixing (minor energy savings)
- O&M savings – gas mixing compressor not in use
- Grease tipping fees - $0.036/gallon
Digester Gas Production vs. Grease Feed

Digester Gas (1,000 CFD)

Grease Feed (1,000 gallons/month)

Nov May Dec Jun Aug Feb Sep Mar Oct Apr
2001 2002 2003 2004 2005 2006 2007
Results

Startup - January 2003

Build it and they will come – if disposal fees are discounted

Anticipated versus actual grease received

No tight control on grease delivery
2003 Daily Grease Loads

Design:
6,000 gallons/day
Grease/Water Mix

- Design assumption 40% grease
- 15% to 20% grease during first year of operation based on increased gas production
- Confirmation from other sources
- Increase acceptance from 6,000 gpd original design to 12,000-16,000 gpd
- Need to pump faster
Grease to Power Economics

- 17% grease, 83% water
- 100% volatile solids, 100% digested
- 15 cf/lb volatile solids destroyed
- 600 btu/cf
- 32% engine-generator efficiency
- 120 KW per 3,000 gal load per day
- At $0.10/KWH - $288/day
- $0.096/gal
## Summary of Grease Digestion Savings

<table>
<thead>
<tr>
<th>Year</th>
<th>CFD NG</th>
<th>CFD DG</th>
<th>Grease Gal/Day</th>
<th>CFD NG Dec</th>
<th>CFD DG Inc</th>
<th>Grease Revenue</th>
<th>NG Savings</th>
<th>Total Savings</th>
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<tbody>
<tr>
<td>2002</td>
<td>98,124</td>
<td>113,250</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$0</td>
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<td>$0</td>
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<td>2003</td>
<td>84,150</td>
<td>143,204</td>
<td>2,612</td>
<td>13,974</td>
<td>29,954</td>
<td>$34,315</td>
<td>$61,207</td>
<td>$95,522</td>
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<tr>
<td>2004</td>
<td>71,250</td>
<td>179,998</td>
<td>5,232</td>
<td>26,874</td>
<td>66,747</td>
<td>$68,742</td>
<td>$117,708</td>
<td>$186,450</td>
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<tr>
<td>2005</td>
<td>65,017</td>
<td>166,457</td>
<td>6,471</td>
<td>33,107</td>
<td>53,206</td>
<td>$85,027</td>
<td>$145,010</td>
<td>$230,036</td>
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<tr>
<td>2006</td>
<td>68,668</td>
<td>185,868</td>
<td>4,526</td>
<td>29,456</td>
<td>72,618</td>
<td>$59,473</td>
<td>$129,018</td>
<td>$188,491</td>
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<td></td>
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<td></td>
<td></td>
<td><strong>Totals</strong></td>
<td></td>
<td><strong>$700,499</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>$247,557</strong></td>
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<td></td>
<td></td>
<td><strong>$452,943</strong></td>
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Next Time

- Intake Screen(s)
- Higher Capacity Digester Feed Pump
- Larger or second grease holding tank
FOG Digestion Can Increase Digester Gas by 50% to 100%

- Virtually 100% volatile solids destruction
- Highly degradable
- Relatively easy to accept, process, and find
- Very small increase in biosolids production
- May improve volatile destruction of primary/WAS
Food Waste Co-digestion

- Requires excess digester capacity. Same benefits. High energy, more biogas, minimal extra solids produced, additional revenue.

- Food Waste can be liquid such as cheese or yogurt whey. Feed to anaerobic digester reduces load on energy intensive secondary treatment.
SSO food waste is 30% solid and 70% liquid. Will require desizing and depackaging (Grinding/pulping)
Foodwaste Co-Digestion at WWTF in New York

- Two anaerobic digesters at municipal treatment facility with low industrial load
- Solution: Co-digestion - Adding primary solids and dairy wastes, e.g. yogurt and cheese whey from local manufacturers.
- Since 2002 after several upgrades to plant, Gloversville Johnstown WWTP have double VS load and electricity output.
- CHP generating nearly all the electric power for the municipal WWTP plant.
FOG and Foodwaste

Thank You

QUESTIONS????

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