Maximizing Bioenergy Resources in the Midwest

October 11-12, 2017
Biogas to Energy and Vehicle Fuel
**Biogas**

bi·o·gas, 'bīōˌgas/, noun, gaseous fuel, especially methane, produced by the fermentation of organic matter.

- Methane, CH₄
- Carbon Dioxide, CO₂
- Nitrogen, N₂
- Oxygen, O₂
- Hydrogen Sulfide, H₂S
- Moisture
- Particulates
- Siloxanes
- Volatile Organic Compounds

**Pie Chart**

- **CO₂** 30%-50%
- **CH₄** 50%-70%

**UNISON SOLUTIONS**
Biogas Conditioning Systems

- Digester or Landfill
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane Removal
- Micro Turbine
- IC Engine-Generator
- Boiler
Hydrogen Sulfide (H$_2$S)

- Equipment Damage from Corrosion (Hydrosulfuric Acid)
- SO$_x$ Emissions
- Health and Safety Issues
  (1000 ppm will cause an individual to lose consciousness)
- Odor Control
- Causes fouling of Siloxane Removal Media
- Measure levels with either lab testing, colorimetric tubes, or onsite meter.
**H₂S Removal Systems**

- Filtration medias
  - Wood based
  - Clay based
  - Ferric hydroxide
  - Carbon

- Biological systems for sites with high H₂S
Siloxanes

- Silica and organic compounds are combined (Organosilicon)
- Used in many consumer and *industrial products (Listed as Silicones as the ingredient on products)
  - Shampoo
  - Conditioner
  - Deodorant
  - Food additives
  - * Dry Cleaning Solutions
  - * Windshield Cleaning Products
  - * RTV Silicone Cleaner
- Siloxanes break down in landfills and digesters, and combine with the methane gas
### Siloxane Impact on Equipment

**Siloxanes**
- Organic Compounds with Silica
  - Tetramethyl silane
  - Trimethyl silanol
  - Hexamethyldisiloxane (L2)
  - Hexamethylcyclotrisiloxane (D3)
  - Octamethyltrisiloxane (L3)
  - Octamethylcyclotetrasiloxane (D4)
  - Decamethyltetrasiloxane (L4)
  - Decamethylcyclopentasiloxane (D5)
  - Dodecamethylpentasiloxane (L5)
  - Dodecamethylcyclohexasiloxane (D6)

**VOC**
- Volatile Organic Compounds (Commonly Found)
  - Acetone
  - Benzene
  - Chlorobenzene
  - Decane
  - Ethylbenzene
  - Heptane
  - Hexane
  - Isopropyl Alcohol
  - Octane
  - Xylene
  - Toluene

22-35 compounds typically reported
Siloxane/VOC Removal

- Coal
- Coconut shell
- Wood
- Extruded pellets
- Silica gel - spheres
- 4 x 8 mesh chips
- Silica gel – irregular shaped
Glenbard Wastewater Authority
Glen Ellyn, IL

Site Information
- 47 MGD municipal plant (Avg. Flow 16 MGD)
- 200 scfm of biogas produced

Gas Conditioning Equipment
- H₂S removal – Iron Sponge
- Gas compression/Moisture removal
- Siloxane removal

End Use Equipment
- (2) Nissen IC Engines
  - 750 kW of electricity - 60% of plants electrical requirements
  - 2.88 MMBTU/hr - 96% of plants thermal energy requirements
Site Information
- 1.01 MGD municipal plant
- 50 scfm of biogas produced

Gas Conditioning Equipment
- Gas compression/Moisture removal
- Siloxane removal

End Use Equipment
- (2) Capstone CR65-ICH turbines, produce 130 kW of electricity and thermal energy
Site Information
- 11 MGD municipal plant
- 160 scfm of biogas produced

Gas Conditioning Equipment
- H₂S removal, Specially activated carbon
- Gas compression/Moisture removal
- Siloxane removal

End Use Equipment
- (2) IC Engines
  - Produce 665 kW of electricity
  - Produce 3.5 MMBTU/hr thermal energy
BioCNG Fueling System
Process Flow Diagram

Digester or Landfill → BioCNG Gas Conditioning System → CNG Vehicle Fueling Station and Vehicles

Traditional System with Addition of CO₂ Removal System

- MicroTurbines
- IC Engines
- Boilers

UNISON SOLUTIONS
## BioCNG Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Biogas Inlet Flow (scfm)</th>
<th>Fuel Production (GGE/day)</th>
<th>Fuel Production (DGE/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BioCNG 50</td>
<td>50</td>
<td>185 - 300</td>
<td>160 - 260</td>
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<tr>
<td>BioCNG 100</td>
<td>100</td>
<td>370 - 600</td>
<td>320 - 520</td>
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<tr>
<td>BioCNG 200</td>
<td>200</td>
<td>740 - 1,200</td>
<td>640 - 1,040</td>
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<tr>
<td>BioCNG 400</td>
<td>400</td>
<td>1,480 - 2,400</td>
<td>1,280 - 2,080</td>
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</table>
**BioCNG Fuel Production**

<table>
<thead>
<tr>
<th>Model</th>
<th>Ford F-150</th>
<th>Waste Hauler</th>
<th>School Bus</th>
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<tbody>
<tr>
<td>BioCNG 50</td>
<td>16</td>
<td>5</td>
<td>4</td>
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<tr>
<td>BioCNG 100</td>
<td>32</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>BioCNG 200</td>
<td>64</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>BioCNG 400</td>
<td>128</td>
<td>40</td>
<td>32</td>
</tr>
</tbody>
</table>

*Assumes 1 fill per day per vehicle*
Janesville WWTP, WI

- Janesville, WI
- Start-up: November 2010
- Gas Flow: 140scfm
  - BioCNG
- Fast Fill – vehicle fueling
- (4) CR65 micro turbines
- (1) CR 200 micro turbine
Riverview Land Preserve, MI

- Riverview, MI
- Start-up: May 2013
- Gas Flow: 100
- Fast Fill – vehicle fueling