Unison Solutions, Inc. Overview

- Company founded on January 1, 2000
- Located in Dubuque, Iowa
- 40 Employees (10 Engineers)
- 45,000 sq. ft. Manufacturing Facility
- 205 systems sold worldwide, 170+ in Operation
- Biogas Conditioning System Design and Fabrication
- Custom System Design and Fabrication

Leaders in Biogas Technology
What is driving the need for increased gas treatment on biogas fueled generation and direct use projects?

Equipment Damage & Performance Issues
Getting Started on a Biogas to Energy Project
System Design Checklist

- Site Conditions
- Inlet Gas Conditions (gas testing)
- Discharge Gas Conditions
- End-use Technology
## Gas Quality Limits To Need Treatment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>H2S</th>
<th>Siloxanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MicroTurbine</td>
<td>&lt;5,000 ppmv</td>
<td>&lt;100 ppbv</td>
</tr>
<tr>
<td>IC Engine</td>
<td>&lt;100 - 500 ppmv</td>
<td>&lt;100 - 1,000 ppbv</td>
</tr>
<tr>
<td>Boiler</td>
<td>&lt;100 - 500 ppmv</td>
<td>&lt;500 - 2,000 ppbv</td>
</tr>
<tr>
<td>Vehicle Fuel</td>
<td>Non-Detect</td>
<td>&lt;100 ppbv</td>
</tr>
</tbody>
</table>

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Hydrogen Sulfide Removal Systems

- Digester or Landfill
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane/VOC Removal

- MicroTurbines
- IC Engines
- Boilers
Hydrogen Sulfide Removal Systems
Why Hydrogen Sulfide Removal?

- Equipment Damage from Corrosion (Hydrosulfuric Acid)
- SOx Emissions
- Health and Safety Issues (1000ppm will cause an individual to lose consciousness)
- Odor Control
- Causes fouling of Siloxane Removal Media
Hydrogen Sulfide Removal Systems Technologies

- SulfaTreat Systems
- Iron Sponge Systems
- Biological/Iron Sponge Systems
- Biological Systems
Hydrogen Sulfide Removal Systems
SulfaTreat/Iron Sponge Process

Biogas containing Hydrogen sulfide (H$_2$S)

Media: SulfaTreat or Iron Sponge

Water to Drain

Biogas free of Hydrogen Sulfide (H$_2$S)

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Hydrogen Sulfide Removal Systems
Biological/Iron Sponge Systems

- **Features**
  - Hydrated iron oxide on a wood shavings and chips carrier.
  - Water is re-circulated through the system.
  - Oxygen is injected into the system.
Hydrogen Sulfide Removal Systems
Biological Systems

Typically used on applications with high H$_2$S levels

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Gas Blower and Compressor Systems
Skid Mounted Equipment

- Digester or Landfill
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane/VOC Removal

- MicroTurbines
- IC Engines
- Boilers
Gas Blower Systems
Generation Supported

- Internal Combustion Engines
  - Caterpillar
  - GE Jenbacher
  - GE Waukesha
  - Cummins
  - MWM
  - Liebherr
  - MAN
  - Tech 3

- Direct Use Boiler

- Fuel Cells

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Gas Blower Systems
Major Components

Gas Blower Inlet
Moisture/Particulate Filter

Rotary Lobe Positive Displacement Blower

OR
Multistage Centrifugal Blower

Forced Air To Gas Heat Exchanger (Optional)

Dual Core Heat Exchanger

Glycol Chiller

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Gas Blower Systems
Skid Mounted Equipment

Rotary Lobe Positive Displacement Blower System

Multistage Centrifugal Blower System

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Gas Compressor Systems
Generation Supported

- Turbines
  - Capstone
  - Solar
- Direct Use Boiler
- Direct Use Pipeline
- Fuel Cells
Gas Compressor Systems
Skid Mounted Equipment

Oil Flooded Twin Screw
Compressor System

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What Are Siloxanes?

- What is a Siloxane?
  - 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
  - *Dry Cleaning Solutions*
  - *Windshield Cleaning Products*
  - *RTV Silicone Cleaner*

- Siloxanes break down in landfills and digesters, and combine with the methane gas

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Siloxane Removal Systems
Siloxane Impact on Engines

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Siloxane Removal Systems
Siloxane and VOC Removal

Biogas with siloxanes and other VOC’s

Carbon Media
Through adsorption, organics are attracted to the surface and pores of the carbon media

Biogas free of siloxanes

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Siloxane Removal Systems
Siloxane and VOC Removal

Carbon Media - Type is determined based on siloxane levels

Biogas with siloxanes - H₂S has been removed

Biogas - ready for use

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Gas Testing/Sampling
Sampling and Shipping Supplies

Box with Limited Quantity Label

Metal Can, Lid and Sealing Ring

Hose Barb Fitting

Flexible Tubing

Tedlar Bag with Valve

Chain of Custody

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Budgetary Biogas System Costs

- **50scfm Systems**
  - Low Pressure Ranges From: $200,000 to $325,000
  - High Pressure Ranges From: $230,000 to $340,000

- **100scfm Systems**
  - Low Pressure Ranges From: $230,000 to $400,000
  - High Pressure Ranges From: $240,000 to $380,000

- **300scfm Systems**
  - Low Pressure Ranges From: $270,000 to $580,000
  - High Pressure Ranges From: $310,000 to $600,000
BioCNG™ Vehicle Fueling System
Process Flow Diagram

Addition of Proprietary CO₂ Removal System

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

- MicroTurbines
- IC Engines
- Boilers

Potential Energy Produced
Vehicle Fuel
Electricity
Heat
Contact Information

Thank You!

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