As the USA leader in anaerobic digestion, DVO’s patented, efficient and cost-effective systems provide:

• Renewable power generation
• Quality solid fertilizer
• Liquid fertilizer for crop application
• Odor and pathogen control
DVO is based in Wisconsin, USA

Founded in 1989 by Steve Dvorak, P.E.
  - Packerland digester in 1985 – still operating
  - Our first digester (patented design)
    - Gordondale Farms, WI in September 2001

DVO is the USA market leader, with 84 digesters operating at 64 sites in 15 U.S. states

19 more are under construction
LARGEST DIGESTER

- 15,000 cow milking dairy, 11M gallon capacity
- 4.5 MW generation capacity
- Commissioning in 2011
BIOLOGICAL SYSTEM

- Manure/Waste Collection System
  - Dairies (flush & scrape), Other Animal Wastes
  - Mixed Materials: Food Processing, Biofuels, etc.
- Digester Vessel
  - Plug-flow Digester
  - First In, First Out
- Digester Mixing
  - Biogas Recirculation
- Digester Temperature
  - Typically Mesophilic = 38.3° C
TRADITIONAL DIGESTERS

MIXED

- **Advantages**
  - For Waste < 11% Solids
  - Solids & Liquids in Suspension
    - Less Stratification & Settling Issues
- **Disadvantages**
  - No Guaranteed Retention Time
    - Incomplete Pathogen & Volatile Fatty Acid Destruction

PLUG-FLOW

- **Advantages**
  - Guaranteed Retention Time
    - Pathogen Destruction
    - Gas Production
    - High Solids Content
- **Disadvantages**
  - No Waste < 11% Solids
    - Solids Settling
    - Temperature Stratification
DVO’S PATENTED DIGESTER

**MIXED**

- **Advantages**
  - For Waste < 11% Solids
  - Solids & Liquids in Suspension
    - Less Stratification & Settling Issues
- **Disadvantages**
  - No Guaranteed Retention Time
    - Incomplete Pathogen & Volatile Fatty Acid Destruction

**PLUG-FLOW**

- **Advantages**
  - Guaranteed Retention Time
    - Pathogen Destruction
    - Gas Production
    - High Solids Content
- **Disadvantages**
  - No Waste < 11% Solids
    - Solids Settling
    - Temperature Stratification
- To more easily maintain an even temperature. By moderating temperature fluctuations bacteria growth is optimized.

- For more efficiency: Far less energy is required to maintain optimal operating temperatures in cooler seasons, than with above-ground tanks

- Very hot days also do not raise temperatures too high.

- GHD vessels are much stronger than steel tanks, which have been known to freeze, fail and even rupture (spilling their contents)
97% Volatile Fatty Acid (VFA) destruction per EPA – AgSTAR study

- Waste is collected and completely contained, then the odor is “burned” away in the biogas engines.
- The digested liquid can be land applied with little odor.
- Facilities can be located closer to populated areas (for shorter waste transport distances).
- To obtain a farm permit some communities are now requiring a DVO digester for optimal odor and pathogen control.
• Pathogens such as E. coli and salmonella are reduced in the digested waste – often to the point of undetectability.

  • An answer to concerns about spreading raw, unprocessed farm wastes on fields
  • This ability is partly due to DVO’s guaranteed hydraulic retention time.
  • Unlike competitor designs, every unit of waste is retained in the vessel for a specific amount of time. Nothing is removed too soon, or too late.
### EPA AgStar Pathogen Evaluation: DVO

#### DIGESTER INFLUENT

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>11/3/04</th>
<th>11/16/04</th>
<th>11/30/04</th>
<th>12/28/04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal Streptococcus (col/g WWB)</td>
<td>380,000,000</td>
<td>110,000,000</td>
<td>64,000,000</td>
<td>480,000,000</td>
</tr>
<tr>
<td>Fecal Coliform (col/g WWB)</td>
<td>350,000,000</td>
<td>170,000,000</td>
<td>130,000,000</td>
<td>160,000,000</td>
</tr>
<tr>
<td>Total Phosphorous (mg/Kg WWB)</td>
<td>950</td>
<td>780</td>
<td>910</td>
<td>750</td>
</tr>
<tr>
<td>Total Solids (%)</td>
<td>10.9</td>
<td>9.8</td>
<td>9.3</td>
<td>9.3</td>
</tr>
<tr>
<td>Volatile Fatty Acids (mg/Kg WWB)</td>
<td>7,520</td>
<td>7,060</td>
<td>6,000</td>
<td>7,140</td>
</tr>
</tbody>
</table>

#### DIGESTER EFFLUENT

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>11/3/04</th>
<th>11/16/04</th>
<th>11/30/04</th>
<th>12/28/04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal Streptococcus (col/g WWB)</td>
<td>8,700,000</td>
<td>6,000,000</td>
<td>1,700,000</td>
<td>34,000,000</td>
</tr>
<tr>
<td>Fecal Coliform (col/g WWB)</td>
<td>660,000</td>
<td>370,000</td>
<td>380,000</td>
<td>240,000</td>
</tr>
<tr>
<td>Total Phosphorous (mg/Kg WWB)</td>
<td>780</td>
<td>840</td>
<td>860</td>
<td>550</td>
</tr>
<tr>
<td>Total Solids (%)</td>
<td>6.4</td>
<td>6.5</td>
<td>6.4</td>
<td>6.1</td>
</tr>
<tr>
<td>Volatile Fatty Acids (mg/Kg WWB)</td>
<td>300</td>
<td>282</td>
<td>321</td>
<td>259</td>
</tr>
</tbody>
</table>

% DWB = (mg/Kg DWB) / 10,000  
mg/Kg = ppm
PERFORMANCE (dairy)

- 55 - 60% Methane (CO₂ ~ 45%)
- By design, GHD offers superior biological degradation and the highest gas production volume for any given waste stream. For example:
  - 3.1 M³ (110 ft³) of biogas/cow/day
  - 6-7 kW/cow/day (FC, manure only, NO substrates)
- Lowest parasitic load (energy cost of operation)
  - <10% average...over 90% of generated electricity is available.
- Provides Electricity and Heat
- Small Amount of H₂S (1500-6000 ppm)
REQUIREMENTS FOR A SUCCESSFUL DIGESTER

- Guaranteed retention time for the entire waste stream (for higher efficiency and pathogen destruction)
- No stratification of solids in-vessel
  - Constant temperature
  - Full dispersion of bacteria population
- Ability to handle multiple waste streams
- Ability to handle a wide range of waste streams, and percent solids concentration
DIGESTER SELECTION CRITERIA

- Farm-practical operation
- Low maintenance
- Cost per kW produced
- kW produced per unit of Waste
- Ability to accept different % solids
- Number of systems in operation (experience & track record)
- System’s parasitic load (% of kW produced)
- Quality of separated solids & liquid effluent
- Third party data / performance verification
Thank You!