
DVO
ANAEROBIC
DIGESTERS
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

BACKGROUND

- 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

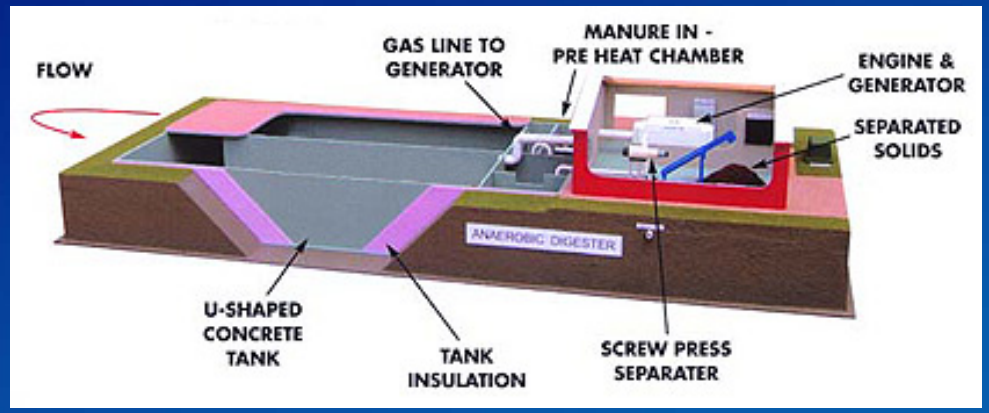
LARGEST DIGESTER

- 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^{o} 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

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- **Advantages**
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Why Below-Ground?

- 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)

ODOR CONTROL

- **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.

PATHOGEN DESTRUCTION

- 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				
PARAMETERS	11/3/04	11/16/04	11/30/04	12/28/04
Fecal Streptococcus (col/g WWB)	380,000,000	110,000,000	64,000,000	480,000,000
Fecal Coliform (col/g WWB)	350,000,000	170,000,000	130,000,000	160,000,000
Total Phosphorous (mg/Kg WWB)	950	780	910	750
Total Solids (%)	10.9	9.8	9.3	9.3
Volatile Fatty Acids (mg/Kg WWB)	7,520	7,060	6,000	7,140
DIGESTER EFFLUENT				
PARAMETERS	11/3/04	11/16/04	11/30/04	12/28/04
Fecal Streptococcus (col/g WWB)	8,700,000	6,000,000	1,700,000	34,000,000
Fecal Coliform (col/g WWB)	660,000	370,000	380,000	240,000
Total Phosphorous (mg/Kg WWB)	780	840	860	550
Total Solids (%)	6.4	6.5	6.4	6.1
Volatile Fatty Acids (mg/Kg WWB)	300	282	321	259

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

PERFORMANCE (dairy)

- 55 - 60% Methane (CO_2 ~ 45%)
- By design, GHD offers superior biological degradation and the highest gas production volume for any given waste stream. For example:
  - 3.1 M^3 (110 ft^3) 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 H_2S (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

DVO | ANAEROBIC SYSTEMS

INFO@DVOINC.NET CHILTON, WI USA 920 . 849 . 9797