Farm-Based Anaerobic Digesters

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What is an anaerobic digester?

Methane is the main component of natural gas. It is generated during the decay of organic waste materials (animal manure) in an anaerobic (oxygen free) environment.
An anaerobic digester is an enclosed tank that excludes oxygen through which manure is passed and broken down by naturally occurring bacteria.

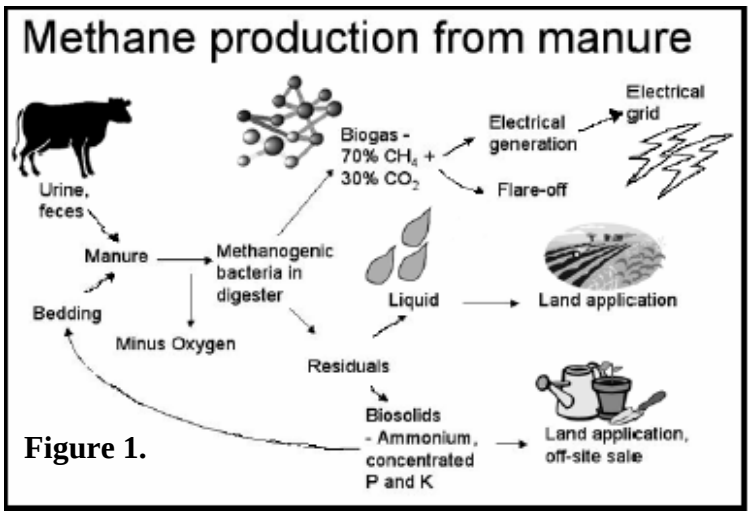

Figure 1.

The process (Figure 1) produces heat and releases biogas. This biogas is composed of approximately 55-70% methane. The methane can either be flared off or captured and harnessed to a generator to produce electricity for use on the farm or sold to a local utility. The heat produced can be recycled to maintain the required digester temperature or used for space or water heating elsewhere on the farm.

What are the benefits of anaerobic digesters?

- **Odor and fly control.** Anaerobic digesters consume noxious compounds in the manure as it moves through the digester. One study showed that anaerobic digestion reduced odor by 97% over fresh manure. The organic content of digested manure is also less than in raw manure, limiting the propagation of flies.
- **Energy production.** Not all digester systems produce energy; in some cases the odor is removed and the gas produced is flared. However, using the methane to produce energy may provide significant payback. Most commonly the methane generated is burned in an engine-generator to produce electricity, and the waste heat is used to maintain the digester temperature or space and water heating. With an efficiently running anaerobic digester, a farm can generally produce two to three times its total electricity need.
- **Increased fertilizer value of remaining biosolids.** The biosolids remaining after anaerobic digestion contain higher concentrations of nitrogen, phosphorus, potassium, and trace elements than raw manure. Also the nitrogen in the biosolids is in a mineralized form (ammonium or nitrate) rather than the organic form, making it more readily available to plants, much like commercial fertilizers. The biosolids can also be composted and marketed as soil amendment.
- **Pathogen and weed seed destruction.** Due to the lack of oxygen and the temperature of the manure digestion process, most weed seeds and more than 90% of pathogens, such as *E. coli* are destroyed.

Types of anaerobic digesters.

Methane producing bacteria flourish at temperatures of 95°-105° F. Therefore heated digesters are more efficient producers of methane than non-heated ones. There are four basic digester

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designs for on-farm use: the covered lagoon digester, complete mix digester, plug flow digester, and temperature-phased anaerobic digesters (TPAD).

Covered Lagoon Digester. A covered lagoon digester is simply a manure lagoon with an impermeable cover. The cover traps gas produced during decomposition of the manure. They work best for liquid manure with less than 2% solids. Because the rate of methane production is dependent on ambient temperature, it is not considered cost-effective for production of biogas for energy in northern climates. It is however, the least expensive of the four types and is effective in reducing odors, even in cold climates.

Complete Mix Digester. Complete mix digesters work best with manure that is 3-10% solids, such as swine manure or dairy manure collected by a flush system. Manure is processed in a heated tank above or below ground. A mechanical gas mixer is necessary to keep the solids in suspension. A complete mix digester is more expensive to install and costs more to operate and maintain than a plug-flow digester.

Plug-Flow Digester. A plug-flow digester (Figure 2) is most suitable for manure with a solids content of 11-14%, such as cow manure collected by scraping. Raw manure enters one end of the plug-flow digester and decomposes as it moves through the digester. New manure added to the digester tank pushes older material through the digester to the discharge end. Coarse solids in the manure form a thick sticky material as they are digested, limiting separation of solids and forming a "plug." A flexible, impermeable cover on the digester traps the biogas as the manure is digested. For optimal digestion, it takes 15-20 days for a plug to pass completely through the digester. The majority of digesters currently being built in the Midwest are plug-flow digesters or some variation of the plug-flow design.

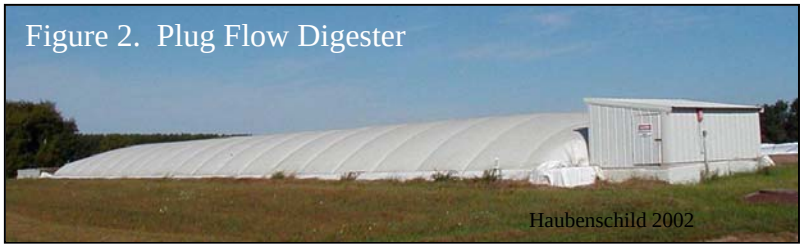

Figure 2. Plug Flow Digester

Temperature-phased Anaerobic Digesters (TPAD). The TPAD is a variation of the complete mix digester recently developed by Iowa State University. It consists of a two-staged reactor to optimize methane recovery from the manure. The first stage operates at a high temperature (135° F) while the second stage digests at a lower temperature (95° F). As with the complete mix digester, the system works best with more dilute manure. Initial research indicates improved odor control, reduced foaming, additional volatile solids destruction, and improved dewatering characteristics compared with conventional plug-flow designs. Also the extremely high temperatures during the first stage of digestion kill more pathogens resulting in a higher quality biosolids product. Although this system is promising, there is very little data available on field-scale systems.

For more information, please contact your county MSU Extension Agent.

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