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UNL's Livestock Environmental Issues Committee
Includes representation from UNL, Nebraska Department of Environmental Quality, Natural Resources Conservation Service, Natural Resources Districts, Center for Rural Affairs, Nebraska Cattlemen, USDA Ag Research Services, and Nebraska Pork Producers Association.

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What is an Anaerobic Digester?

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What is a Methane Digester?

The first methane digester plant was built at a leper colony in Bombay, India in 1859[1]. A methane digester system, commonly referred to as an AD (anaerobic digester) is a device that promotes the decomposition of manure or "digestion" of the organics in manure to simple organics and gaseous biogas products. Manure is regularly put into the digester after which the microbes break down the manure into biogas and a digested solid. The digested manure is then deposited into a storage structure. The biogas can be used in an engine generator or burned in a hot water heater modified for biogas. AD systems (Figure 1) are simple biological systems and must be kept at an operating temperature of 100 degrees F in order to function properly.

Anaerobic Digestion*/noun*: a biochemical degradation process that converts complex organic material, such as animal manure, into methane and other by-products.

What is Biogas?

Biogas is formed by the activity of anaerobic bacteria. Microbial growth and biogas production are very slow at ambient temperatures. These bacteria occur naturally in organic environments where oxygen is limited. Biogas is comprised of about 60% methane, 40% carbon dioxide, and between 0.2 to 0.4% hydrogen sulfide. Biogas is very corrosive to equipment and requires frequent oil changes in an engine generator set to prevent mechanical failure. The heating value of biogas is about 60% of natural gas and about 1/4 of propane. That is, one cubic foot of propane is the same as 4 cubic feet of biogas. Because of the low energy content and it's corrosive nature of biogas, storage of biogas is not practical.

Types of Anaerobic Digesters

There are three primary types of anaerobic digesters used for livestock farms.

Covered Anaerobic Lagoon Covered anaerobic lagoons can be used to generate and collect biogas from manure. They consist of a plastic impermeable flexible cover with manifolds designed to collect the gas produced. They are most applicable for swine or dairy operations which utilizing a flush system to transport manure to the lagoon. The manure

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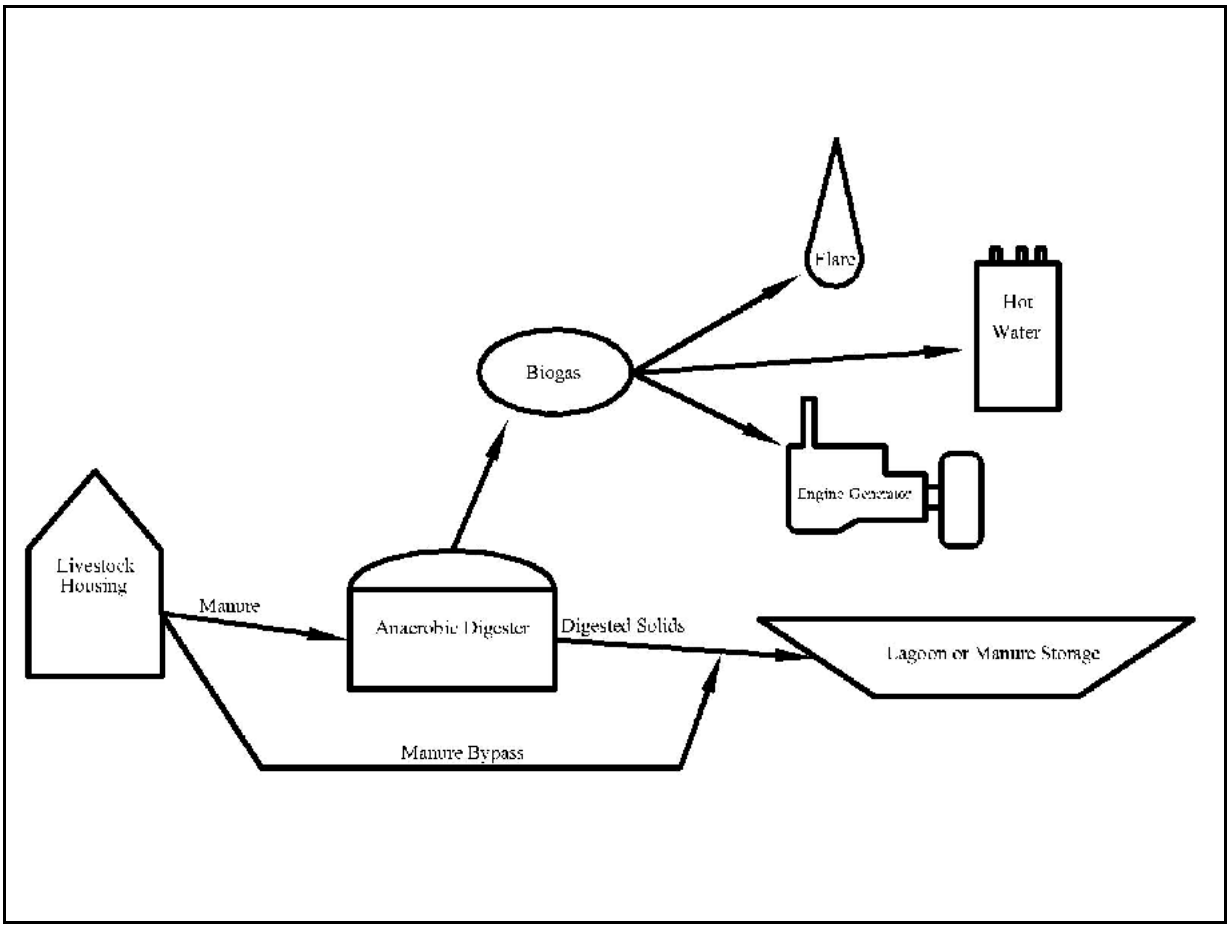

Figure 1. Schematic of AD System

should be dilute and contain less than 2% solids. Covered lagoons require warm climates to produce gas year round. They may be used in cold climates, such as Nebraska, for odor control by flaring the collected gas.[3]

Complete Mix A complete mix digester is an engineered tank either above or below ground typically constructed of either steel or concrete that is heated. They can treat manure with a solids concentration of 3 to 10 percent. Complete mix digesters are appropriate for all climate conditions.[3]

Plug Flow A technology borrowed from Asia and first attempted by Cornell scientists for dairy operations. They are engineered, heated, rectangular tanks with a flexible cover for biogas collection. They are best suited for scraped dairy manure that has a solids concentration of 11-13 percent. Swine manure has not been successfully digested in plug flow digesters because of the low fiber content of swine manure. Because they are internally heated, plug flow digesters can operate in any climate.[3]

Uses for Biogas

Biogas is highly corrosive due to the hydrogen sulfide and water vapor present in the gas. Biogas has been effectively used as a fuel in industrial high compression spark ignition engines. To generate electricity an induction generator can be used and is the simplest to interface to the electrical grid. Induction generators derive their voltage, phase, and frequency from the utility and cannot be used for stand-by power. If a power outage occurs generator will cease to operate. The other type of generator is a synchronous and can be used to generate electricity to the grid or on standby. However, they require expensive and

sophisticated equipment to match the phase, frequency and voltage of the utility grid. A lactating dairy cow would generate enough biogas from manure to generate 2.5 to 3 KWh per day. Using Nebraska's energy price of $0.06 would equal about $0.15-$0.18/day compared to New York's price of $0.15- $0.18/KWh or about $0.30-$0.36/day. Biogas can also be used as fuel in a hot water heater if hydrogen sulfide is removed from the gas supply.

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Odor Control Benefits of AD

Digested manure is very stable and since the volatile compounds are removed, produces much less odor than undigested manure. This means there is less odor emitted from the manure storage and from the land application of manure. This is an important point, since most odor complaints tend to arise during the agitation and spreading of manure.

What type of operation is a good candidate for a digester (in Nebraska)?

- Must handle manure as a slurry. So flush systems and dry lots are not good candidates for an AD.
- Nebraska climate is too cold for a covered anaerobic lagoon to generate enough biogas for electricity generation.
- Dairies using sand for bedding will not be able to use AD technology. The sand is causes handling and maintenance problems.
- AD operators must be mechanically inclined. Most AD owners indicate at least 20 minutes a day are devoted to generator maintenance.
- An anaerobic digester will require a long term commitment somewhere between 10-20 years depending on the specific economics of the situation.
- If the facility is existing, there will need to be space for the digester and a generating facility.
- The facility must be able to exclude any water additions to the manure put into the digester. This includes rainwater and any wash water, such as water used to clean parlors.

What We Know So Far...

Research on anaerobic digesters has been ongoing since the early to mid 1970's. The technology works well and is proven. Many of the early digester projects failed because of poor design or technical support to keep them maintained. However, the failure rate of digesters after 1984 is much better than those constructed from 1972-1984.[2]

One of the most significant barriers is economics. It is very difficult to justify the investment in an anaerobic digester based only on the revenue received for electricity and the sales of surplus electricity.[2] The operation must attribute some added value to the odor benefit in order to justify the additional cost a livestock operation must bear for the AD.

1 Meynell, P-J. 1976. Methane: Planning a Digester. New York: Schocken Books. pp 3
2 Lusk. P. 1998. Methane Recovery from Animal Manures The Current Opportunities Casebook. National Renewable Energy Laboratory. pp.3-22.
3 Roos, K. F. And M. A. Moser. 1997. AgSTAR Handbook. US EPA.

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