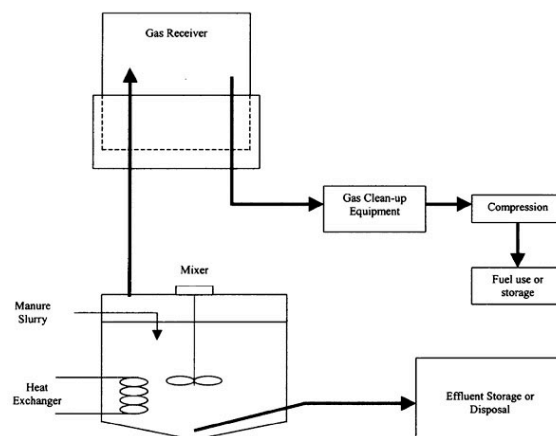


# Anaerobic Digestion

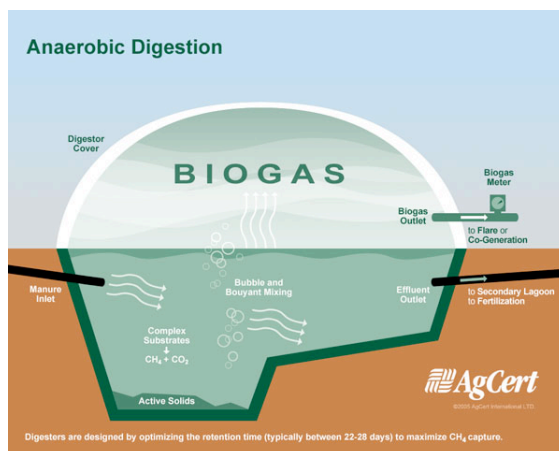
Anaerobic digestion is the expedited natural process by which manure solids are converted to biogas (predominately methane) and digested solids or liquids. Anaerobic digestion provides a solution to many waste management problems and the environmental effects. The basic components of an anaerobic digestion system are outlined in figure 1. Digestion for methane production occurs best at temperatures between 95°-105° F, so heated systems are the most efficient producers of methane. Specific designs and types of anaerobic digesters are discussed in more detail below. Although anaerobic digesters have many benefits, the cost effectiveness of a system must be evaluated for each individual operation (Balsam, 2006).



**Figure 1: Basic components of an anaerobic digestion system.** Source: Balsam, 2006

## Covered Lagoon Digester

The covered lagoon digester uses the same principles that apply to any lagoon system with an added pontoon or floating cover. Sections of the cover, called seal plates, extend down into the lagoon to prevent the exposure of generated gas to the atmosphere. Covered lagoons work best with a low amount of manure solid content, preferably around 2% or less, and in warmer climates where the consistent atmospheric heat help maintain digester temperatures to optimize methane production. However, it is the least expensive design and is an effective odor control system in any climate.



**Figure 2 : Diagram of a Covered Lagoon Digester**  
Source: Ag Cert

Dr. Rhonda Miller  
Utah State University,  
Logan, Utah

Author's email:  
rhonda.miller@usu.edu

Assistance and Design:  
Jennifer Major  
[Other]

## Complete Mix Digester

Complete mix digester is the most expensive system to install and operate, but is the most efficient system for wash out manure operations. The complete mix digester is a silo-like tank where the manure is heated and mixed, with an optimal solid content of 2-10%. Several farms have used smaller mix digesters in conjunction with lagoons or other hybrid systems.

## Plug-flow Digester

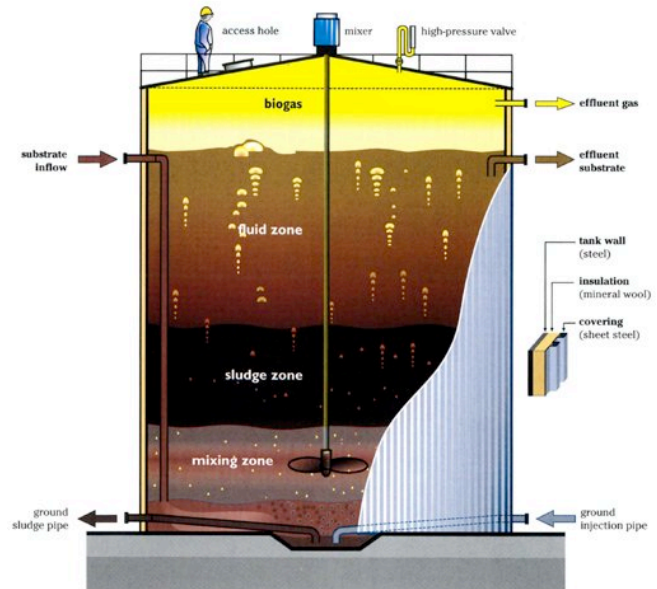
A horizontal, cylindrical tank where gas and other by-products are pushed out as manure is loaded in the other end. The plug-flow digester optimally handles a solid content of 11-13% and generally has hot-water piping to maintain the necessary temperatures for digestion. This is the most appropriate system for operations that remove manure mechanically. Over one half of the digester systems in the U.S. are plug-flow systems.



**Figure 4: Plug-flow Digester** Source: <http://www.plugflowdigester.com>

## Hybrid systems

Many operations today are installing hybrid systems with one or more components from each system type. Because of their adaptability, using a hybrid system can alter any system to meet the specific needs and optimize the gas production of each operation (Balsam, 2006). One example is the Temperature-phased Anaerobic Digester (TPAD) developed by Iowa State University to optimize the process for methane production. The TPAD is a two-stage reactor where the first stage is a high temperature treatment and the second stage operates at a lower temperature. The system is very similar to the complete mix digester and works best with dilute manure. The potential of this system is to achieve more complete pathogen kill as a result of the high temperature (Pillars, 2009).



**Figure 3: Diagram of a Complete Mix Digester**

Source: [http://www.daviddarling.info/encyclopedia/A/AE\\_anaerobic\\_digestion.html](http://www.daviddarling.info/encyclopedia/A/AE_anaerobic_digestion.html)

## Benefits of Anaerobic Digesters

### Odor and Fly Control

Due to the nature and design of anaerobic digestion systems, odor and fly problems on an operation's manure storage sites are virtually eliminated. During the digestion period when the manure does not have any contact with the open atmosphere there are no side effects associated with odor and fly control. Even when digestion is finished and digested solids are stored outside the limited available organic matter yield a reduced fly population. The process of anaerobic digestion itself converts odor-causing organic matter into methane and carbon dioxide, which are odorless.

### Energy Production

Anaerobic digestion produces a biogas that can be used for a variety of productions, including cooking, heating, cooling, lighting, and generating electricity or steam. In general the biogas by-product contains 60-70% methane, 30-40% carbon dioxide, 1-2 % water, and various toxic gases like ammonia and hydrogen sulfide in trace amounts. The use of biogas as an energy source has the potential to reduce an operation's dependency on outside energy by 60-100%. For example 50 dairy cows, 600 hogs, or 7,870 layers can produce enough biogas energy to heat a well-insulated three-bedroom home during the winter months; this assumes that 35% of the energy produced goes back to maintain the

digester temperature. Depending on the operation's current design, some major renovations may be required to use biogas as a major energy source. Although it can be used 'as is' it is recommended that the biogas be refined as methane before use in a house or other facilities. If the operation is already designed to handle natural gas, some very simple adjustments will convert the system to the use of biogas; however, if that is not the case a more costly renovation is required. Instead of using biogas energy in-house, another option is to convert it to electricity and sell it to a utility company; make contract arrangements before investing in equipment.

### Increased fertilizer value

The digestion process reduces many nutrients in animal manure from an organic form to a mineralized form similar to that of commercial feeds. The concentrations of nutrients like nitrogen, phosphorus, potassium, and other trace elements are also higher in the biosolids remaining after digestion. These characteristics make biosolids an optimal fertilizer or soil amendment for market.

### Pathogen and Weed seed Destruction

Due to the nature of the digestion process, namely the lack of oxygen and high temperature, 90% of pathogens and most weed seeds are destroyed.

## Resources

Balsam, J. (2006). *Anaerobic Digestion of Animal Waste: Factors to Consider*. Retrieved January 2010, from National Sustainable Agriculture Information Service: <http://attra.ncat.org/attra-pub/anaerobic.html>

Gaddy, J., Park, E., & Rapp, E. (1974). *Kinetics and Economics of Anaerobic Digestion of Animal Waste*. Retrieved January 2010, from Springerlink.com: <http://www.springerlink.com/content/vv857ux433680477/fulltext.pdf>

Pillars, R. (2009). *Farm-based Anaerobic Digesters*. Retrieved February 2010, from Agricultural Marketing Resource Center: [http://www.agmrc.org/media/cms/FinalAnearobicDigestionFactsheet\\_2E11FAB524961.pdf](http://www.agmrc.org/media/cms/FinalAnearobicDigestionFactsheet_2E11FAB524961.pdf)

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