Anaerobic Digester FAQs

Michigan Biomass Energy Program
Dulcey Simpkins | 517-241-6223 | dlsimpk@michigan.gov

What are anaerobic digesters?

Anaerobic digesters provide an environment for the oxygen-free decomposition of organic materials by bacteria. In contrast to aerobic decomposition such as that which takes place in compost heaps and is “aerated” by frequent turning to expose materials to oxygen-rich air, anaerobic digestion requires a sealed and usually a heated environment that has no oxygen present. In each situation, different kinds of decomposing bacteria present work to break down complex fats, proteins and carbohydrates into simpler constituent elements.

Two kinds of bacteria are needed for anaerobic digesters to function properly. Fermenting bacteria, such as those used in composting and in culturing dairy products, feed off the manure or other organic materials and release organic acids. These acid byproducts then foster the growth of methanogenic (methane producing) bacteria. This second type of bacteria also feeds on the organic matter, and emits methane as a waste. Only by working together can these bacteria produce the complete digestion of the organics into biogas. As a result, the heat, pH balance, and input rate into a digester must be appropriate to both sets of bacteria.

In sum, the anaerobic digestion process is very similar to digestion in your gastro-intestinal tract. The operations of a digester—like those of your own food processing abilities—can be called a metabolism. This metabolism is sensitive to changing conditions both inside and outside the digester, just as your metabolism changes based upon what you eat and how you exercise, as well as your climate.

Who uses anaerobic digesters?

Urban waste water treatment facilities frequently run anaerobic digestion systems in order to kill pathogens. Occasionally, cities invest in making the biogas byproduct available for energy production, but often the biogas is flared to “save money” in the short term. Livestock operations also use digesters to remove the “volatile solids” content of manure that creates odor, as well as to generate higher value compost and sometimes to produce energy as well. For similar reasons, some food processors and rendering facilities are also investing in anaerobic digesters.

Why doesn’t the US have many digesters?

People world-wide depend on anaerobic digestion to extract methane from waste. Kitchens in China and India often run off of digested household waste in a simple plastic container lagoon placed some short distance away from a house. Digesters are commonly used in Europe as a result of high land values, intermingling of residential and agricultural land uses, and proactive renewable energy policies. In addition, digesters are commonplace in US wastewater treatment facilities because of their ability to kill pathogens and create a “clean” soil-like biosolid in the process. However, the view of digesters as value-producing capital investments is only slowly catching on in agriculture, food processing, and other industries with organic waste products.

Because energy policy has supported fossil fuel least cost energy sources here, and because land generally has been viewed as a limitless resource, the United States has not seen sustained digester technology development and deployment until quite recently.

The initial round of digesters built in the 1970s was prompted by the worldwide energy crisis. Some of those digesters are still in operation today, but many of them failed due to inferior parts, lack of standardized systems and—most importantly—poor management by farm owners, who were unable or unwilling to commit some time to maintain the digester's "metabolism."

Why are digesters becoming more important in agriculture?
Low fossil fuel prices have not encouraged the use of renewable fuels. As a result, the energy production potential of anaerobic digesters has not been realized. However, new laws regulating odor, groundwater contamination, and greenhouse gases in various parts of the United States make this technology increasingly attractive for manure management compliance. As farmers make digester investments, they have been looking for ways to mitigate this new capital cost, and have been using energy production from methane as one of the "payoffs" of their investment. Other payoffs include the value of the digestate (the solid by-product of the digestion process), which is enhanced in available nutrient value as well as odorless and virtually pathogen free. In addition, liquid byproducts can be augured out and sold as concentrated fertilizers. Other uses for these byproducts of anaerobic digestion are under study.

Is anaerobic digestion different from composting?
Yes. Biogas is formed solely through the activity of bacteria in the digestion process, which takes place in an anaerobic (oxygen-free) environment. In contrast, fungi and lower creatures that require oxygen, as well as bacteria, are also involved in the composting process.

Does anaerobic digestion produce ammonia?
Yes. However, anaerobic digester designers have not been asked to address an ammonia "problem" because ammonia can be advantageous in agricultural settings. One of the largest problems facing the livestock industry is oversupply of nutrients to water resources. Nitrogen from straight manure is not in an easily accessible form, and much of it runs off into water. However, digesters take available N and convert most of it into ammonia. The higher the percentage of N in the ammonia form, the less uncontrolled release of N from organic compounds to the soil. To maximize the benefit of manure fertilization and minimize leaching losses, ammonia is preferred.

Does anaerobic digestion reduce the amount of manure from livestock operations?
There are some small reductions in overall volume of manure. However, digestion primarily transforms the content of manure to a different form. It is not "elimination of manure" that makes digesters helpful; it is the transformation of properties and separation of solids permitted by the digestion process. By doing so, the nutrients in manure are made more readily available to plants, and the undesirable odor aspects of manure are minimized. In addition, water can be separated out of the manure through the digestion process, leaving a compost-like solid as one by-product and a nutrient-rich water as another. Both of these products have a higher market value after digestion, because they are easier to transport as a lighter solid (sold as compost locally or bagged for chain stores) and as a liquid fertilizer (or simply as water if the nutrients are removed). In this way, manure can be made more valuable and less likely to become a water pollution and odor problem by moving it off the land in different post-digestion forms.

Does the digestion process kill diseases that can be spread by manure?
Heated digesters (mesophilic and thermophilic) do kill pathogens, or disease-spreading bacteria. The hotter the process, the higher the kill rate; thermophilic digesters kill more than 99.99% of all pathogens.

What is the optimal temperature for anaerobic digestion?
This is a complex question. In terms of gas production and pathogen kill, higher temperatures are best [thermophilic temperature range (125°-135°F)]. However, in terms of overall system cost and reliability, medium-high temperatures are best [mesophilic temperature range (95°-105°F)].

Do antibiotics affect anaerobic digestion?
Yes. Use of antibiotics in livestock has a negative effect on creation of methane in the anaerobic digester. Antibiotics can kill off the fermenting and methanogenic bacteria that allow for the production of methane.

Is running a digester complicated?
No. BUT—operators MUST observe and adjust your digester daily. 10-20 minutes per day should be devoted to checking the temperature, pH, gas production rates, and overall function of the digester. This is a capital investment that is essentially a living machine, helping to address a manure management situation while producing energy and other by-products with its “metabolism.” Naturally, operators will want to make sure that it does not have indigestion on a regular basis!

Can anaerobic digestion take place without machinery?
Yes, but more slowly. Biogas production is very slow at ambient temperatures, but increases when higher temperatures facilitate bacterial growth. Anaerobic digestion occurs naturally wherever high concentrations of wet organic matter accumulate in the absence of dissolved oxygen, most commonly in the bottom sediments of lakes and ponds, in swamps, peat bogs, intestines of animals, and in the anaerobic interiors of landfill sites. However, the development of various anaerobic digestion equipment that create zero-oxygen heated environments dramatically increases the productivity of the bacteria that digest the organic materials.

References

Methane from Anaerobic Digestion--EERE
http://www.eere.energy.gov/consumerinfo/factsheets/ab5.html

Farm-Based Energy from Anaerobic Digestion—The Minnesota Project
http://www.mnproject.org/programs/energy_sub/farmbased_sub/fblinks.htm

Farm Energy from Manure—Focus on Energy, Wisconsin
http://www.focusonenergy.com/data/common/dmsFiles/W_RB_MKFS_Farm%20energy%20from%20manure.pdf

Agricultural Anaerobic Digestion Handbook—Colorado
http://www.state.co.us/oemc/programs/agriculture/hog_wastes/aad_book.pdf

Anaerobic Digestion: Holistic Bioprocessing of Animal Manures—Ann Wilkie, University of Florida
http://www.mlui.org/downloads/wilkieholistic.pdf