

AGRI-FACTS

Practical Information for Alberta's Agriculture Industry

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Anaerobic Digesters: Frequently Asked Questions

What is the anaerobic digestion process?

Anaerobic digestion is a process that occurs naturally in the absence of air. During this process, micro-organisms stabilize waste organic matter and release biogas.

What is biogas?

Micro-organisms convert a fraction of the organic waste matter into methane (CH_4) and carbon dioxide (CO_2) gases during the anaerobic digestion process. This mixture of gases is known as biogas. The composition of biogas is 50 to 75 per cent CH_4 and 25 to 45 per cent CO_2 . Power generators, engines, boilers and burners can use biogas as a fuel like natural gas.

What impurities are in the biogas?

Biogas coming from anaerobic digesters has trace gases such as water vapour (H_2O), hydrogen sulphide (H_2S), nitrogen (N_2), hydrogen (H_2) and oxygen (O_2). Of these trace gases, water and H_2S gases require removal before producing energy. A gas scrubber usually removes corrosive H_2S . The H_2S content in biogas should be less than 200 ppm to ensure a long life for the power generators.

The cooling of warm biogas in a condenser removes water vapour. Scrubbing the biogas with water can remove CO_2 in a situation where biogas is to be supplied to the natural gas lines.

What are anaerobic digesters?

Anaerobic digesters are specially designed and insulated tanks used to facilitate the anaerobic digestion process under a controlled atmosphere to achieve maximum biogas production in a short period.

What is digestate?

Digestate is the effluent coming from the digester at the completion of the digestion process. Digestate has nutrient value, so producers can apply digestate to land, much like manure.

What materials do anaerobic digesters process?

Manure, feed spills, crop residues, offal and most domestic and industrial organic wastes can be used as feed materials for digesters. However, care must be taken to make sure that pathogens that cause diseases in livestock, such as mad cow disease or avian influenza, are prevented from entering the anaerobic digesters.

What is meant by co-digestion?

Most of the anaerobic digesters in the agriculture industry process a single type of waste known as substrate. An example of this material is cattle feedlot manure. The term co-digestion means processing different types of agricultural wastes in an anaerobic digestion facility. Additional organic feed materials, other than the primary one, are known as co-substrates.

Usually, there will be a substrate and one or many co-substrates. The co-digestion system provides flexibility and the opportunity for farmers to grow and use energy crops to make additional revenue. This process may also enrich or balance the nutrients in the digestate.

What are energy crops?

Agricultural producers can grow some crops for the sole purpose of producing energy using renewable energy technologies such as anaerobic digestion, combustion, incineration, ethanol or biodiesel manufacturing. Those crops are known as energy crops.

Anaerobic digestion is a process that occurs naturally in the absence of air

What are the main process controlling parameters?

Most of the anaerobic digesters are operated in the temperature range of 15 to 45°C. The pH of the slurry in the digester is maintained between 6.5 and 7.5. The typical retention time of organic matter in the anaerobic digesters varies from 2 to 60 days, depending on the type of digester and the concentration of organic matters processed. Anaerobic digesters can process liquid organic waste with a solids concentration in the range of 0.5 to 12 per cent.

How can agricultural producers utilize the potential of biogas energy?

Agricultural producers can use on-farm electricity to meet their farm's demand and then sell the excess electricity to neighbouring communities or to the electricity supplier using the grid.

An anaerobic digester may use approximately half the heat energy produced by a co-generator. Pumping heat energy for the farm's needs and to the neighbouring community are also options. After removing the CO₂ and H₂S, biogas may potentially be added to the natural gas lines. Modified automobiles may use purified or blended biogas as fuel.

How is electricity produced using biogas?

Internal combustion engines or power turbines can convert biogas into electrical energy.

What is a co-generator?

A co-generator is a sophisticated electricity generator that recovers and utilizes the waste heat created in producing electrical and thermal energy. Thus, co-generator efficiency can be up to 90 per cent compared to the 20 to 30 per cent efficiency in conventional electricity generators.

Do all the anaerobic digesters operate in the same way?

While the basic operating principle remains the same, different types of anaerobic digester technologies are commercially available. Choosing a type of digester technology depends on the type of feed material, retention time, solid contents and cost.

Covered lagoons, complete mix, plug flow and attached growth/fixed film are some of the common types. Covered lagoon digesters may not be suitable for Alberta as the atmospheric temperature in winter is extremely low.

Is the digester suitable for Alberta's cold weather?

Most of the anaerobic digesters require heating for optimum biogas production. Therefore, digesters with good insulation can withstand the cold weather in Alberta.

How many additional workers are needed for day-to-day operation?

A fully automated anaerobic digester plant only requires a couple of hours a day of monitoring by a suitably qualified person. However, plant failure or maintenance during shutdown may require more manpower.

Is it expensive to install a biodigester plant, and what would be the payback period?

The capital costs of anaerobic digester plants are very high and may range from a few hundred thousand to a few million dollars, depending on the size of the plant. Some of the feasibility studies in North America concluded that the payback period can range from 5 to 16 years, respectively, when operated under either the optimum or the worst conditions.

How many digesters are there in Alberta?

At least five anaerobic digesters are in use for processing agricultural wastes in Alberta. A few more digesters are in use for processing municipal and industrial wastes.

Is there any opportunity to integrate anaerobic digesters with other renewable energy production methods?

Investors, governments and researchers are still exploring the opportunities for integrating ethanol, biodiesel and anaerobic digestion plants. At least a couple of such plants are being built in North America, one in Ontario and another in Nebraska.

What is renewable energy?

Fossil fuels are the primary energy source in use at present. However, the rapid depletion of fossil fuel resources due to high energy demand is being blamed for increasing greenhouse gas emissions and accelerating global warming.

Fossil fuels were formed over millions of years and are finite in contrast to renewable energy sources, which produce electricity or thermal energy without depleting natural resources. Producing biogas takes a few days or months at most, unlike fossil fuels. Besides biogas, other renewable energy sources include ethanol, bio-diesel, solar and wind energy.

Does this technology reduce odour? If so, by how much?

Measuring odour with confidence is a challenge. However, based on the number of complaints, suppliers claim that anaerobic digesters can reduce odour by 80 per cent with adequate manure management. The anaerobic process appears to transform most of the volatile odorous compounds into biogas. Burning the captured biogas in co-generators to produce energy reduces the odour emission.

Is a permit/approval required to operate digesters?

On-farm digesters do not require a permit/approval as long as the agricultural producer does not bring in off-farm feed material or try to sell excess electricity or construct or modify manure storages. If a producer wishes to use off-farm material or sell excess electricity or modify or construct manure storage, the following steps may apply:

1. Application to Alberta Environment for an environmental approval that will deal with the transportation of waste to an appropriate facility and any air/water issues as well as waste disposal from the project.
2. Application to the Energy Utilities Board for a power plant approval if the facility is generating over 1 MW of electricity.
3. Application to the Natural Resources Conservation Board (NRCB) if new manure storage is constructed or existing ones are modified.
4. Application to an energy provider for grid connection.

How can producers handle the digestate?

The digestate from anaerobic digesters usually contains about the same amount of nutrient as in the feed materials for the digesters; however, nutrients in the digestate are in a more readily available form for plants. Therefore, farmers can apply digestate to land like manure from an on-farm digester.

However, the land application of digestate should meet the allowable nutrient loading levels recommended by the *Agricultural Operations Practices Act and Regulations*. If the digestate is from an off-farm digester, the producer must consult Alberta Environment and the NRCB for permission and guidance for land application. Applying digestate to cropland may replace commercial fertilizer use.

Are there any commercial technology suppliers in Alberta?

Yes, there are some anaerobic digester technology suppliers in Alberta. An up-to-date list of commercial technology suppliers with contact details can be found at the following Alberta Agriculture and Rural Development website link: [www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/eng11239](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/eng11239).

More information

For additional information, see the Alberta Agriculture and Rural Development factsheet *Anaerobic Digesters*, Agdex 768-1.

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