

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 or iron filter can remove corrosive H_2S content in the biogas. 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. In the case of injecting biogas into natural gas pipelines, the CO_2 content needs to be removed along with the other impurities. Either scrubbing the biogas with water or using the pressure swing adsorption technique can remove CO_2 .

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.

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

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 ensure that toxic elements such as heavy metals and pathogens that may 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?

The term co-digestion means simultaneously processing more than one agricultural waste from different sources in an anaerobic digestion facility. Additional organic feed materials, other than the primary one, are known as co-substrates.

The advantage of the co-digestion process is that not only does it process organic wastes from various sources simultaneously, but the process also provides flexibility and opportunity for producers to grow and use energy crops to make additional revenue.

What are energy crops?

Agricultural producers can grow some crops as feedstock for producing renewable energy. Such crops are known as energy crops.

What are the main process controlling parameters?

Most of the anaerobic digesters are operated either in the mesophilic (moderate) temperature range (35 - 37° C) or in the thermophilic (higher) temperature range (55 - 60° 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 30 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 send the excess or all electricity to the grid. After moisture removal, CO₂ and H₂S, biogas may potentially be added to the natural gas lines as well. Apart from this use, modified automobiles may use purified or blended biogas as fuel.

Typically, an anaerobic digester uses approximately half the heat energy produced by a co-generator. Producers may use the excess heat energy either to meet their farm's requirements or to sell to a neighbouring community, if possible.

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 generated while producing electrical energy. Thus, co-generators have a higher efficiency of up to 90 per cent compared to the 20 to 40 per cent efficiency of the generators that do not recover the waste heat.

Do all the anaerobic digesters operate 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/fixd film are some of the common types. Covered lagoon digesters may not be suitable for Alberta as the atmospheric temperature in the province's 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, depending on the plant's efficiency.

How many digesters are there in Alberta?

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

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

Yes. Integrated facilities are desired despite their high capital investment requirement because such facilities are more efficient and make better economic sense. At least one such integrated plant is in Alberta; it houses an ethanol and biogas production facility in a confined feeding operation.

What is renewable energy?

Renewable energy is the energy derived from natural sources that can replenish itself naturally at a rate faster than it is consumed. Biogas, bioethanol, biodiesel, etc. are some examples of renewable fuels that are derived from biomasses. Apart from those sources, energy produced from solar, wind, geothermal and hydro power are considered renewable energy as well.

However, fossil fuels are the primary energy source in use at present. Not only the rapid depletion of fossil fuel resources, but also the increasing global greenhouse gas emissions due to high fossil fuel consumption are significant concerns. Because of these concerns, renewable energy production and its use have become important.

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

Measuring odour with confidence is a challenge. However, based on the number of complaints, plant suppliers claim that anaerobic digesters can reduce odour by 80 per cent with adequate manure management. The anaerobic digestion process appears to transform most of the volatile odorous compounds into biogas.

Therefore, adopting this technology and burning the captured biogas in co-generators not only reduces odour, but also produces renewable energy.

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's generating capacity is over 1 MW of electricity and the producer wants to send the electricity to the grid.
3. Follow the micro-generation regulations under the *Electric Utilities Act*, effective 2009, if the facility's generating capacity is less than 1 MW electricity and the producer wants to send the excess electricity into the grid and claim a credit for the excess supply into the grid.
4. Application to the Natural Resources Conservation Board (NRCB) if new manure storage is constructed or existing ones are modified.
5. Application to an energy provider for grid connection.

How can producers handle the digestate?

The digestate from anaerobic digesters usually contains approximately the same amount of nutrients as the feed materials. However, nutrients in the digestate are in a form more readily available for plants. Therefore, using appropriate technologies, farmers can apply digestate to cropland similar to the way they apply manure.

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.

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More information

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

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