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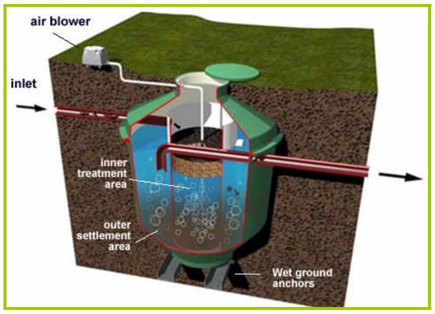
Greenpaper©

Biodigesters

Prepared For:
The Los Angeles Community College District



Subterranean Biodigester

Dual Chamber Biodigester

Biodigester In Mechanical Room

HISTORY

Biodigesters use a combination of two technologies currently used commercially in the United States: a bioreactor and gasification. Self-contained membrane bioreactors, used to treat raw sewage, have been around for over 20 years. Gasification processes were originally used in the 1800's to produce gas for fueling lighting and cooking. Eventually electricity and natural gas replaced the need for the gasification process.

Today, by combining these two systems one can treat water, produce energy, and reduce greenhouse gas emissions with an on-site biodigester. In addition to providing energy, biodigesters produce a high grade fertilizer that is free of bacteria such as E. coli. Biodigesters have widespread use in developing countries, such as India, China, and Guatemala.

PROCESS

Effluent from the plumbing fixtures and drains is routed in a conventional waste system to a grinder to break up the solids. It then passes through to a screen, where the waste is captured and put through a fermentation process under anaerobic (no light, no oxygen) conditions.

The fermentation process produces an inflammable gas mixture consisting of 60-70% methane (CH_4) and 30-40% carbon dioxide (CO_2). Getting proper fermentation is complex and requires specific microbes to produce a pH range of 6.8-7.5, as the methane will eliminate inhibitory byproducts. If the pH drops below 6.8, methanogen can grow. If the pH rises above 7.5, the organic material may become too rich in proteins or ammonia. The ideal temperature during the process is between 68°F and 104°F. If the temperature of the digester drops below 68°F, an external heat source is required to aid proper fermentation. During the anaerobic process, approximately two-thirds of the methane produced comes from acetic acid. The remainder comes from a direct reduction of carbon dioxide.

The process for digestion can take between 2 and 6 days before the microorganisms complete their work. At this time, the methane can be used in one of the following ways.

- Direct fuel source for space heating or domestic hot water heating
- Direct combustion in a burner for producing electricity
- Feedstock for a fuel cell

In general, 1 lb of human waste (e.g. from water closets) can produce about 1.5 ft^3 of methane/CO_2 gas. However, 1 lb of food waste (e.g. from a commercial kitchen) can produce about 0.5 ft^3 of methane/CO_2 gas.

1 cubic foot of pure methane has a heating value of about 1,000 BTU. Since the fermentation process creates a mixture of methane and carbon dioxide, the heating value is derated to 600 BTU per cubic foot.

BuildLACCD

XelaTeco Tubular Biodigester

Polyethylene Biodigester

As an option, an additional bioreactor can be provided downstream of the biodigester. This bioreactor would fully treat the waste water for potable reuse. Otherwise, the wastewater from the biodigester is routed to the city sewer.

APPLICATION

The ideal application for biodigesters is where a consistent source of waste can be anticipated. To make biodigesters feasible, a minimum of 1000 lbs/day of human waste or 3000 lbs/day of food waste is a typical threshold. For LACCD projects, food service kitchens are good candidates to consider this technology.

Example: Commercial Kitchen

For a commercial kitchen, the following potential energy would be available.

- 3,000 meals per day, averaging 2 lbs of food waste per meal
- 6,000 lbs of food waste per day
- 6,000 lbs of food waste = 3,000 ft^3 of methane/CO_2
- 3,000 ft^3 of methane/CO_2 = 1,800,000 BTU per day

If this energy were used for domestic hot water heating, this would be the equivalent of 6,500 therms per year, or $9,800 energy savings per year. In an application tied to a fuel cell for electricity production, it would be the equivalent of 131,000 kWh per year, or roughly $19,600 per year.

COST CONSIDERATIONS

These systems are typically high in cost. However, recent technologies, known as “tubular” biodigesters have been used to make biodigesters more cost effective.

When connected to a fuel cell, such systems will generate more energy relative to the installed cost than monocrystalline solar photovoltaics or wind turbines.

ADDITIONAL RESOURCES

- apps1.eere.energy.gov/consumer/your_workplace/farms_ranches/index.cfm/mytopic=30003
- www.eia.doe.gov/oiaf/archive/ieo02/biomassbox_txt.html
- www.velacreations.com/methane.html
- www.aidg.org/biodigesters.htm