Development of Bio Gas Processing for Small Scale Cattle Form

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Introduction

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source and in many cases exerts a very small carbon footprint.

Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials.

Biogas is primarily methane (CH4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulphide (H2S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat.

Biogas can be compressed, the same way natural gas is compressed to CNG, and used to power motor vehicles. In the UK, for example, biogas is estimated to have the potential to replace around 17% of vehicle fuel. It qualifies for renewable energy subsidies in some parts of the world. Biogas can be cleaned and upgraded to natural gas standards, when it becomes bio-methane. Biogas is considered to be a renewable resource because its production-and-use cycle is continuous, and it generates no net carbon dioxide. Organic material grows, is converted and used and then regrows in a continually repeating cycle. From a carbon perspective, as much carbon dioxide is absorbed from the atmosphere in the growth of the primary bio-resource as is released when the material is ultimately converted to energy. .

Feed methods

A distinction is made between batch and continuous plants. Batch plants are filled completely and then emptied completely after a fixed retention time. Each design and each fermentation material is suitable for batch filling. Large gasholders or a number of digesters are required for uniform gas supply from batch plants. Continuous plants are filled and emptied regularly -normally daily. Each design is suitable for continuous operation, but the feed material must be flowable and uniform. Continuous plants empty automatically through the overflow.

Continuous plants are more suitable for rural households. The necessary work fits better. into the daily round. Gas production is constant, and somewhat higher than in batch plants. If straw and dung are to be digested together, a biogas plant can be operated on a semi batch basis. The slowly digested straw-type material is fed in about twice a year as a batch load. The dung is added and removed regularly.

Plant types

Three main types of simple biogas plants can be distinguished (see Figure 3):

- **Balloon plants,**
- **Fixed-dome plants,**
- **Floating-drum plants**

1.Balloon Plants

A balloon plant consists of a plastic or rubber digester bag, in the upper part of which the gas is stored. The inlet and outlet are attached direct to the skin of the balloon. When the gas space is full, the plant works like a fixed-dome plant - i.e., the balloon is not inflated; it is not very elastic.

The fermentation slurry is agitated slightly by the movement of the balloon skin. This is favourable to the digestion process. Even difficult feed materials, such as water hyacinths, can be used in a balloon plant. The balloon material must be UV-resistant. Materials which have been used successfully include RMP (red mud plastic), Trivia and butyl.

Advantages:

- Low cost, ease of transportation, low construction (important if the water table is high), high digester temperatures, uncomplicated cleaning, emptying and maintenance.

Disadvantages:

- Short life (about five years), easily damaged, does not create employment locally, little scope for self-help.
- Balloon plants can be recommended wherever the balloon skin is not likely to be damaged and where the temperature is even and high.
- One variant of the balloon plant is the channel-type digester with folia and sunshade.

2.Fixed-Dome Plants

A fixed-dome plant consists of an enclosed digester with a fixed, non-movable gas space. The gas is stored in the upper part of the digester. When gas production commences, the slurry is displaced into the compensating tank. Gas pressure increases with the volume of gas stored, therefore the volume of the digester should not exceed 20 m^3. If there is little gas in the holder, the gas pressure is low. Difference in level = gas pressure in cm WC. 8. Supernatant scum; broken up by varying.

If the gas is required at constant pressure (e.g., for engines), a gas pressure regulator or a floating gasholder is required. Engines require a great deal of gas, and hence large gasholders. The gas pressure then becomes too high if there is no floating gasholder.

Advantages:

- Low construction cost, no moving parts, no rusting steel parts, hence long life (20 years or more).
- Underground construction, affording protection from winter cold and saving space.
- Creates employment locally.

Disadvantages:

- Plants often not gaslight (porosity and cracks), gas pressure fluctuates substantially and is often very high, low digester temperatures.
- Fixed-dome plants can be recommended only where construction can be supervised by experienced biogas technicians.

3.Floating-Drum Plants

Floating-drum plants (Figure 5) consist of a digester and a moving gasholder. The gasholder floats either direct on the fermentation slurry or in a water jacket of its own. The gas collects in the gas drum, which thereby rises. If gas is drawn off, it falls again. The gas drum is prevented from tilting by a guide frame.

Advantages:

- Simple, easily understood operation, constant gas pressure, volume of stored gas visible directly.

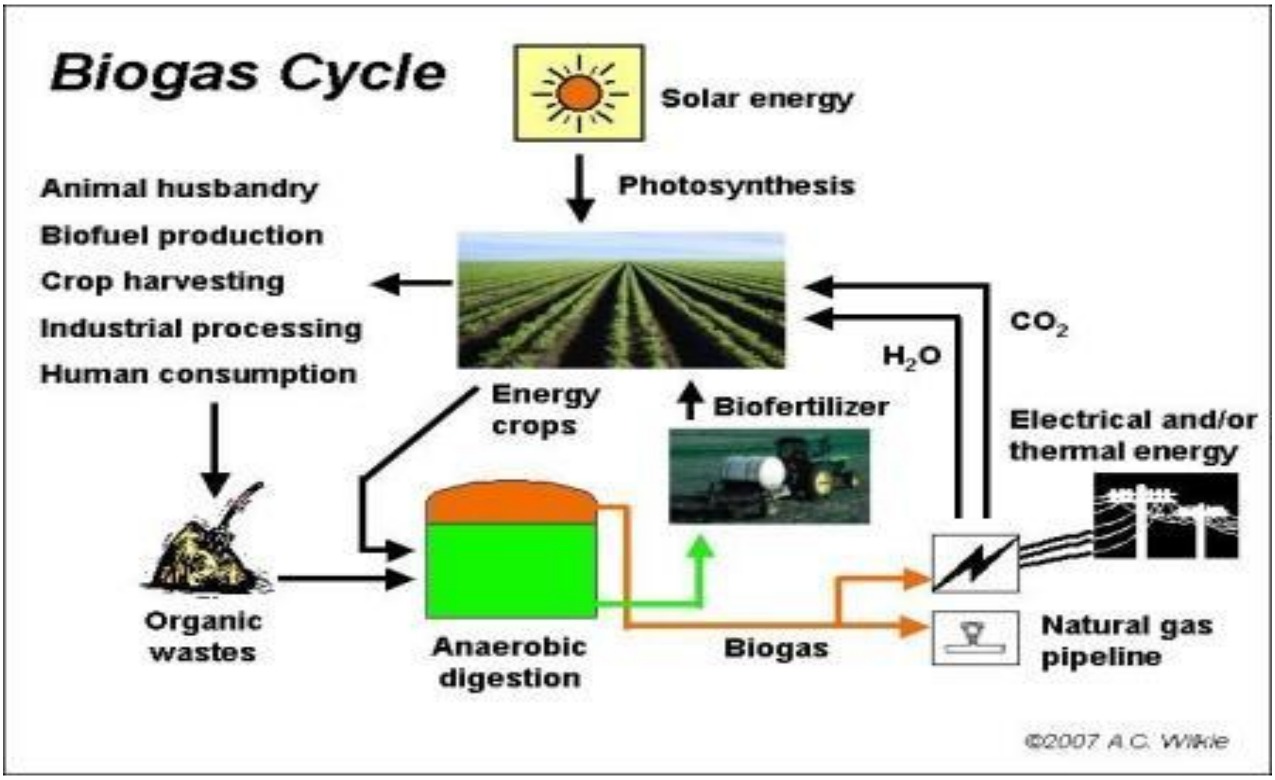
Disadvantages:

- High construction cost of floating-drum, many steel parts liable to corrosion, resulting in short life (up to 15 years; in tropical coastal regions about five years for the drum).
- Regular maintenance costs.

Biogas utilization

Biogas can be used in the same way as any other combustible gas. When biogas is mixed with air in the proportions of 1:20, highly explosive detonating gas forms. Leaky gas pipes in enclosed spaces constitute a hazard! However, there have been no reports of dangerous explosions caused by biogas. The calorific value of biogas is about **6 kWh/m³** - this corresponds to about half a litre of diesel oil. The net calorific value depends on the efficiency of the burners or appliances .

Efficiency is high if, for example, a litre of water boils quickly. This takes longer if the burner is wrongly set. Efficiency is then poor. The air supply substantially determines the efficiency. A gas pressure of 5-20 cm WG is best for cooking. Lamps require a pressure of about 10 cm WG.



The hydrogen sulphide in the biogas combines with condensate to form corrosive acids. Water-heating appliances and utensils and refrigerators are particularly at risk. The combustion chambers and burners should be made of cast steel, high-grade steel or enamel.

Biogas can be rid of sulphur by iron oxide filters
($FeO + H_2S \rightarrow FeS + H_2O$; $2FeS + O_2 \rightarrow 2FeO + 2S$).

With large volumes of gas, the filter material has to be replaced frequently and this becomes a laborious task. In this case filtration should be omitted and high-grade steel utensils should be used despite the higher cost. The gas does not have to be filtered for use in engines. The gas pressure may be low because the engine aspirates the gas. It is seldom worthwhile using the gas from simple plants to run engines.

Biogas cannot be economically liquefied. Gas pipes may be made of steel, copper, ruber or plastic. Rubber hoses and rigid PVC pipes quickly become porous and leaky when exposed to the sun and should therefore either be shaded or wrapped in some sort of protective material.

Composition

The composition of biogas varies depending upon the origin of the anaerobic digestion process. Landfill gas typically has methane concentrations around 50%. Advanced waste treatment technologies can produce biogas with 55%–75% methane, which for reactors with free liquids can be increased to 80%-90% methane using in-situ gas purification techniques. As produced, biogas contains water vapour. The fractional volume of water vapour is a function of biogas temperature; correction of measured gas volume for water vapour content and thermal expansion is easily done via simple mathematics[14] which yields the standardized volume of dry biogas.

Compound	Formula	%
Methane	CH_4	50–75
Carbon dioxide	CO_2	25–50
Nitrogen	N_2	0–10
Hydrogen	H_2	0–1
Hydrogen sulfide	H_2S	0–3
Oxygen	O_2	0–0.5

In some cases, biogas contains siloxanes. They are formed from the anaerobic decomposition of materials commonly found in soaps and detergents. During combustion of biogas containing siloxanes, silicon is released and can combine with free oxygen or other elements in the combustion gas. Deposits are formed containing mostly silica (SiO_2) or silicates and can contain calcium, sulphur, zinc, phosphorus. Such *white mineral* deposits accumulate to a surface thickness of several millimetres and must be removed by chemical or mechanical means.

Practical and cost-effective technologies to remove siloxanes and other biogas contaminants are available.

For 1000 kg (wet weight) of input to a typical bio digester, total solids may be 30% of the wet weight while volatile suspended solids may be 90% of the total solids. Protein would be 20% of the volatile solids, carbohydrates would be 70% of the volatile solids, and finally fats would be 10% of the volatile solids.

Measuring in biogas environments

Biogas is part of the wet gas and condensing gas (or air) category that includes mist or fog in the gas stream. The mist or fog is predominately water vapour that condenses on the sides of pipes or stacks throughout the gas flow. Biogas environments include wastewater digesters, landfills, and animal feeding operations (covered livestock lagoons).

Ultrasonic flow meters are one of the few devices capable of measuring in a biogas atmosphere. Most thermal flow meters are unable to provide reliable data because the moisture causes steady high flow readings and continuous flow spiking, although there are single-point insertion thermal mass flow meters capable of accurately monitoring biogas flows with minimal pressure drop. They can handle moisture variations that occur in the flow stream because of daily and seasonal temperature fluctuations, and account for the moisture in the flow stream to produce a dry gas value.