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Biogas: converting waste to Energy

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INTRODUCTION

Biogas is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen (anaerobically), primarily consisting of methane and carbon dioxide. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste.

Properties of Biogas

Biogas is a mixture of different components and the composition varies depending upon the characteristics of feed materials, the amount of degradation, etc. Biogas predominantly consists of 50 to 70 percent methane, 30 to 40 percent carbon dioxide, and a low amount of other gases. Methane is a combustible gas. The energy content of biogas depends on the amount of methane it contains.

Biogas plant and its components:

A physical structure designed to carry out anaerobic digestion of organic materials is called "Biogas plant". Following are the components of biogas plants:

Ø **Mixing tank**: Cow dung is collected from the shed and mixed with the water in equal proportion (1:1) to make a homogenous mixture (slurry) in the mixing tank

Ø **Feed inlet pipe/tank**: The homogenous slurry is let into the digester through this inlet pipe.

Ø **Digester**: The fed slurry is subjected to anaerobic fermentation with the help of microorganisms inside the digester.

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Ø **Gas holder**: As a result of anaerobic fermentation, gas produced is stored in gas holder (Drum in the case of KVIC and in the dome in the case of fixed dome biogas plants)

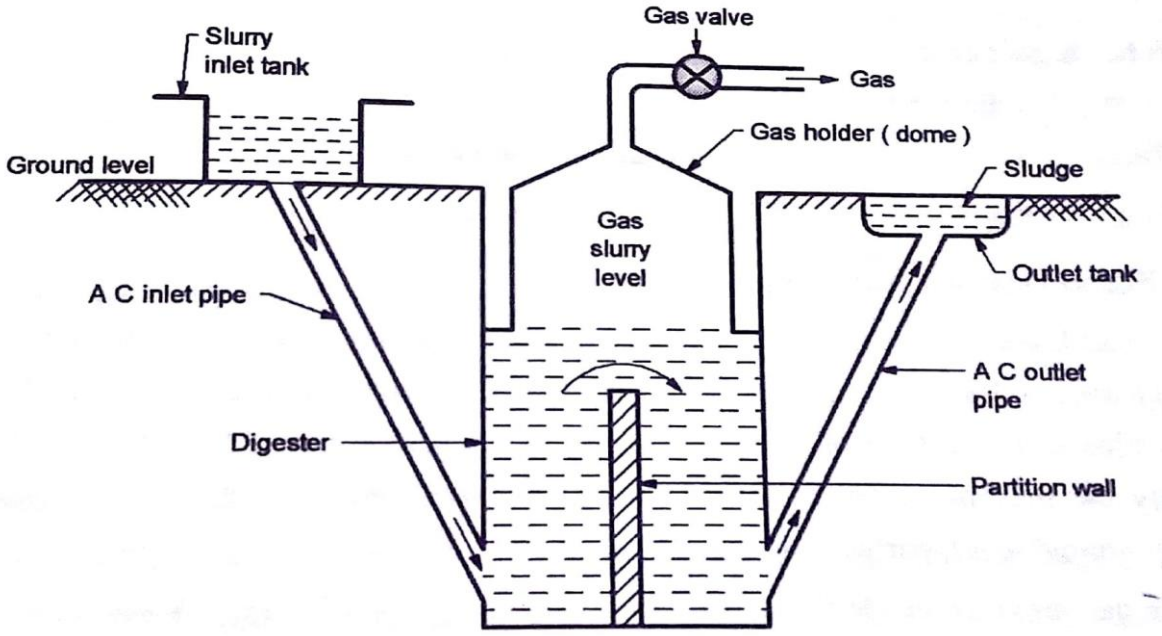
Ø **Slurry outlet tank/pipe**: The digested slurry is let out from the digester through the slurry outlet pipe.

Ø **Gas outlet pipe**: Stored gas is released and conveyed through the gas outlet pipe present at the top of the gas holder.

Microbiology of biogas production:

Ø The production of biogas from organic material under anaerobic conditions involves the sequence of microbial reactions. During the process complex organic molecule present in the biomass are broken down to sugar, alcohols, pesticides and amino acids by acid-producing bacteria. The resultant products are then used to produce methane by another category of bacteria. The biogas production process involves three stages namely:

i. Hydrolysis
ii. Acid formation and
iii. Methane formation



Bio-Gas Plant's components

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The process of degradation of organic material in every step is done by range of bacteria, which are specialized in reduction of intermediate products formed. The efficiency of the digestion depends how far the digestion happens in these three stages. Better the digestion, shorter the retention time and efficient gas production.

Hydrolysis

The complex organic molecules like fats, starches and proteins which are water-insoluble contained in cellulosic biomass are broken down into simple compounds with the help of enzymes secreted by bacteria. This stage is also known as polymer breakdown stage (polymer to monomer). The major end product is glucose which is a simple product.

Acid formation

The resultant product (monomers) obtained in the hydrolysis stage serve as input for acid formation stage bacteria. Products produced in previous stage are fermented under anaerobic conditions to form different acids. The major products produced at the end of this stage are acetic acid, propionic acid, butyric acid and ethanol.

Methane formation

The acetic acid produced in the previous stages is converted into methane and carbon dioxide by a group of microorganism called “Methanogens”. In other words, it is the process of production of methane by methanogens. They are obligatory anaerobic and very sensitive to environmental changes. Methanogens utilize the intermediate products of the preceding stages and convert them into methane, carbon dioxide, and water. It is these components that make up the majority of the biogas emitted from the system. Methanogenesis is sensitive to both high and low pHs and occurs between pH 6.5 and pH 8.

Biogas plants have huge potential to produce clean fuel from unhygienic, wet organic waste. There are many more rural and peri-urban areas where traditional dung-based plants could be used. There may be even more potential in towns and cities, where waste disposal and sanitation is becoming an increasing challenge as more people move to urban areas. Interest is also growing in the use of larger plants for electricity generation and to supply gas grids.

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Advantages:

· Biogas plants rely on anaerobic digestion, a fermentation process in which waste is digested by microbes to produce methane gas (biogas). The waste can be converted into biofertiliser and spread directly onto fields, or the biogas itself can be used interchangeably with natural gas as fuel.

· Biogas could be particularly useful in rural or poorer areas due to the low cost of set-up and the availability of waste materials. Almost any organic waste can be used in the process.

· It has been cited as a renewable energy alternative with great potential due to the fact that it is a zero-emissions process. By capturing methane emissions, biogas plants work to curb the greenhouse effect and limit the number of harmful gases spread in the atmosphere.

· In addition, biogas generation relies on renewable, natural materials that can be replanted or reproduced, thus making it a sustainable method.

· The by-product of the biogas generation process is enriched organic digestate, which is a perfect supplement to, or substitute for, chemical fertilizers, which often have toxic and harmful effects. In contrast, the organic digestate can accelerate plant growth and resilience to diseases.

Disadvantages

i. It has a higher cost, as cost is dependent on steel and cement

ii. Heat is lost through the metal gasholder.

iii. Gasholder required painting once or twice a year, depending on the humidity of the location.

iv. Flexible pipe joining the gasholder to the main gas pipe requires maintenance, as ultraviolet rays in the sun damage it.

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CONCLUSION

1) Biogas based energy could provide a sustainable solution for rural areas.

2) As economics is attractive, it becomes a multipliable and scalable model.

3) Supply of energy would assist rural businesses and enterprises to grow and prosper.

4) Production and use of organic fertilizers would improve soil and increase yields.

5) Considerable savings in subsidy bills and foreign exchange outflow could be achieved through such projects.

6) The project would help employment generation by creating local job opportunities.

7) Through availability of fuel and energy, the overall health and hygiene in the region will improve.