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Biogas Production: An Overview

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Biogas is also called as gobar gas and it is a renewable natural gas. Biogas is a mixture of a different gases produced by anaerobic digestion of organic material such as manure, sewage, municipal waste, plant material and crops**.** The biogas consists of primarily methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulphide(H_2S) and other gases. The gases methane, carbon monoxide and hydrogen can be combusted or oxidized with oxygen. This energy release allows gobar gas to be used as a fuel, it can be used for any heating purpose such as cooking. Biogas can be upgraded and cleaned to natural gas standards when it becomes bio-methane. The formation of biogas is an important part of the biogeochemical carbon cycle. Methanogens are the last link in a chain of microorganisms which are degrade organic material and return the decomposition products to the environment, producing biogas. Methane in atmosphere, from biogenic sources: 90 % and methane in atmosphere, from petrosources: 10%

Ingredient

Raw Material:

- Plant biomass (husk, grass and weeds)
- Animal biomass – cattle dung, manure from poultry, goats & sheep slaughter house & fishery wastes.
- Agricultural wastes
- Human excreta
- Industrial waste (saw dust, waste from food processing industries)
- Domestic waste (vegetable peels and waste food materials)

All forms of biomass listed above may be used along with water

- The size of the biogas plant is to be decided based on availability of raw material. Generally average cattle yield is about 10 kg dung per day. For example the average gas production from dung may be taken as 40 lit/kg of fresh dung. The total dung required for production of 3 m^3 biogas is 3/0.04= 75 kg. Hence, the minimum of 4 cattle is required to generate the required quantity of cow dung.

Production of biogas:

Biogas is produced by 4 steps:

1. Hydrolysis
2. Acidogenesis
3. Acetogenesis

4. Methanogenesis

Hydrolysis:

- Biomass is made up of large organic polymers
- Complex polymers hydrolysed to monomers
- Complex organic molecules → simple sugars, amino acids and fatty acids.
- Hydrolysis done by hydrolytic fermentative bacteria.

Acidogenesis:

- Further breakdown of the rest components by acidogenic bacteria.
- Ammonia, H_2, H_2S, CO_2, shorter volatile fatty acids, alcohols, carbonic acids as well as trace amounts of other by-products produced.

Acetogenesis:

- Simple molecules created through the acidogenic bacteria further digested to acetic acid, hydrogen and carbon dioxide.
- Acetogenesis done by acetogenic bacteria.

Methanogenesis:

- This is the terminal stage
- Intermediate products of the preceding stages converted to methane, CO_2 and water. These components make up the major part of the biogas.
- Done by Methanogenic bacteria.

There are different types of biogas production plants. The main two types are as follows:

1. Fixed-dome Plant
2. Floating-drum Plants

1. Fixed-dome Plant:

Construction: The biogas plant is a brick and cement structure having the following five section:

i. Mixing tank- present above the ground level.
ii. Inlet tank- the mixing tank opens underground into a sloping inlet chamber.
iii. Digester- the digester is a huge tank with a dome like ceiling in which the inlet chamber opens from below. The ceiling has an outlet with a valve for the supply of biogas.
iv. Outlet tank- the digester exposes from below into an outlet chamber.
v. Overflow tank- the outlet chamber exposes from the top into a small over flow tank.

Working of fixed dome type plant:

The various forms of biogas are mixed with an equal quantity of water in the mixing tank. This forms the slurry. The digester filled with slurry through the inlet chamber. When the digester is partially filled with the slurry, the introduction of slurry is stopped and the plant is left unused for about 2 months. During this period, anaerobic bacteria present in the slurry decomposes of ferments the biomass in the presence of water. As the results of anaerobic fermentation,

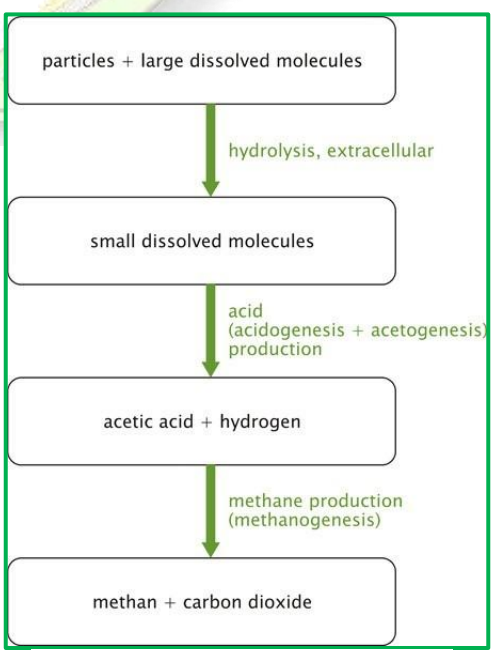

Figure: production of biogas

biogas is formed, which starts collecting in the dome of the digester. The collection of biogas is started more as more, the pressure exerted by the biogas forces the spent slurry into the outlet chamber and then the spent slurry overflows into the overflows tank. The spent slurry is manually removed from the overflows tank and used as manure for crops. The gas valve attached to a system of pipelines is opened when a supply of biogas is required.

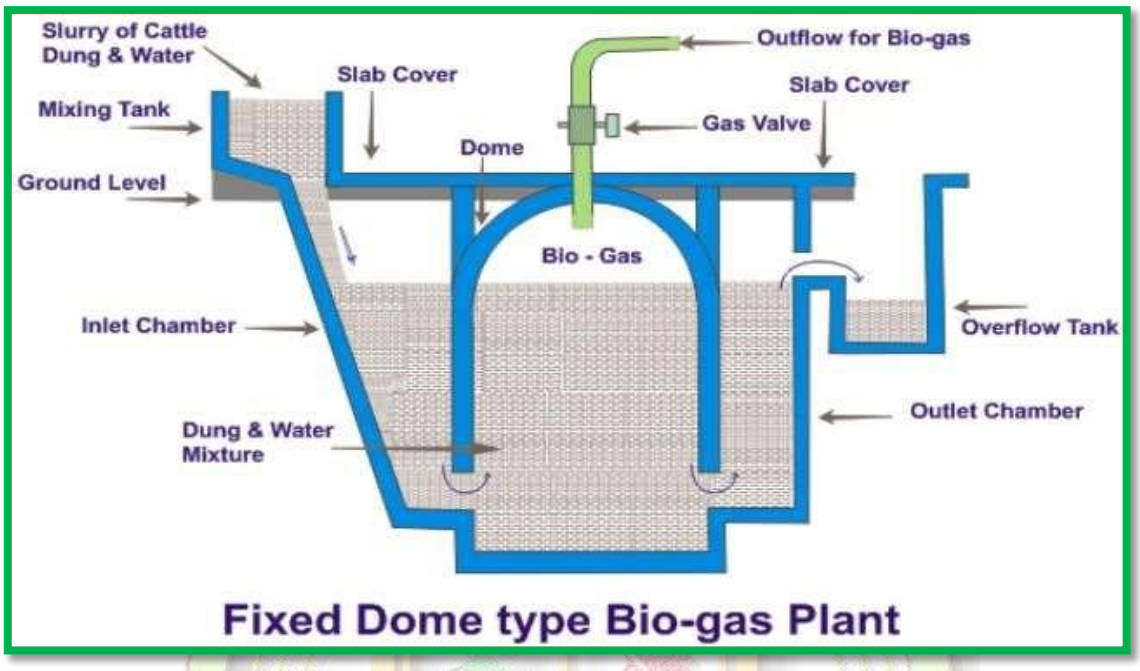

Figure: Fixed Dome type Biogas Plant

2. Floating-drum plants:

Construction: the floating gas holder type of biogas plant has the following section:

i. Mixing tank- present above the ground level.
ii. Digester tank- deep underground well like structure. It is divided into 2 chambers by a partition wall in between. It has 2 long cement pipes a) inlet pipe opening into the inlet chamber for introduction of slurry. b) outlet pipe opening into the overflow tank for removal of spent slurry.
iii. Gas holder- an inverted steel drum stays above the digester. The drum can move up and down that is float over the digester. The gas holder has an outlet at the top which could be attached to gas stoves.
iv. Over flow tank- present above the ground level.

Working of floating drum plant:

The preparation of slurry (mixture of equal quantities of biomass and water) is start in the mixing tank. The digester filled with prepared slurry through the inlet pipe. The plant is left unused for about 2 months and introduction of more slurry is stopped. During these two months, anaerobic fermentation of biomass takes place in the presence of water and produces biogas in the digester. The collection of biogas being lighter rises up and started. The gas holder now starts moving up. The collection of biogas is started more as more, the pressure exerted by the biogas forces. the spent slurry into the outlet chamber. When the outlet chamber gets the spent slurry, the excess is forced out through the outlet pipe into the overflow tank and this slurry later used as manure for crops. The gas valve of the gas outlet is opened when supply of biogas is required.

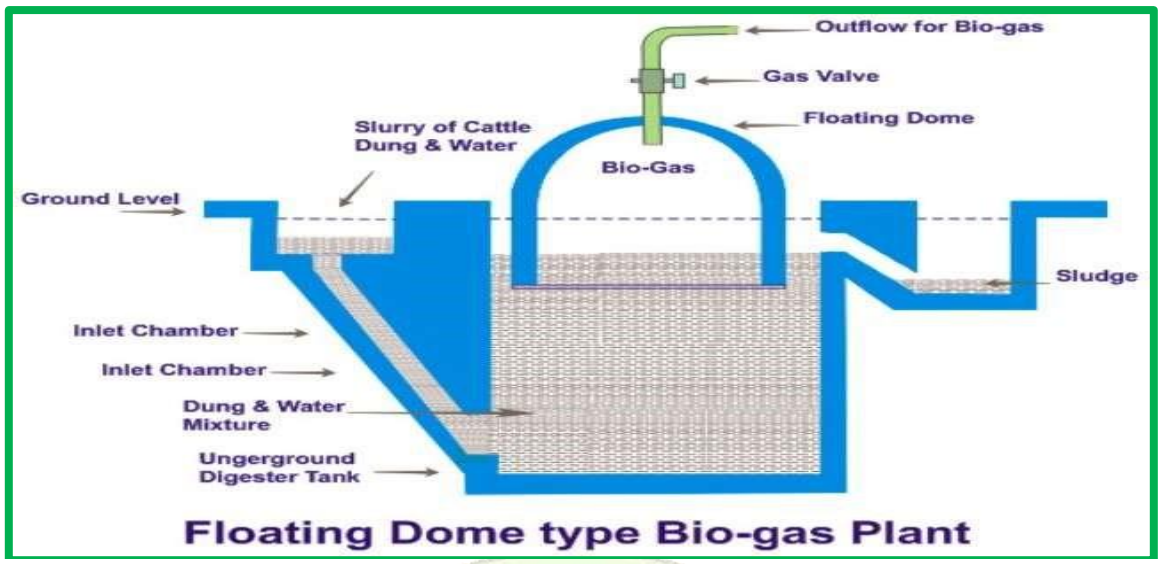

Figure: Floating Dome type Biogas Plant

Composition of biogas:

Typical composition of biogas

Compound	Molecular Formula	Percentage
Methane	CH_4	50-75
Carbon dioxide	CO_2	25-50
Nitrogen	N_2	0-10
Hydrogen	H_2	0-1
Hydrogen sulphide	H2S	0-3

Benefits of biogas:

- Alternate energy source
- Fertilizer
- Requires only locally and easily available material for construction
- Control pollution
- Little operational skills and maintenance required
- Pathogens and weed seed control

Conclusion

Biogas is a clean source of energy. Biogas plants have been in operation for a long period of time, especially in village areas around the globe. The research organizations should focus on newer efficient low-cost designs. The government can play important role by introducing different education schemes, legal frameworks and the availability of technology and simultaneously creating more awareness and providing more subsidies.

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