

Biogas Generation Plant Based On Kitchen Waste Material

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Abstract: -

Millions of cubic meters of methane in the form of biogas are produced every year by the decomposition of organic matter, both animal and vegetable. It is almost identical to the natural gas pumped out of the ground by the oil companies and used by many of us for cooking our meals.

In the past biogas has been treated as a dangerous by-product that must be removed as quickly as possible, instead of being harnessed for any useful purposes. It is only really in very recent times that a few people have started to view biogas in an entirely different light, as a new source of power for the future.

The impending scarcity of petroleum threatens the world's fuel supply. Mankind can face this threat successfully with the help of biogenous methane, but the world is yet to take full advantage of this technology. In this paper we discuss about floating drum biogas plant which is very effective for small scale use. It has been running successfully for last 6 month.

Index Terms

Bacterial process in anaerobic fermentation, Biogas plant – Boon to rural family, Biogas plant based on kitchen waste, Discussion and Conclusion, Fabrication and installation, References, Utilization of biogas and slurry,

Introduction:-

The impending scarcity of petroleum threatens the world's fuel supply. Mankind can face this threat successfully with the help of biogenous methane, but the world is yet to take full advantage of this technology, because its practitioners have so far ignore the basic tenet of science – viz. output of work is dependent on the energy available for doing that work.

This fact is seen in the current practice of using low calorie inputs like cattle dung, distillery effluent, municipal solid waste or sewerage, in biogas plants, which makes methane generation highly inefficient. Biogas plants may be classified in several ways depending upon the plant design and mode of working. Efficient disposal of kitchen waste can be eco friendly as well as cost effective.

1 General thought about energy supply

Human beings are the only animals with the ability to ignite and use a fire. This advantage has been important for the growth of mankind, particularly during the past few decades, when the rapid rate of innovation in industry was especially facilitated by the immense richness of oil. Today, thousands of oil platforms exist globally, which provide the oil for ca. 50 000 kWh of energy per year. But, as with all fossil resources, the quantity of oil is limited and will not last forever. A time will come for sure when all the existing accessible oil fields will have been exploited.

How will human beings generate energy when all the oil resources we benefit from today are fully consumed? There is as yet no clear answer to this question. But regardless of what the answer may be, it is clear that the mankind will always want to continue building huge inventories of energy. With the declining quantity of fossil fuels it is critical today to focus on sustained economic use of existing limited resources and on identifying new technologies and renewable resources.e.g. Biogas, biomass for future energy supply.

2 Energy supply – today and in the future

Today, globally most energy is provided by burning oil. Only a very small percentage is generated by nuclear power plants. The contribution of energy from renewable resources is almost negligible. But this will change in the future with increasing prices of oil. In the future, countries may use different technologies, depending on their climatic and geographical location.

2.1 Primary energy sources

In general, primary energy sources are classified as follows:

2.1(A) Fossil energy sources

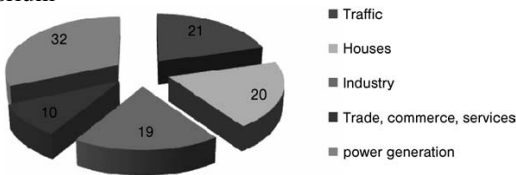
- Hard coal
- Brown coal
- Petroleum
- Natural gas

2.1(B) Renewable energy sources

- Water
- Sun
- Wind
- Geothermal heat
- Tides

2.1(C) Nuclear fuels

Uranium
Plutonium
Thorium



Primary energy as resource in % segmentation in industrialized countries

2.2 Secondary energy sources

Secondary energy sources are defined as products that have been produced by transforming primary energy carriers into higher quality products by applying processes such as refining, fermentation, mechanical treatment, or burning in power stations.

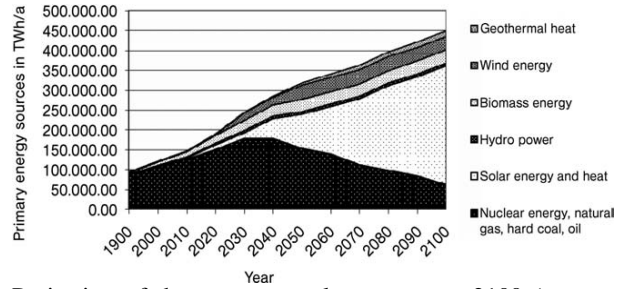
2.2(A) Products derived from coal

- Coke
- Briquettes

2.2(B) Products derived from petroleum

- Petrol
- Fuel oil
- Town gas
- Refinery gas

3 Energy supply in the future – scenarios



Projection of the energy supply up to year 2100 (acc. to Shell International).

METHODOLOGY:-

Anaerobic digestion is a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is widely used to treat wastewater sludges and organic wastes because it provides volume and mass reduction of the input material.. Anaerobic digestion is a renewable energy source because the process produces a methane and carbon dioxide rich biogas suitable for energy production helping replace fossil fuels. Also, the nutrient-rich solids left after digestion can be used as fertilizer.

The digestion process begins with bacterial hydrolysis of the input materials in order to break down insoluble organic polymers such as carbohydrates and make them available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. Acetogenic bacteria then convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Methanogenic bacteria finally are able to convert these products to methane and carbon dioxide.

Application of anaerobic digestions

Anaerobic digestion is particularly suited to wet organic material and is commonly used for effluent and sewage treatment.

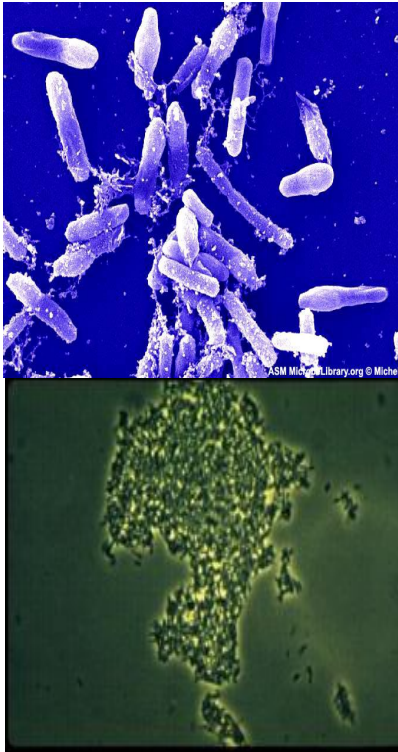
Almost any organic material can be processed with anaerobic digestion. This includes biodegradable waste materials such as waste paper, grass clippings, leftover food, sewage and animal waste. The exception to this is woody wastes that are largely unaffected by digestion as anaerobes are unable to degrade lignin.

In developing countries simple home and farm-based anaerobic digestion systems offer the potential for cheap, low-cost energy for cooking and lighting. From 1975, China and India have both had large

government-backed schemes for adaptation of small biogas plants for use in the household for cooking and lighting. Methane and power produced in anaerobic digestion facilities can be utilized to replace energy derived from fossil fuels, and hence reduce emissions of greenhouse gases.

Bacterial process in anaerobic fermentation

There are a number of bacteria that are involved in the process of anaerobic digestion including acetic acid-forming bacteria (acetogens) and methane-forming bacteria (methanogens). These bacteria feed upon the initial feedstock, which undergoes a number of different processes converting it to intermediate molecules including sugars, hydrogen & acetic acid before finally being converted to biogas. Populations of anaerobic bacteria typically take a significant period of time to establish themselves to be fully effective.



MICROSCOPIC VIEWS OF METHANE FORMING BACTERIA

Suitable organic material for anaerobic fermentation (In kitchen waste plant)

1. Following organic materials are suitable for the generation of biogas.
2. Liquid manure, solid dung

3. Separately collected biowaste from households
4. Secondary-growth raw materials, e.g. corn silage, non-food grains
5. Old grease
6. Grass
7. Biowaste from slaughter houses
8. fruit and wine press houses
9. dairies

Configuration for anaerobic digesters

Anaerobic digesters can be designed and engineered to operate using a number of different process configurations:

- Batch or continuous
- Temperature: Mesophilic or thermophilic
- Solids content: High solids or low solids
- Complexity: Single stage or multistage

1 Batch or continuous for anaerobic digesters

A batch system is the simplest form of digestion. Biomass is added to the reactor at the start of the process in a batch and is sealed for the duration of the process. Batch reactors suffer from odour issues that can be a severe problem when they are emptied.

2 Temperature for anaerobic digesters

There are two conventional operational temperature levels for anaerobic digesters.

- **Mesophilic** which takes place optimally around 37°-41°C or at ambient temperatures between 20°-45°C where mesophiles are the primary microorganism present
- **Thermophilic** which takes place optimally around 50°-52° at elevated temperatures up to 70°C where thermophiles are the primary microorganisms present

3 Solids for anaerobic digesters

There are two operational parameters associated with the solids content of the feedstock to the digesters:

- High-solids
- Low-solids

Digesters can either be designed to operate in high solids content, with a total suspended solids concentration greater than 20%, or a low solids concentration less than 15%.

4 Number of stages of anaerobic digesters

Digestion systems can be configured with different levels of complexity:

- One-stage or single-stage
- Two-stage or multistage

4.1 One-stage or single-stage

A single-stage digestion system is one in which all of the biological reactions occur within a single sealed reactor or holding tank. single stage reduces construction costs, however facilitates less control of the reactions occurring within the system.

4.2 Two-stage or multistage

In a two-stage or multi-stage digestion system different digestion vessels are optimized to bring maximum control over the bacterial communities living within the digesters. Methanogenic bacteria require stable pH and temperature in order to optimize their performance.

Composition of biogas:

Methane, CH ₄	50-75%
Carbon dioxide, CO ₂	25-50%
Nitrogen, N ₂	0-10%
Hydrogen, H ₂	0-1%
Hydrogen sulfide, H ₂ S	0-3%
Oxygen, O ₂	0-2%

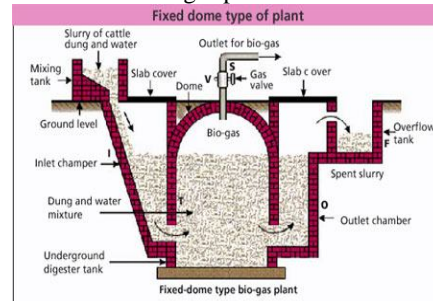
Biogas is the ultimate waste product of the bacteria feeding off the input biodegradable feedstock, and is mostly methane and carbon dioxide, with a small amount hydrogen and trace hydrogen sulfide. The formation of methane is a biological process that occurs naturally when organic material decomposes in a humid atmosphere in the absence of air but in the presence of a group of natural microorganisms which are metabolically active.

The methane in biogas can be burned to produce both heat and electricity, usually with a reciprocating engine or micro turbine—often in a cogeneration arrangement where the electricity and waste heat generated are used to warm the digesters or to heat buildings. Electricity produced by anaerobic digesters is considered to

be renewable energy and may attract subsidies. Biogas does not contribute to increasing atmospheric carbon dioxide concentrations because the gas is not released directly into the atmosphere and the carbon dioxide comes from an organic source with a short carbon cycle.

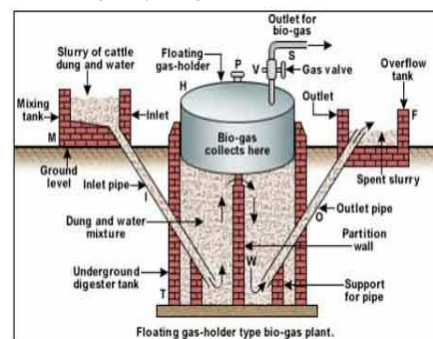
Types of Biogas Plants

1 Fixed dome biogas plant



2 Floating dome biogas plant

Advantages of biogas



- 1] Highly acceptable and most convenient domestic fuel for rural areas.
- 2] Availability of smokeless fuel for cooking and lighting.

lighting.

3] Better sanitation due to safe disposal of waste.

4] Biogas systems make clean energy for household use.

5] Biogas systems produce excellent safe fertilizers for use on the farm

Disadvantages of biogas

1] Separate burners are required

2] Biogas cannot be compressed easily

3] Contains moisture which can block the receiving end of burner

RESULT AND ANALYSIS

Selection of size of biogas plants

For selection of size of biogas plants, there are two important factors, namely:

(a) Total availability of biodegradable materials for biogas production.

(b) Consumption of Biogas.

Availability of total biodegradable material

The biogas is generated mainly from cow dung. Other animal's dung and human excreta, agricultural and forest wastes and household waste could also be used as biogas feed. Total quantity of feed available per day should be determined and then size of biogas plant can be decided.

Conclusion:

- 1) It is concluded that of 400 liters of gas collection, 350 can be used effectively which is available for about 1 hour continuously.
- 2) The gas is clean and odourless.
- 3) The slurry is an excellent fertilizer.
- 4) The gas production is high in summers while the efficiency is reduced in winters.
- 5) Water droplets present in the gas chokes the passage of gas.

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