

Renewable Energy Sources

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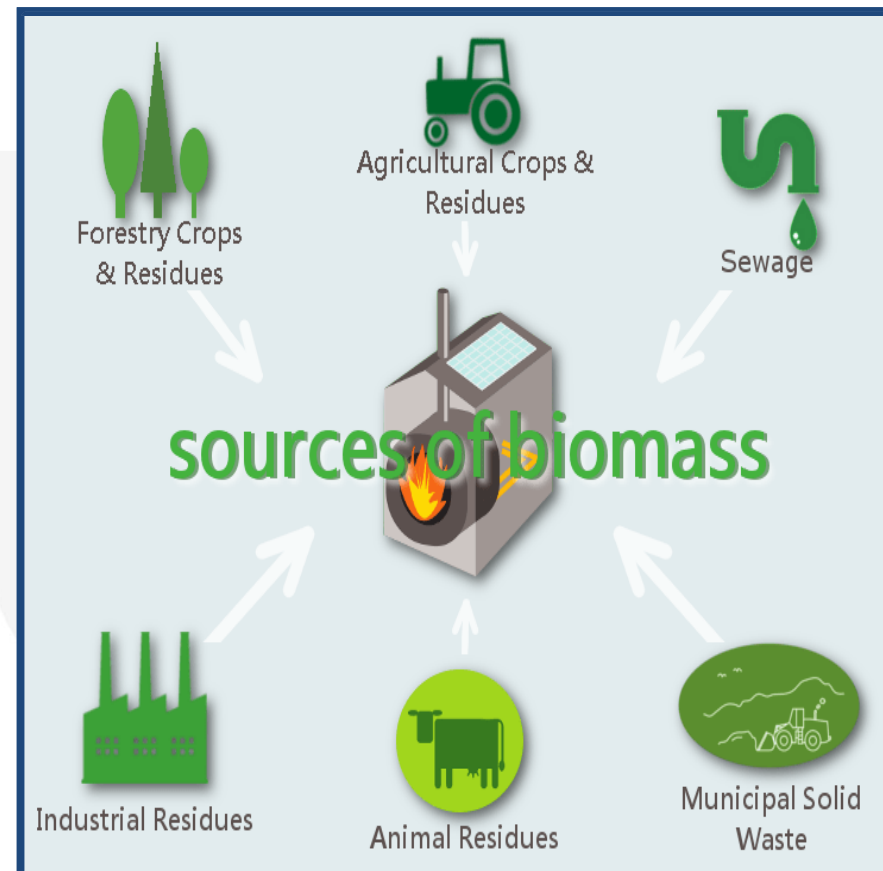
CHAPTER-4

Bio Energy



Introduction

- Biomass is a organic matter produced by living materials.
- It renews naturally in short span of time.
- Biomass is a derivative of solar energy.
- The energy stored in Biomass is Known as bio energy.





What is biogas?

- Energy produced from biomass is known as biogas.
- It is a clean fuel that can be obtained by anaerobic digestion of organic waste.
- Biogas consist about 40% carbon dioxide and 60% methane.



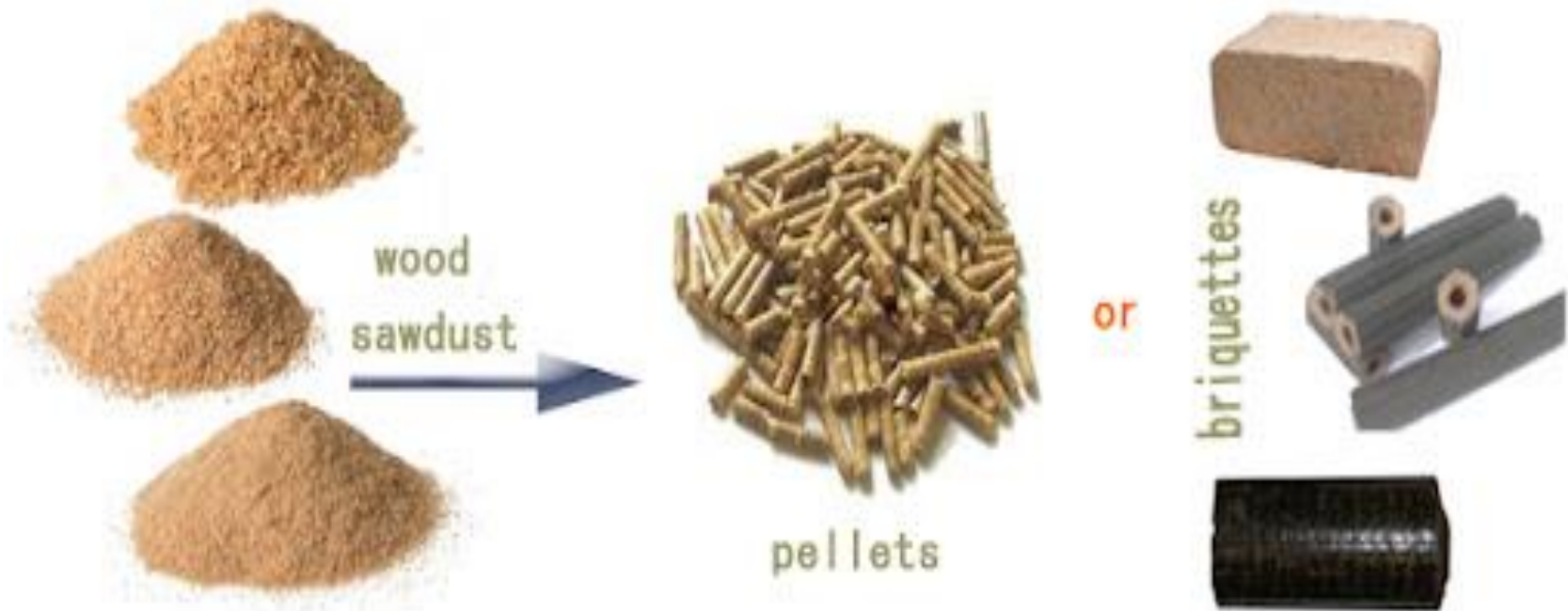


What is biogas?

- 1) Densification of Biomass
- Bulky Biomass is reduced to better Volume to Weight Ratio by compressing in a die at a high temperature and pressure
- It is shaped into briquettes or pellets to make a more compact source of energy, which is easier to transport and store than natural biomass.



What is biogas?





What is biogas?

- 2) Combustion
- Direct combustion is the main process adopted for utilizing biomass energy.
- It is burnt to produce heat utilized for cooking, space heating, industrial processes and for electricity generation.
- Very inefficient method with heat transfer losses of 30-90% of the original energy contained in the biomass.



What is biogas?

- 3) Incineration
- Process of burning completely the solid biomass to ashes by high temperature oxidation.
- Incineration and combustion are synonymous, but the process of combustion is applicable to all fuels i.e. solid liquid and gases.
- Incineration is a special process where dry municipal solid waste is incinerated to reduce the volume of solid refuse and to produce heat, steam and electricity.



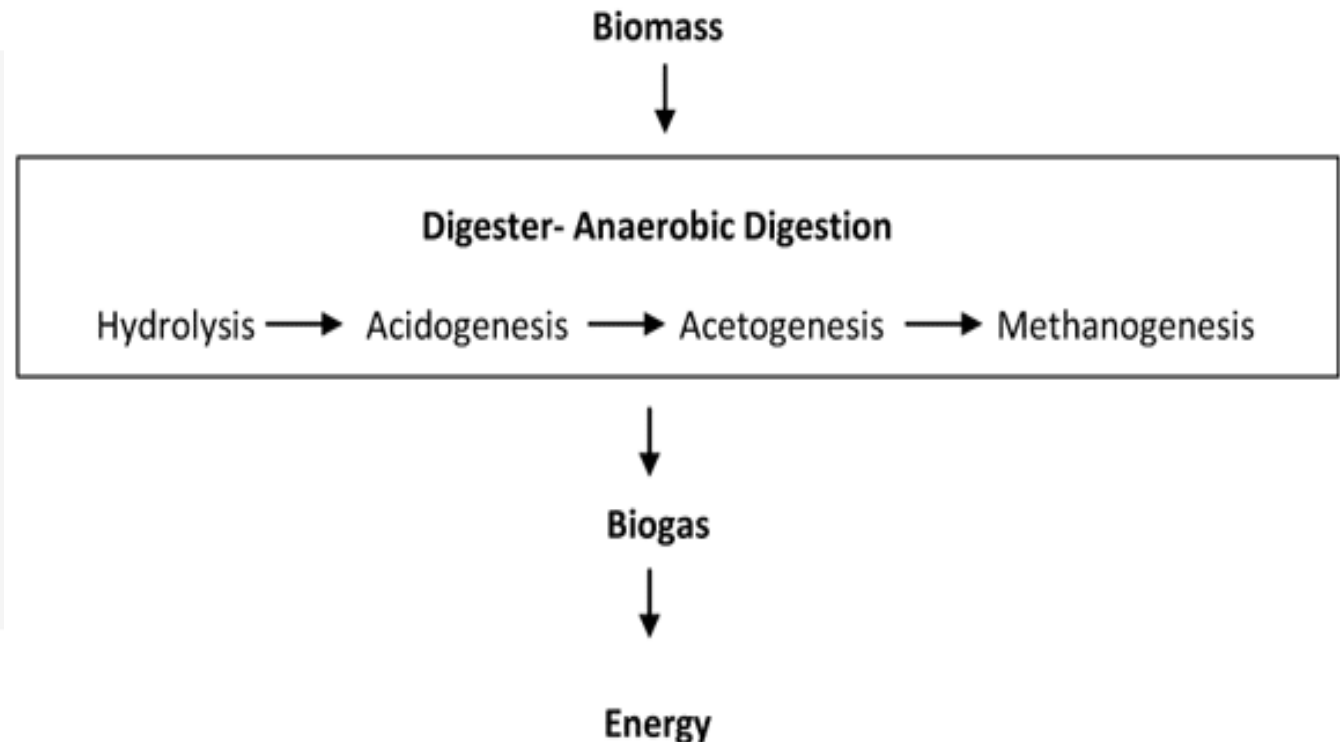
What is biogas?

- 4) Pyrolysis
- Biomass is heated in absence of oxygen, or partially combusted in limited oxygen supply, to produce a hydrocarbon, rich in gas mixture , oil like liquid and a carbon rich solid residue.

Biogas Generation

- The are four main stages of Biogas generation

1. Hydrolysis
2. Acedogenesis
3. Acetogenesis
4. Methanogenesis





What is biogas?

a) Hydrolysis

- The process of breaking large biomass organic chains into their smaller constituent parts such as sugar, fatty acids, and amino acids and dissolving the smaller molecules into solution is called hydrolysis.
- Hydrolysis of these high-molecular-weight polymeric components of biomass completes the first step in anaerobic digestion. Hydrogen and acetate products of first stage are directly used by methanogens.



What is biogas?

b) Acedogenesis

It is the biological process in which the remaining components are broken down by fermentative bacteria. It creates volatile fatty acids together with ammonia, carbon dioxide, and hydrogen sulphide, and other by-products.



What is biogas?

c) Acetogenesis

In this stage, simple molecules created through the Acedogenesis phase are further digested to produce more acetic acid, carbon dioxide, and hydrogen.



What is biogas?

(d) Methanogenesis

It is a final stage of biogas production in which the methanogens use intermediate products of the preceding stages and convert them into methane, carbon dioxide, and water that consist of majority of biogas generated from plant.

A simplified generic chemical equation for the overall processes outlined earlier is as follows:



The process takes about two weeks time to complete at 25° C. The methane constituent of biogas is about 60% that make it suitable to be use in cooking, lighting and generation of power.

Types of biogas plants

- **Biogas plant can be classified as**

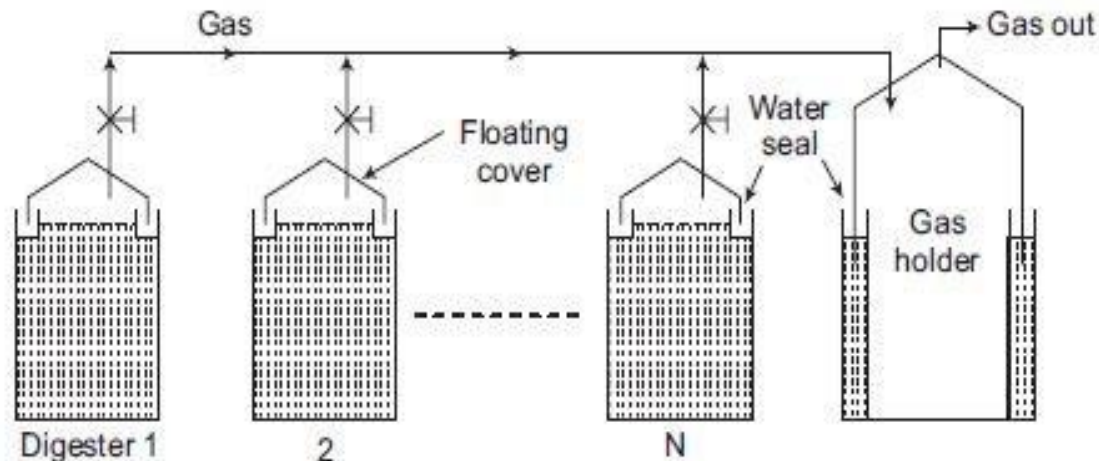
1. Batch type
2. Continuous type
 - (a) Floating-Drum Type
 - (b) Fixed-Dome Type





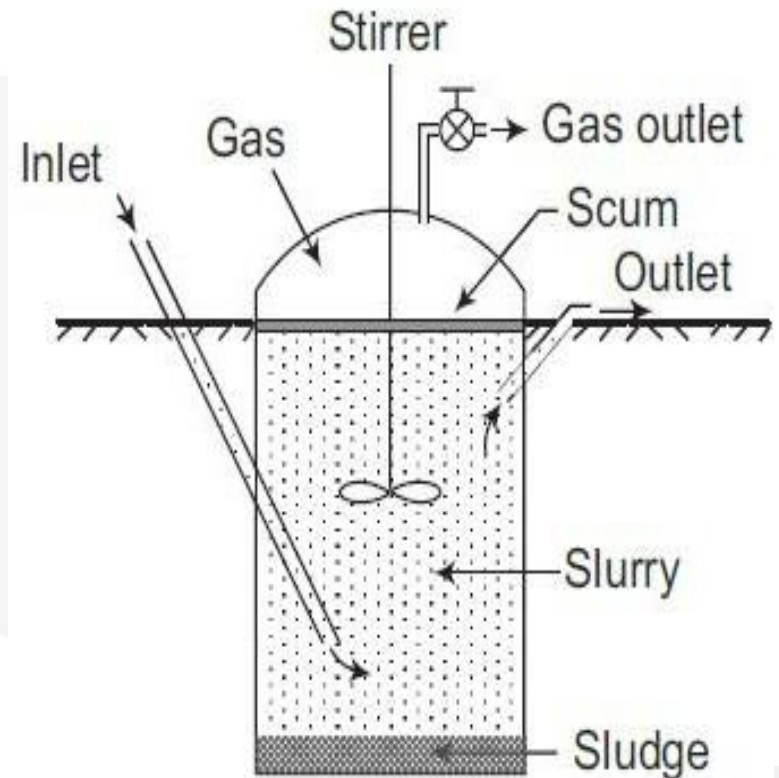
Batch type biogas plant

- The biomass is fed in batches.
- Batch type plant is charged at 50 –60 days interval.
- The installation and operation of plants are uneconomical.
- Gas production in batch type plant is uneven.



Continuous type biogas plant

- The supply of gas is continuous.
- The digester is regularly fed with biomass.
- Continuous operation and shut only for maintenance and removal of residue.
- Convenient for individual owner.
- Plant are popular in India and China.



Floating Drum type biogas plant

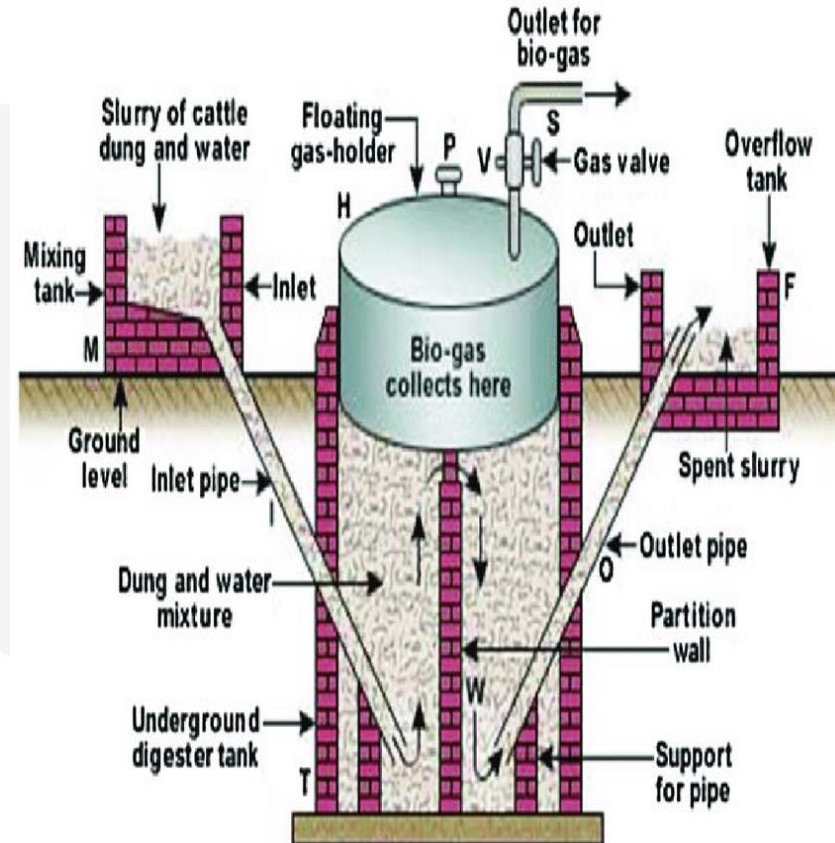
- The Biogas supply is continuous and the digester is fed regularly.
- Jashu Bhai JPatel from India designed the first floating drum biogas plant.
- It consist of an underground digester and a moving gas holder.
- The gas is collected in gas holder.





Khadi Village Industries Commission (KVIC)

- It consists of masonry digester.
- Partition wall is provided for bifurcation of digestion chamber.
- The movable gas Holder is made up of steel and used to collect the gas.
- Digester Diameter varies from 1.2 to 1.6m.
- Built a gas pressure of 10 cm of water column and can supply gas up to 100m.



Advantages and Disadvantages of Floating Drum type Biogas Plant

Advantages

- It Provide higher gas production.
- It operate under constant pressure naturally.
- No problem of gas leakage.
- There is no danger of explosion.

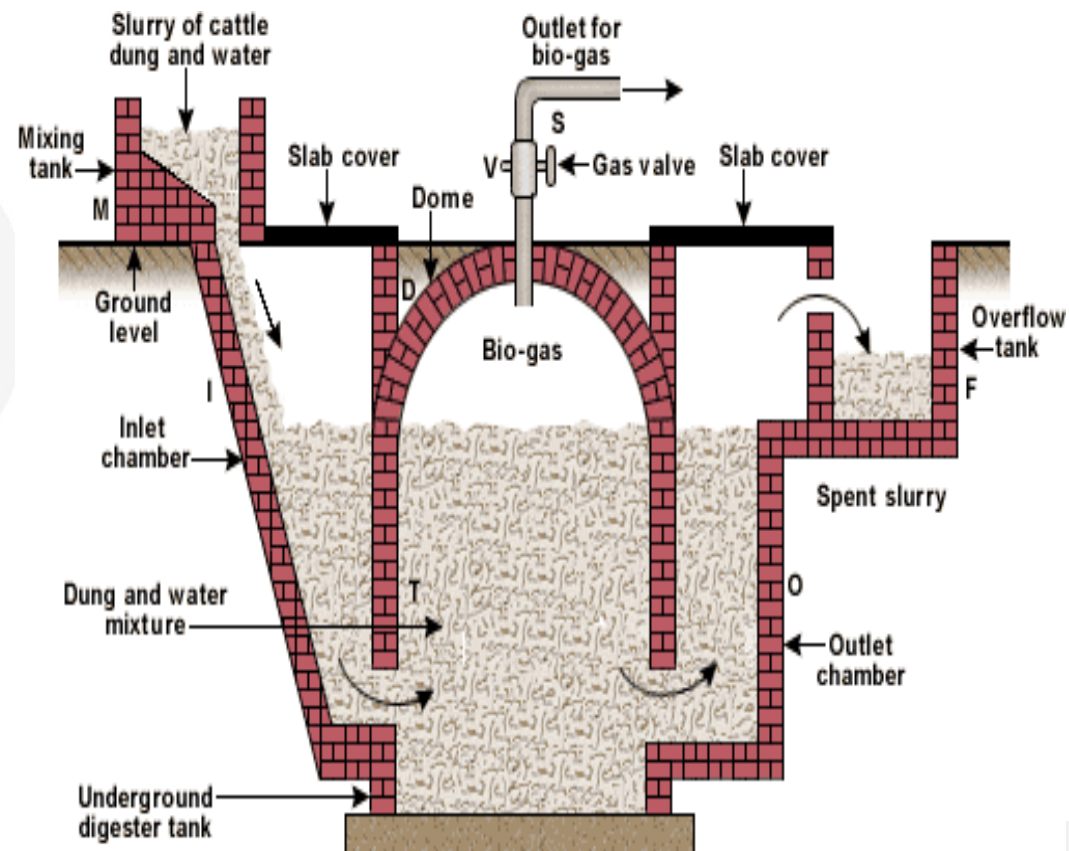
Disadvantages

- High initial cost.
- The outlet pipe is flexible, it requires regular attention.
- High maintenance cost .
- No heat loss through gas holder.



Fixed Dome (Constant Volume) Type Biogas Plants

- Gas is stored in upper part of digester.
- Pressure of gas varies depending on consumption.
- The plant is more economical.
- To maintain pressure the Dome is constructed Underground.



Advantages and Disadvantages Fixed Dome type Biogas Plants

Advantages

- Low cost
- No corrosion problem
- Maintenance free
- Better heat insulation so not affected by weather

Disadvantages

- Less volume of gas production
- skilled masons are required for construction.
- variable gas pressure
- It has problem of scum formation

Factor affecting Biogas Generation.

- **Temperature**

- The digestion occurs at highest rate at temperature range of 35 -38 °C.
- The gas production reduces sharply below 20 °C

- **Pressure**

- A minimum pressure of 6–10 cm of water column is ideal.
- It should never be allowed to exceed 40–50 cm of water column.

- **Retention Period**

- Period for which fermentable material remain inside the digester.
- Retention period ranges from 35 to 50 days.

Factor affecting Biogas Generation.

- **PH Value**

- Optimum gas generation occurs at PHvalue of 6.5 -7.5.

- **Loading rate**

- amount of fermentable material fed in digester per unit volume of digester capacity per day
- too much raw material ,acids will accumulate and digestion process may stop.

- **Carbon to Nitrogen (C/N) Ratio**

- (C/N) Ratio 30:1 Provide maximum digestion .
- Improper ratio reduces methane production.



Advantages Biogas Plants

- Environmental Friendly technology.
- Cheaper and simpler technology .
- Smaller unit can be used for lightning and cooking purpose.
- Provides nutrient rich (N and P) manure for plants.
- It Conserve the earth's natural resources.
- It does not produced smoke, has no residue.



Disadvantages Biogas Plants

- Installation cost is high.
- Lower biogas yield.
- Irregularity of organic raw materials and its continuity of supply.
- No control on the rate of gas production on larger scale.
- Economically acceptability on large industrial scale.
- Social acceptability.



Site selection Of Biogas Plants

- Easy construction of biogas plant.
- Minimum construction cost.
- Soil at selected site should have good load bearing capacity.
- The plant should be Located near to the point of application .
- Easy operation and maintenance .
- The site should be Sunny rather than cool places for biogas plant.
- It should be at sufficient distance from trees to avoid damage of biodigester

Applications of Biogas Plants

- Domestic fuel for cooking and lighting purpose.
- Electricity generation.
- Waste management in agriculture.
- Biogas Fuel Cells.
- Combined heat and power Plants.
- Fuel for motive power.
- To operate a dual fuel engine



Scope of biogas Energy in India

- Present availability of biomass in India is estimated at about 500 million metric tonnes per year.
- Ample potential of setting up biogas plants considering the livestock population of 512.06 million.
- Digested slurry produced from Biogas Plants used as organic manure in farms
- A total capacity of 9806 MW power has been installed.
- The total of 50.28 Lakh small size biogas plants set up in the country till 2018 -19 based on the initial estimated of 12.3 million plant.
- There is a tremendous scope for generation of energy using Biogas plant in India



Biomass energy

- Energy generated by living or non living organisms.
- It can be burned to Generate heat or converted into electricity.
- Raw biomass has a low energy density and their direct use are burning them to produce heat for cooking.
- Inconvenient method of raw biomass transportation, Inefficient way of direct cooking and high environmental pollution problems made them unsuitable for efficient and effective use.
- Necessitated pre -processing and conversion technology for enhancing the usefulness of biomass.



Energy plantation

- Production of plant material for fuel.
- carried out to provide substantial amounts of usable fuel continuously across the year
- An energy crop is planted and harvested periodically.
- The cycle of planting and harvesting for a relatively short interval of time insures the sustainability of the resource.
- Energy plantations include pine sugarcane, cottonwood, and eucalyptus.
- The potential of production of bio-diesel through plantation of certain plants is attracting the attention, the world



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