

**YA GOVERNMENT COLLEGE FOR WOMEN,**  
**CHIRALA**



**A Review on various type of Raw materials Used  
in Biogas Production And its Applications**

By

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## INTRODUCTION

This project is based on biogas, which is increasingly used as an alternative source of energy, in today's world where there is crisis for energy. Human civilisation has been using energy in different form from the very first day of their existence. Most of this energy comes from fossil fuels, which supply nearly 75% of the world's energy. The abundant, cheap energy provided by fossil fuels has made it possible for humans to exploit a staggering variety of resources, effectively expanding their resource base. In particular, the development of mechanized agriculture has allowed relatively few farmers to work vast tracts of land, producing an abundance of food and making possible a wild growth of population. But fossil fuels are being depleted a hundred thousand times faster than they are being formed. At current rates of consumption, known reserves of Petroleum will be gone in about thirty-five years; natural gas in fifty-two years; and coal in some two hundred years. Hence there is a need to look for alternative sources of energy including in rural areas of INDIA where majority people live. BIOGAS PLANT is one of the alternatives which are efficient, cost effective and hygienic. This project tells about the construction, working, cost, advantages and demand of biogas in coming decades.

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## Featured snippet from the web

The pioneer of anaerobic digestion in **India** is S.V. Desai, for his first experiments on **biogas** production in 1939. This led to the development of the first **Indian biogas plant** in 1951, the Gramalaxi **plant** of the Khadi and Village Industries Commission (KVIC), better known as the KVIC digester. Jun 2, 201

## Where are biogas plants in India?

Methan village in **Sidhpur tehsil**, Patan district of Gujarat saves 500 metric tonnes of fuelwood annually. They've been doing it for the last 15 years. This village is home to India's largest biogas plant, run by Silver Jubilee Biogas Producers and Distributors Cooperative Society Limited.

## Who discovered biogas?

**Alessandro Volta**, an Italian physicist, was the first person to discover methane generated from marshlands. This discovery led to the onset of biogas production and energy generation across the world. Mar 14, 2017

# **BIOGAS PLANT**

## **WHAT IS BIOGAS?**

Biogas is a flammable gas that accrues from the fermentation of biomass in biogas plants. Biogas typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas originates from biogenic material and is a type of biofuel.

Biogas is a renewable source of energy.

Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted into a gaseous fuel called biogas.

Biogas comprises primarily methane ( $\text{CH}_4$ ) and carbon dioxide ( $\text{CO}_2$ ) and may have small amounts of hydrogen sulphide ( $\text{H}_2\text{S}$ ), moisture and siloxanes.

The gases methane, hydrogen, and carbon monoxide ( $\text{CO}$ ) can be combusted or oxidized with oxygen. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, much like natural gas, and used to power motor vehicles.

## **HOW IS BIOGAS GENERATED?**

Biogas is practically produced as landfill gas (LFG) or digester gas. Biogas can be produced using anaerobic digesters. These plants can be fed with energy crops such as maize silage or biodegradable wastes including sewage sludge and food waste. During the process, an air-tight tank transforms biomass waste into methane producing renewable energy.

Landfill gas is produced by wet organic waste decomposing under anaerobic conditions in a landfill. The waste is covered and mechanically compressed by the weight of the material that is deposited from above. This material prevents oxygen exposure thus allowing anaerobic microbes to thrive. The gas builds up.

## **WHAT IS BIOGAS PLANT?**

A biogas plant is the name often given to an anaerobic digester that treats farm wastes or energy crops. Biogas can be produced using anaerobic digesters.

A biogas plant consists of the following things-

- Concrete tank (digester) - The bio wastes are collected here.
- Floating cover- It is placed over the tank and it keeps on rising as the gas keeps on increasing in the tank.
- An outlet- The outlet is connected to a pipe through which the gas is collected and further used.
- Slurry collector- Here cow dung is added which contains bacteria methanogens, which is present in the rumen part of the stomach of cattle, that act on the bio wastes and produce methane gas.
- Sludge collector- The spent slurry is removed through this and can be used as fertilizer or various purposes.

## **STEPS IN BIOGAS GENERATION-**

There are four key biological and chemical stages of anaerobic digestion:

- (i)Hydrolysis
- (ii)Acidogenesis
- (iii)Acetogenesis
- (iv)Methanogenesis

**HYDROLYSIS**-In most cases, biomass is made up of large organic polymers. For the bacteria in anaerobic digesters to access the energy potential of the material, these chains must first be broken down into their smaller constituent parts. These constituent parts, or monomers, such as sugars, are readily available to other bacteria. The process of breaking these chains and dissolving the smaller molecules into solution is called hydrolysis.

Therefore, hydrolysis of these high-molecular-weight polymeric components is the necessary first step in anaerobic digestion.

Through hydrolysis the complex organic molecules are broken down into simple sugars, amino acids, and fatty acids.

Acetate and hydrogen produced in the first stages can be used directly by methanogens. Other molecules, such as volatile fatty acids (VFAs) with a chain length greater than that of acetate must first be catabolised into compounds that can be directly used by methanogens.

**ACIDOGENESIS**-The biological process of Acidogenesis results in further breakdown of the remaining components by acidogenic (fermentative) bacteria. Here, VFAs are created, along with ammonia, carbon dioxide, and hydrogen sulphide, as well

as other by-products. The process of Acidogenesis is similar to the way milk sours.

**ACETOGENESIS**-The third stage of anaerobic digestion is acetogenesis. Here, simple molecules created through the acidogenesis phase are further digested by acetogens to produce largely acetic acid, as well as carbon dioxide and hydrogen.

**METHANOGENESIS**-The terminal stage of anaerobic digestion is the biological process of Methanogenesis. Here, methanogens use the intermediate products of the preceding stages and convert them into methane, carbon dioxide, and water. These components make up the majority of the biogas emitted from the system. Methanogenesis is sensitive to both high and low pH and occurs between pH 6.5 and pH 8. The remaining, indigestible material the microbes cannot use and any dead bacterial remains constitute the digestate.

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



## TEMPERATURE

The two conventional operational temperature levels for anaerobic digesters are determined by the species of methanogens in the digesters:

- Mesophilic digestion takes place optimally around 30 to 38 °C, or at ambient temperatures between 20 and 45 °C, where mesophiles are the primary microorganism present.
- Thermophilic digestion takes place optimally around 49 to 57 °C, or at elevated temperatures up to 70 °C, where thermophiles are the primary microorganisms present.

## METHANOGENS

Methanogens are microorganisms that produce methane as a metabolic by-product in anoxic conditions. They are classified as archaea, a group quite distinct from bacteria. They are common in wetlands, where they are responsible for marsh gas, and in the guts of animals such as ruminants and humans, where they are responsible for the methane content of belching in ruminants and flatulence in humans. Methanogens are usually coccoid (spherical) or bacilli (rod shaped). There are over 50 described species of methanogens, which do not form a monophyletic group, although all methanogens belong to Archaea.

Methanogens are anaerobic organisms and cannot function under aerobic conditions. They are very sensitive to the presence of oxygen even at trace level. Usually, they cannot sustain oxygen stresses for a prolonged time.

## **TYPES OF BIOGAS PLANT**

Classification of biogas plants depends upon the plants design and mode of working-

1. Movable type drums plant
2. Continuous type plant
3. Batch type plant

### **BATCH TYPE BIOGAS PLANT**

Batch type biogas plants are appropriate where daily supplies of raw waste materials are difficult to be obtained. A batch loaded digester is filled to capacity sealed and given sufficient retention time in the digester. After completion of the digestion, the residue is emptied and filled again. Gas production is uneven because bacterial digestion starts slowly, peaks and then tapers off with growing consumption of volatile solids.

This difficulty can overcome by having minimum two digesters so that at least one is always in operation. This problem can also minimize by connecting batch loaded digester in series and fed at different times so that adequate biogas is available for daily use. The salient features of batch-fed type biogas plants are:

- (i) Gas production in batch type is uneven.
- (ii) Batch type plants may have several digesters for continuous supply of gas occupying more space.
- (iii) This type of plants require large volume of digester, therefore, initial cost becomes high.
- (iv) This plant needs addition of fermented slurry to start the digestion process.

## Bio gas plant in Vijayawada



## **CONTINUOUS TYPE BIOGASS PLANT**

In continuous type biogas plant, the supply of the gas is continuous and the digester is fed with biomass regularly.

Continuous biogas plants may be single stage, double stage or multiple stages. Digestion of waste materials in a single chamber or digester is called single stage process, in two chambers or digester is called multi stage process. In double stage process, acidogenic and methanogenic stage are physically separated into two chambers. These plants are economic, simple and easy to operate. These plants are generally for small and medium size biogas plants.

The important features of continuous type biogas plants are:

- (i) Gas production is continuous.
- (ii) Retention period is less
- (iii) Less problems as compared to batch type.
- (iv) Small digestion chambers are required

## **MOVABLE DRUM TYPE PLANTS**

This also known as floating dome type biogas plants. The conventional movable drum type comprises a masonry digester with an inlet on one side for feeding slurry and an outlet on the other side for removing digested slurry. The gas collects in a steel gasholder which is inverted over the slurry and moves up and down depending upon accumulation and discharge of gas guided by a central guide pipe. This movable gas holder is made of steel.

Advantages:

- (i) Constant gas pressure.
- (ii) No problem of gas leakage
- (iii) Higher gas production
- (iv) Scum problem is less

## RAW MATERIAL FOR BIOGAS PRODUCTION-

Agricultural residues from both the agricultural and agro-industry abound and are usually treated as waste materials and not as a potential resource. Biomass is any material originating from living organisms consisting of carbon and hydrogen that can be combusted or burned. Agricultural wastes such as manure and faeces also is biomass and can be harnessed to generate ethane gas, a useful gas that can be used for energy production.

Biogas can be produced from mixtures of cattle slurry and pressed sugar cane stalk, with and without urea.

SOURCES	RAW MATERIAL
Crop wastes	Sugar cane trash, weeds, crop stubble, straw, spoiled fodder, haulms and tops, silage liquor.
Animal wastes	Excreta and urine from man and domesticated animals, slaughterhouse wastes, fishery wastes, tannery wastes, wool wastes.
Municipal wastes	Sewage, kitchen wastes, domestic refuse.
Agro-industry wastes	Oil cakes, sugar cane bagasse, rice bran, tobacco wastes, fruit and vegetable processing wastes, sisal pulp, tea wastes, coffee pulp, textile wastes, brewery and distillery wastes, sawdust.
Forestry wastes	Leaves, twigs, bark.



**Plant waste**



**Animal waste**

### Aquatic sources

Marine and freshwater algae, water hyacinth and other aquatic plants.

## QUALITY OF BIOGAS

Every day, BIOGAS used for power generation and heat transfer robs the client of valuable dollars due to the improper treatment of gas. Crude BIOGAS, like crude oil, cannot be used as a fuel without at least some minimal form of refinement.

Each BIOGAS has its own "Signature".

- ❖ Methane Gas Content.
- ❖ Non-Methane Gas Fraction.
- ❖ Moisture Content.
- ❖ Sulphur Species Content.
- ❖ Volatile Organic Contaminants.

## WHAT ARE SILOXANES?

Siloxanes are organosilicons added to many personal care products and are present in almost all biogas. These siloxanes are formed from the anaerobic decomposition of materials commonly found in soaps and detergents.

Typical levels are of siloxanes:

- ✓ □□ Landfills - 0.5 to 50 ppm v/v.
- ✓ □□ Digesters - 0.5 to 140 ppm v/v.

During combustion of biogas containing siloxanes, silicon is released and can combine with free oxygen or various other elements in the combustion gas. Deposits are formed containing mostly silica ( $\text{SiO}_2$ ) or silicates ( $\text{Si}_x\text{O}_y$ ) and can also 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. Carbon Dioxide, Nitrogen, and Oxygen-containing organics also cause problems. Water, hydrogen sulphide, and halogens also play a role depending on the end use of the gas. Practical and cost-effective technologies to remove siloxanes and other biogas contaminants are currently available.

## APPLICATION OF BIOGAS

Biogas is a renewable source of energy. Since it is cleaner and greener and friendly it is used for a variety of purposes.

- Biogas production units provide a decentralized fuel supply and waste management system, both of which are becoming increasingly attractive, particularly in rural areas of developing countries.
- The enormous potential of biogas, estimated at 17,000 MW. The capacity was derived principally from estimated agricultural residues and dung from India's 300 million cattle. Biogas technology may have the potential to short-circuit the 'energy transition' and is described from biomass to 'modern' fuels.
- With the burgeoning population in metro cities and growth of urban centres, the enormity of waste generated is proving to be a huge task for disposal by city municipal authorities. Therefore, this process, driven further can turn out to be best boon in waste management.
- The scope for saving huge funds used for transporting the waste as at present is immeasurable. Also the search and location for land-fills and promotion of pollution in areas nearer to urban centres can be avoided.
- The gas is useful as a fuel substitute for firewood, dung, agricultural residues, petrol, diesel, and electricity, depending on the nature of the task, and local supply

conditions and constraints, thus supplying energy for cooking and lighting.

- Biogas systems also provide a residue organic waste, after anaerobic digestion that has superior nutrient qualities over the usual organic fertilizer, cattle dung, as it is in than aerobic digesters also function as a waste disposal system, particularly for human waste, and can, therefore, prevent potential sources of environmental contamination and the spread of pathogens.
- Apart from the direct benefits gleaned from biogas systems, there is other, perhaps less tangible benefits associated with this renewable technology. By providing an alternative source of fuel, biogas can replace the traditional biomass based fuels, notably wood. Introduced on a significant scale, biogas may reduce the dependence on wood from forests, and create a vacuum in the market, at least for firewood (whether this might reduce pressure on forests however, is contestable).
- Can be used as alternate power-generation to lift water for farming purpose, house-hold, street lighting.

## **BIOGAS AND RURAL PEOPLE**

Biogas technology is a particularly useful system in the Indian rural economy, and can fulfil several end uses. The Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC) introduced biogas technology in rural India. It is known as "gobar gas" in rural India. Due to the huge availability of cow dung in rural areas it is growing as a huge source of energy.

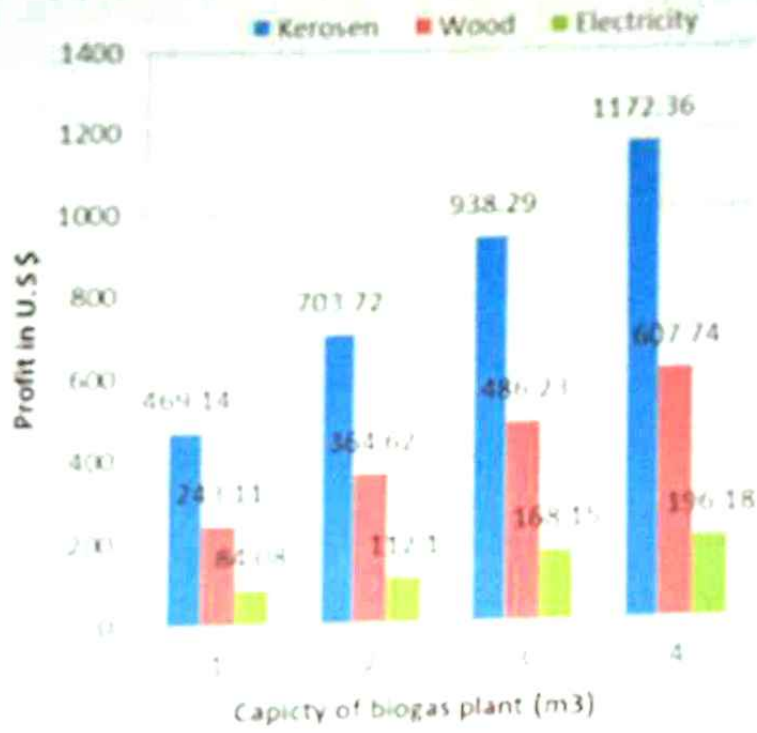
Due to the low cost of a biogas plant it can be set up in every household and the people get various benefits from it.

### **1. PERSONEL USE-**

- The people get manure and gas for their personal use like lighting and cooking.
- Child education improves as they are no longer needed in collection and process of fire wood and the mother can spare time on child education
- Soil fertility increases as the humus in the form of organic fertilizer is applied and replaces the chemical fertilizers.
- Women empowerment is seen as she generates income equalling the family income per year.

**2. INDUSTRIES-** Small-scale industries are also made possible, from the sale of surplus gas to the provision of power for a rural-based industry; therefore, biogas may also provide the user with income generating opportunities. The gas can also be used to power engines, in a dual fuel mix with petrol and diesel, and can aid in pumped irrigation systems.

# statistics



3. **WASTE MANAGEMENT-** At village level, Taluk and District levels, the waste management is effectively carried out by optimum utilization of bio-waste for producing bio-gas. In addition, the spending by local self-governments is drastically cut down by using the Bio-waste for producing bio-gas and thereby contributes for better environment.
4. **INCOME & EMPLOYMENT GENERATION-** By introducing the digesters at individual households, ample employment is generated for villagers, income by way of sale of bio-gas, sale of residuals etc.

## **ECONOMICS**

Biogas plant can be set up at individual level also. It is within the range of farmer family. However setting up of big biogas plant takes about 5 lakh which can be regained within few years by selling of the gas generated. Raw materials are also easily available and priceless.

## **SCOPE OF THE TECHNOLOGY:**

Enriched biogas is made moisture free by passing it through filters, after which it is compressed up to 200 bar pressure using a three stage gas compressor. Compressed gas is stored in high pressure steel cylinders as used for CNG. There is large potential of this technology in buses, tractors, cars, auto rickshaws, irrigation pump sets and in rural industries. This will help to meet energy demand for rural masses thus reducing burden of petroleum demand, moving towards energy security and will improve economic status by creating employment generation in rural area.

## **PROBLEMS FACED IN INDIA**

- Many people and farmers are not aware of the technology and thus cannot obtain optimum utilisation.

- People often throw away the bio wastes along with other wastes unknowingly.
- If operational short-comings are often reported, the setup of the system is not appropriate to the farmer.
- People are still dependent on chemical fertilizer and fossil fuels.
- Due to less availability of cow dung it is still not used in urban areas.
- Often due to less knowledge the plant gives rise to breeding grounds for mosquitoes and pathogens.
- Sometimes bad smell spreads due to leakage.

## RECOMMENDATION

Biogas plant is better than landfill as there is no chance of leakage. The main task of a biogas engineer is to design and construct a user-friendly biogas unit. A well designed biogas unit is easy to maintain. The ease of maintenance ensures constant attention by the farmer.

The clay sealing of the lid must stay moist. Therefore, the lid must be covered with water all the time. In order to reduce evaporation and prevent mosquito breeding, machine oil can be added on the surface of the water. Mineral oil pollutes ground water and should only be used in small quantities and with care.

The plant must be fed regularly in order to achieve regular gas production. Chopping of the fodder into pieces of 3-5 cm length saves fodder grass and reduces the amount of stalk mixing with the dung on the floor.

The government must spread the knowledge between the farmers and rural people to get maximum advantage from biogas. The wastes material needs to be separated well before using them to generate sufficient biogas.

# ADVANTAGES

- It's a renewable source of energy.
- It's a comparatively lesser pollution generating energy
- Biomass energy helps in cleanliness in villages and cities
- There is tremendous potential to generate biogas energy.
- Biomass energy is relatively cheaper and reliable.
- It can be generated from every day human and animal wastes, vegetable and agriculture left-over etc.
- Growing biomass crops use up carbon dioxide and produce oxygen.

## CONCLUSION

With the increasing demand of energy biogas demand has also increased. Many biogas plants have been set up in the rural and urban area by the municipality. Biogas will soon replace fossil fuels as a source of energy. With this global warming and greenhouse effect will also reduce in the coming years. As we head into the 21<sup>st</sup> century, awareness and education will most assuredly continue to be the most important ways to spread use of biogas.

The developed countries are coming up with new technologies to make better biogas plant to meet the increasing demand. This project will help the people to contribute towards the biogas plant and understand it as a better source of energy. In short, with the coming technology the energy scenario will be changed in the coming years.

# BIBLIOGRAPHY

- WIKIPEDIA
- BOOKS ON BIOGAS PLANT
- GOOGLE
- NCERT BOOK CLASS 12<sup>TH</sup> CBSE
- IMAGES.COM
- NEWSPAPER