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# Fabrication and Experimentation of an Anaerobic Bio gas digester for Domestic Biodegradable Solid Waste

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**ABSTRACT:** The project investigates the development of a low cost, efficient, portable biogas plant for the generation of energy from discarded kitchen wastes and food waste. The main purpose of the project is to cut down on the landfill wastes and generate a reliable source of renewable, decentralized source of energy for the future. Biogas generation does not require a complex technology and can be applied globally. Kitchen waste discarded causes public health hazards, the project also looks into prevention of various diseases including malaria, typhoid and also meets the social concerns in the society. Household digesters represent a boon for urban and rural people to meet their energy needs. These digesters help in two ways: one is to reduce waste and the other is to provide valuable energy

**KEYWORDS:** Biogas, Digesters, GSM, Kitchen waste,

## I. INTRODUCTION

Biogas is a mixture of gases, primarily consisting of methane and carbon dioxide, produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste and food waste. It is a renewable energy source.

Biogas is produced by anaerobic digestion with anaerobic organisms or methanogen inside an anaerobic digester, Bio digester or a Bioreactor.

Biogas is primarily methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) and may have small amounts of hydrogen sulfide (H<sub>2</sub>S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used in fuel cells and for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat.

Biogas can be compressed after removal of carbon dioxide, the same way as natural gas is compressed to CNG, and used to power motor vehicles. In the United Kingdom, for example, biogas is estimated to have the potential to replace around 17% of vehicle fuel.<sup>[4]</sup> It qualifies for renewable energy subsidies in some parts of the world. Biogas can be cleaned and upgraded to natural gas standards, when it becomes bio-methane. Biogas is considered to be a renewable resource because its production-and-use cycle is continuous, and it generates no net carbon dioxide. As the organic material grows, it is converted and used. It then regrows in a continually repeating cycle. From a carbon perspective, as much carbon dioxide is absorbed from the atmosphere in the growth of the primary bio-resource as is released, when the material is ultimately converted to energy.

Biogas is produced by microorganisms, such as methanogens and sulfate-reducing bacteria, performing anaerobic respiration. Biogas can refer to gas produced naturally and industrially.



### 1.1 Anaerobic digestion

Anaerobic digestion is a sequence of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion.

Anaerobic digestion occurs naturally in some soils and in lake and oceanic basin sediments, where it is usually referred to as "anaerobic activity". This is the source of marsh gas methane as discovered by Alessandro Volta in 1776.

The digestion process begins with bacterial hydrolysis of the input materials. Insoluble organic polymers, such as carbohydrates, are broken down to soluble derivatives that become available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. In acetogenesis, bacteria convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide amongst other compounds. Finally, methanogens convert these products to methane and carbon dioxide. The methanogenic archaea populations play an indispensable role in anaerobic wastewater treatments.

Anaerobic digestion is used as part of the process to treat biodegradable waste and sewage sludge. As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere. Anaerobic digesters can also be fed with purpose-grown energy crops, such as maize.

Anaerobic digestion is widely used as a source of renewable energy. The process produces a biogas, consisting of methane, carbon dioxide, and traces of other 'contaminant' gases. This biogas can be used directly as fuel, in combined heat and power gas engines or upgraded to natural gas-quality biomethane. The nutrient-rich digestate also produced can be used as fertilizer.



### 1.2 Applications

Schematic of an anaerobic digester as part of a sanitation system. It produces a digested slurry (digestate) that can be used as a fertilizer, and biogas that can be used for energy. Using anaerobic digestion technologies can help to reduce the emission of greenhouse gases in a number of key ways:

Replacement of fossil fuels

- Reducing or eliminating the energy footprint of waste treatment plants
- Reducing methane emission from landfills
- Displacing industrially produced chemical fertilizers
- Reducing vehicle movements
- Reducing electrical grid transportation losses
- Reducing usage of LP Gas for cooking
- An important component of the Zero Waste initiatives.

### 1.3 Waste and wastewater treatment

Anaerobic digesters in a sewer treatment plant. Anaerobic digesters in a sewage treatment plant. The methane gas is managed by burning through a gas flare. Anaerobic digestion is particularly suited to organic material, and is commonly used for industrial effluent, wastewater and sewage sludge treatment. Anaerobic digestion, a simple process, can greatly reduce the amount of organic matter which might otherwise be destined to be dumped at sea, dumped in landfills, or burnt in incinerators.

Pressure from environmentally related legislation on solid waste disposal methods in developed countries has increased the application of anaerobic digestion as a process for reducing waste volumes and generating useful byproducts. It may either be used to process the source-separated fraction of municipal waste or alternatively combined with mechanical sorting systems, to process residual mixed municipal waste. These facilities are called mechanical biological treatment plants.

### 1.4 Power generation

In developing countries, simple home and farm-based anaerobic digestion systems offer the potential for 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. At present, projects for anaerobic digestion in the developing world can gain financial support through the United Nations Clean Development Mechanism if they are able to show they provide reduced carbon emissions.

Methane and power produced in anaerobic digestion facilities can be used to replace energy derived from fossil fuels, and hence reduce emissions of greenhouse gases, because the carbon in biodegradable material is part of a carbon cycle. The carbon released into the atmosphere from the combustion of biogas has been removed by plants for them to grow in the recent past, usually within the last decade, but more typically within the last growing season. If the plants are regrown, taking the carbon out of the atmosphere once more, the system will be carbon neutral. In contrast,



carbon in fossil fuels has been sequestered in the earth for many millions of years, the combustion of which increases the overall levels of carbon dioxide in the atmosphere.

## II. TYPES OF BIOGAS DIGESTER

### Types of Small-Scale Digesters

- 1.1 Fixed Dome Biogas Plants
- 1.2 Floating Drum Plants
- 1.3 Low-Cost Polyethylene Tube Digester
- 1.4 Balloon Plant
- 1.5 Horizontal Plants
- 1.6 Earth-pit Plants
- 1.7 Ferro-cement Plants

### 2 Industrial Digester Types

- 2.1 Batch plants
  - 2.1.1 Continuous plants
  - 2.1.2 Semi-batch basis

### 3 Dry Fermentation Plants

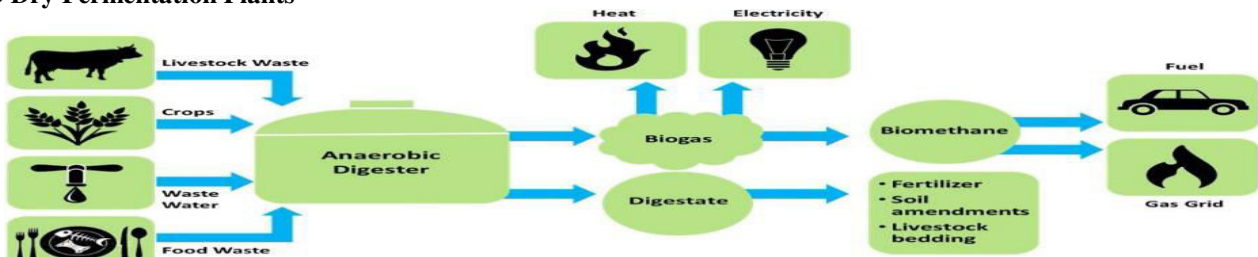


Figure 1. Bio Gas Digester

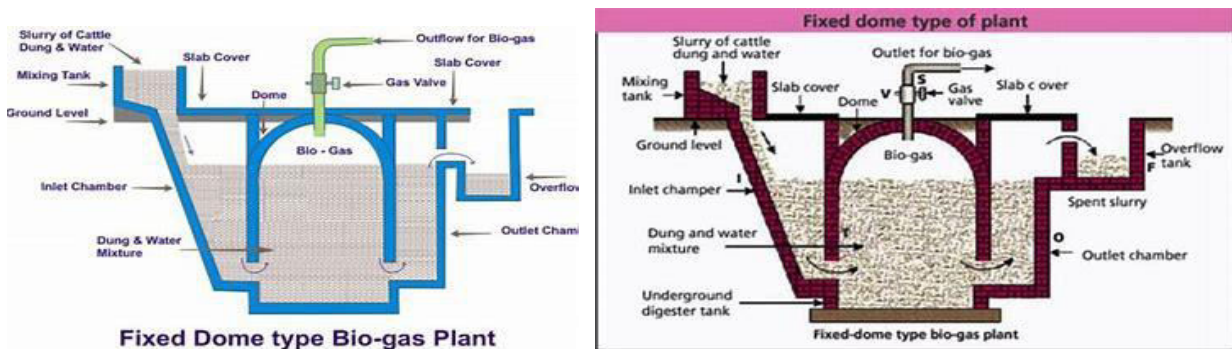
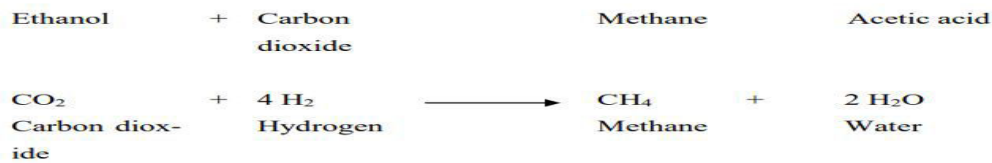


Figure 2. Types of bio gas digester plants

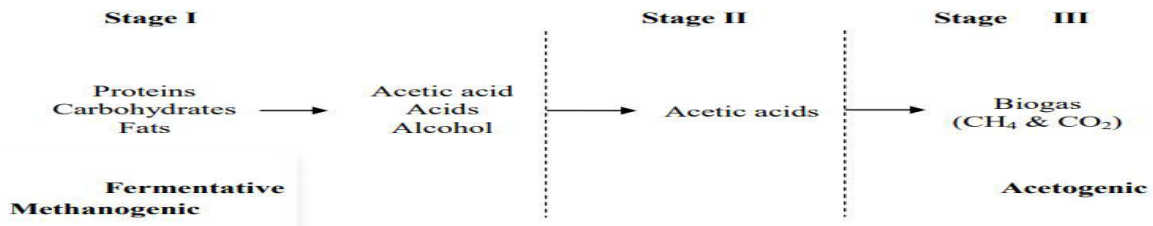
Table 1. Composition of Biogas

Gases	Formula	Percentage present
Methane	CH <sub>4</sub>	50-70
Carbon dioxide	CO <sub>2</sub>	25-50
Nitrogen	N <sub>2</sub>	0-9
Hydrogen	H <sub>2</sub>	0-1
Hydrogen sulfide	H <sub>2</sub> S	0.1-0.5
Oxygen	O <sub>2</sub>	0-0.5





The process of biogas formation through different stages is depicted in figure.



### III. LITERATURE REVIEW

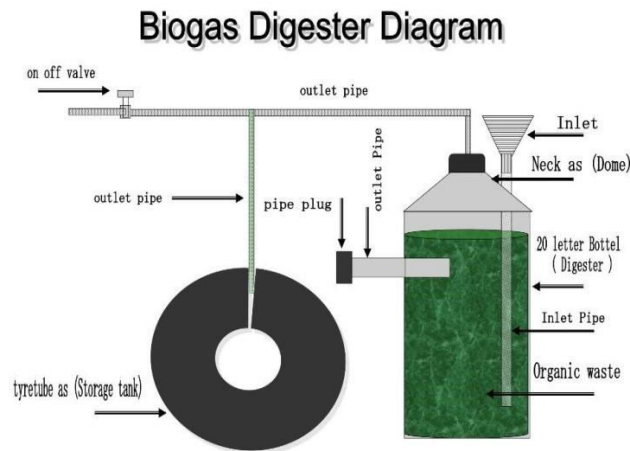
**Ravi Agrahari and Tiwari (2013)** investigated that the kitchen waste is the best alternative For biogas production in a community level Biogas plant. It is produced when bacteria Degrade organic matter in the absence of air. Biogas contains around 55- 65% of methane, 30- 40% of carbon dioxide. The calorific Value of biogas is appreciably high (around 4700 kcal or 20 MJ at around 55% methane Content). The gas can effectively be utilized for generation of power through a biogas Based power- generation system after Dewatering and cleaning of the gas. In Addition, the slurry produced in the process Provides valuable organic manure for farming And sustaining the soil fertility. In this paper, An attempt has been made to test the Performance of different ratio of kitchen Waste in a metal made portable floating type Biogas plant of volume capacity 0.018 m<sup>3</sup> for Outdoor climatic condition of New Delhi, India. Each of the biogas plant 30 Kg slurry Capacity in batch system for all measurement.

**Vipul Vaid and Shivangi Garg (2013)** studied That the biogas is a valuable renewable energy Source containing 55% methane and a Sustainable mode of waste disposal. It does not have any geographical limitations nor does it require advanced technology for producing energy, also it is very simple to use and apply but is yet to achieve its true Potential. These resources, coupled with new And emerging conversion technologies and Appropriate energy policy, can make biogas a Powerful addition to the renewable energy Landscape. Biogas can help decentralize Energy generation and immediate benefit from Owning a compact biogas system is the Savings in cost as compared to the use of Kerosene or LPG for cooking. Biogas systems That take kitchen wastes are 800 times Efficient than conventional biogas systems. Kitchen waste has high calorific value and Nutritive value to microbes due to which Efficiency of methane production can be Increased by several orders of magnitude.

### IV. EXPERIMENTAL INVESTIGATION

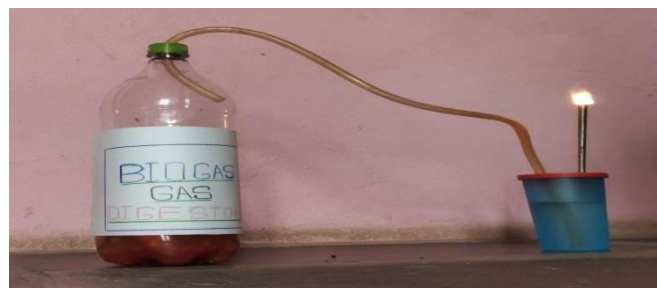
#### 4.1 Materials and Equipment

- Digester seed material
- Digester feed stock (Animal dung, vegetables)
- 20-litre water can
- 1/4" plastic tubing – possible use in the gas collection system
- Medium size Tyre tube for gas storage
- Tub for mixing water feedstock
- PVC Pipe 3/4" 2.5 ft
- T-valve
- Valve
- Super Glue
- Fine Sand
- Soldering Iron



1.3 Symatic diagram of Biogas digester

- Mixing tank – The feed material (dung) is collected in the mixing tank. Sufficient water is added and the material is thoroughly mixed till a homogeneous slurry is formed.
- Inlet pipe – The substrate is discharged into the digester through the inlet pipe/tank.
- Digester – The slurry is fermented inside the digester and biogas is produced through bacterial action.
- Gas holder or gas storage dome – The biogas gets collected in the gas holder, which holds the gas until the time of consumption.
- Outlet pipe – The digested slurry is discharged into the outlet tank either through the outlet pipe or the opening provided in the digester.
- Gas pipeline – The gas pipeline carries the gas to the point of utilization, such as a stove or lamp.



1.3 Experimental model

#### 4.2 PRECAUTIONS

- Avoid the biogas digester from getting in direct contact with sunlight.
- Avoid it from high-temperature variations (Neither too hot, nor too cold )
- It must not go out of 30C – 40C temperature variations.
- Use all safety precautions when testing the biogas, must keep the valve face away while testing the biogas.
- If you do not find any results after one week of feeding in a biogas digester. Check the pipes for dung or water blockage.
- Dung from the animals who are being or were injected antibiotics recently for any reasons is highly harmful

#### V. CONCLUSION

The use of biogas digesters as replacements for single resident septic systems is not economically viable due to high costs and low benefits. Regardless, biogas digester technology has successfully been used on a municipal, agricultural, and domestic scale throughout the world. Large scale biogas generation through anaerobic digestion is viable economically, producing enough biogas to lower energy costs and providing a valuable source of fertilizer for agriculture. Small scale use is only viable in developing third world countries, where fuel sources are scarce and waste management systems are needed to prevent harm to human and environmental health. Besides cheap alternative sources of energy, a need for more advanced and proven commercial biogas systems, and regulation barriers, the amount of



waste generated by a single household does not have a large enough nutrient potential to produce enough biogas in a digester to be economically viable. Conventional septic systems, if installed and maintained correctly, can successfully replace failing systems. Improved education, regulation, management, and funding for septic system programs are needed to guarantee working systems and thus preserve environmental and human health.

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