

# Pure Biogas generated from MSW -A Sustainable Alternative Fuel for Cooking

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**ABSTRACT:** Now-a-days one of the greatest challenge for society is the growing energy demands and reduction of green house gas emission. The major causes of such emissions are due to combustion of the fossil fuels. One of such approach is to reduce the bulk usage of fossil fuel effectively using bio fuels like biogas. Biogas is produced by following an anaerobic digestion of waste foods collected from Hostel Canteens, where bacteria degrades the food wastes in absence of oxygen. Biogas can be used as a better alternative energy source for cooking. The purified Biogas having high methane content may be used as better alternative fuel for cooking purpose in comparison to other cooking gases like CNG,LPG,etc . This paper reports an experimental investigation on biogas production, its purification and its comparison with other cooking gases.

**KEYWORDS:** Biogas, purified biogas, food waste, high methane value, CNG.

## I. INTRODUCTION

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible and environmentally friendly. The recent time demand of energy requirement for different purposes putting a big pressure on government. The conventional sources on energy like woods, coals, petroleum derivatives, etc. are getting exhausted to meet the surplus demand. So researchers are encouraged to work on new renewable energy sources to meet such challenges and create oppurnities to overcome such fuel crisis. One such initiative being taken to introduce Biogas as one of the alternative fuel to solve these problems in the following decades. Biogas is normally produced from different organic wastes like animal manures, industrial wastes, food wastes & kitchen wastes etc. These large volumes of wastes generated, without proper treatment, pollute the environment in high scale. By anaerobic degradation process, these organic wastes will produce biogas. Biogas is produced from organic waste (food wastes) by anaerobic bacteria through anaerobic decomposition. Bio-gas is a result of anaerobic decomposition of organic material by micro organisms in a moist environment and in the absence of oxygen. Its composition is a mixture of gases in which methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) are in larger amount but it also contains some other constituents. This composition mainly dependent on the different type of plants and even can change in a certain plant regarding the location of the digester.

Natural gases are found to be superior as compare to fossil fuels due to higher efficiency and lower emissions. There are three forms of natural gas: liquefied natural gas (LNG) liquefied petroleum gas (LPG) and compressed natural gas (CNG). Both LNG and CNG are based on methane. The availability of the CNG and the demand to use it for power generation has led to manufacturing of the gas engines. Liquefied petroleum gas (LPG) consists of various hydrocarbons, mainly propane, propylene, butane, and butylenes in various mixtures.LPG is a by-product of natural gas processing or a product that comes from crude oil refining and is composed primarily of propane and butane with smaller amounts of propylene and butylenes. Since LPG is largely contains propane, the characteristics of propane are taken as a close approximation to those of LPG. There are three forms of natural gas: liquefied natural gas (LNG), liquefied petroleum gas (LPG) and compressed natural gas (CNG). Both LNG and CNG are based on methane.

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Biogas which is generated from food waste contributing a lot to the better health and sanitation as compared to traditional wood fuel such as fire wood and charcoal, which are the major sources of fuel used in contributing as households cooking fuel .

## II. MATERIALS AND METHODS

### Composition of Biogas

The anaerobic digestion process which helps to produce biogas from food wastes following four stages of digestion process such as hydrolysis, acidogenesis, autogenesis, methanogenesis. Generally biogas contains some impurities like 50-70% methane CH<sub>4</sub> and 30-50% carbon dioxides (CO<sub>2</sub>) and also some amount of hydrogen sulphide(H<sub>2</sub>S) depending upon the organic wastes. On the other hand carbon dioxide and hydrogen sulphide are toxic in nature which will create problem when the gas is burnt.

**Table 1 Chemical Composition of Biogas compared with CNG and LPG**

Component	% Concentration (by Volume)		
	Biogas	CNG	LPG
Methane (CH <sub>4</sub> )	60-70	90-94	–
Ethane ( C <sub>2</sub> H <sub>6</sub> )	–	2.29	–
Propane (C <sub>3</sub> H <sub>8</sub> )	–	0.03	29
Butane (C <sub>4</sub> H <sub>10</sub> )	–	0.25	70
Carbon dioxide (CO <sub>2</sub> )	35- 40	0.57	0-1
Water (H <sub>2</sub> O)	2-7	0-2	–
Hydrogen Sulphide (H <sub>2</sub> S)	20-20,000	0-0.001	–
Ammonia ( NH <sub>3</sub> )	0-0.05	–	–
Nitrogen ( N <sub>2</sub> )	0-2	0-1	–
Oxygen (O <sub>2</sub> )	0-2	0-1	–
Hydrogen ( H <sub>2</sub> )	0-1	–	–

Natural gas is produced from gas wells or tied in with crude oil production. Natural gas (NG) is made up primarily of methane (CH<sub>4</sub>) but frequently contains trace amounts of ethane, propane, nitrogen, helium, carbon dioxide, hydrogen sulphide, and water vapour. Methane is the principal component of natural gas. Normally more than 90% of natural gas is methane, the detail of natural gas compositions as shown in Table 1 [2].

So for better improvement the gas should be purified by some purification technique. The purified biogas is more efficient to use as fuel, it has high calorific value which gives more heat.

### Mechanism of Biogas Production

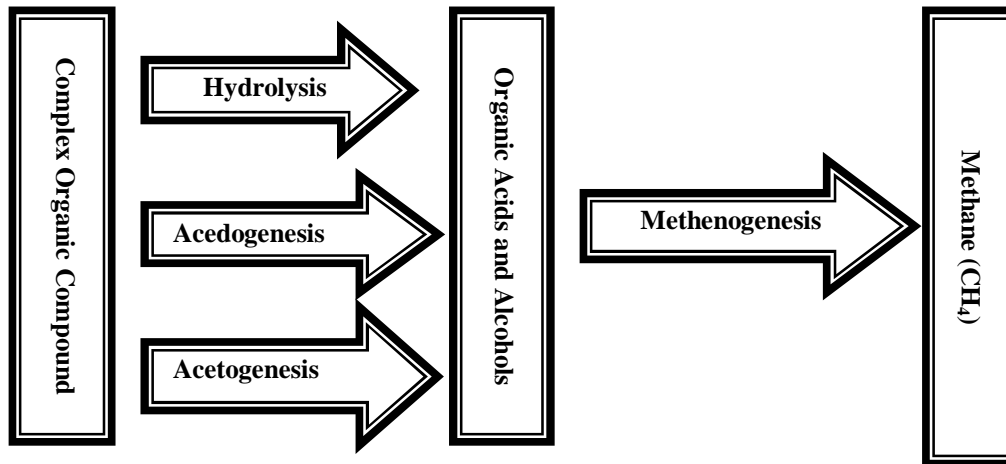
Anaerobic digestion occurs inside the digester with certain bacterial fermentation. The entire process of digestion is completed in a sequence of stages like Hydrolysis, Acidogenesis, Acitogenesis, and Methanogenesis. In the first stage Hydrolysis process involves convert complex organics to sugars and amines, second stage involves in converting the organic acids to acetic acids. The End digestion period of the conversion of acetic acid into methane and carbon dioxide is called as the methanogenic phase.

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**Fig 1 Schematic diagram of Methanogenesis Process**

The growth of methenogenesis bacteria is basically depending on various parameters like pH value, temperature, C/N ratio, organic loading rate, digester design, etc. Bio digester is operated on temperature range for psychrophilic below 28<sup>0</sup>C, mesospheric at medium temperature range from 29<sup>0</sup>C to 40<sup>0</sup>C and thermopile temperature from 50<sup>0</sup>C to 55<sup>0</sup>C [Das et al].

### Biogas production from food wastes

Biogas is produced from the food wastes, kitchen wastes, animal excreta and some other organic wastes. These organic wastes are collected from hostels, hotels & also from home. Then the organic wastes are allowed to digest by the bacteria in the process known as anaerobic reaction. The food wastes are collected from the canteen and the slurry being prepared by water with right proportion. Then the slurry is fed to the digester and facilitates the process of generation of gas in the absence of oxygen.



**Fig 2 Biogas Digester**



**Fig 3 Slurry prepared fed to Digester**

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Vol. 6, Issue 8, August 2017

**Table 2 Thermodynamic Properties of different gases used as fuel**

Properties	Biogas	Gasoline	CNG	LPG
Octane Number	110	96	120-130	100
Stoichiometric ratio	2.1	14.2	17.2	15.6
Higher Calorific value MJ/Kg	40	45	50.3	45
Lower Calorific value MJ/Kg	35	42.2	45.9	44
Density kg/m <sup>3</sup>	1.15	749	2.52	0.72
Adiabatic flame temperature (K)	2148	2227	2266	2810
Compression ratio	-	9-12	9-12	8-12

## Purification of Biogas

Biogas contains high volume of methane (CH<sub>4</sub>) and some impurities like carbon dioxide (CO<sub>2</sub>), hydrogen sulphide (H<sub>2</sub>S) etc. The presence of hydrogen sulphide (H<sub>2</sub>S) and carbon dioxide (CO<sub>2</sub>) becomes harmful due to their toxic nature. Due to its corrosive nature, hydrogen sulphide (H<sub>2</sub>S) highly affects metallic parts of the container and also produces sulphur dioxide (SO<sub>2</sub>). So the removal of hydrogen sulphide from biogas is essential for safe storage and supply in pipeline. The removal of carbon dioxide and hydrogen sulphide from the biogas is done by the scrubbing technology. Water scrubbing technology is a type of chemical scrubbing technology. It involves the use of pressurized water as an absorbent.



**Fig 4 BioGas Burner**

Biogas is compressed and fed into a packed bed absorption column and pressurized water is sprayed from top. Then when the carbon dioxide and hydrogen sulphide dissolves with water, then it is collected from the bottom part and then purified biogas is found. The purified biogas can be a better substitute for cooking as compared to LPG.

## III. RESULTS AND DISCUSSION

Biogas can serve as fuel for cooking, central heating and to water heating and is a particularly cost-effective and efficient for homes. It can be supplied with normal atmospheric pressure to cooking stove. The gas is very non toxic and eco friendly.

The Calorific value of biogas found 35-40MJ/kg which is very close to other hydrocarbon fuels and produces sufficient heat for cooking. Due to less compression ratio, it is better to use in domestic purpose. It is reported that the gas produced for 2 hours by 10 kg food waste digestion .The lower flash point temperature indicates that the fuel can easily burn to produce high amount of heat for cooking.

The purified biogas reports to contain a maximum value of methane up to 80% of the total volume. So the biogas after purification becomes more suitable for cooking and other applications. Compared to CNG and LPG, the processing

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methodology of generation of biogas is very easy and effective. The cost of the gas production in comparison to other domestic fuels is also very cheap.

## IV. CONCLUSION

Biogas is a very useful renewable energy source for the rural India. It can be also produced at low cost. It has many good characteristics than the compressed or liquid natural gas. In the present scenario, the fuel deficiency can be averted by promoting the excess use of biogas and lesser use of fossil fuel. Biogas is proved as a new approach to renewable energy for the better and clean society. The research on biogas may be promoted to find different applications like power generation, lighting, water heating and alternative fuel for IC engines, etc.

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