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BOTTLING OF BIOGAS – A RENEWABLE APPROACH

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ABSTRACT

Energy is essential for human development. Energy is the key input for socio-economic development of any nation. The fast industrialization and rapid urbanization besides mechanized farming have generated a high demand of energy in all forms i.e. thermal, mechanical and electrical. To meet this ever-increasing demand, fossil fuels such as coal, oil and natural gas have been overexploited in an unsustainable manner. The overexploitations of fossil fuels have been posing serious environmental problems such as global warming and climate change. While we have shortage of energy and more dependent on imports in case of petroleum, we are fortunate enough to be blessed with plenty of natural sources of energy such as solar, wind, biomass and hydro. These sources are environmentally benign and non-depleting in nature as well as are available in most parts of the country throughout the year.Biomass resources such as cattle dung, agriculture wastes and other organic wastes have been one of the main energy sources for the mankind since the dawn of civilization. There is a vast scope to convert these energy sources into biogas. Biogas production is a clean low carbon technology for efficient management and conversion of organic wastes into clean renewable biogas and organic manure/fertilizer. It has the potential for leveraging sustainable livelihood development as well as tackling local and global land, air and water pollution. Biogas obtained by anaerobic digestion of cattle dung and other loose and leafy organic matters/ biomass wastes can be used as an energy source for various applications namely, cooking, heating, space cooling/ refrigeration, electricity generation and gaseous fuel for vehicular application.The Central Sector Scheme on National Biogas and Manure Management Programme (NBMMP), which mainly caters to setting up of family type biogas plants, has been under implementation. In this program many biogas plants are implemented on small level. These plants are generally used to generate electricity or in cocking with direct supply.

Key word: Bio digester, Bio methane

I. INTRODUCTION

India has a huge population of humans and cattle. One fifth of the population of earth as well as millions of cattle reside in India. Biological wastes are available in abundance.But there is no conscientious effort, except the traditional use of animal waste as manure, has been made to some extent. No effort has been made to use this waste for the purpose of production of energy to run power plants, vehicles etc. Several years back a half-heartedeffort was made to use this Bio-Gas as a source of cooking with the help of bio-digesters. This was done by marginal farmers/cattle breeders having one or two cattle. Obviously it did not bring any worthwhile response. Due to the small size of the plant and improper handling the output of the gas was limited and irregular.

By an approximate formula, 100 cows will give/day 1000/Kg of cow dung, this, in a bio digester will yield about 40 M^3 of Gobar gas. After removing impurities such as CO_2, Sulphur, Moisture etc. will yield about 20M^3 or 17Kg of pure methane gas. Based on the availability of cattle dung alone from about 304 million cattle, there exists an estimated potential of about 18,240 million cubic meter of biogas generation annually. In addition, kitchens of all the institutions, universities, restaurants, banquet halls, industries, parks and gardens in urban and semi-urban areas also offer a very large potential. There is a need for treating these wastes for better environmental condition and reducing methane emission affecting climatic change. The potential can be translated to an aggregated estimated capacity of 8000 MW per day power generation or 2.2 million LPG cylinders and 21 lakh kg of urea equivalent or 3974 lakh tones of organic manure/fertilizer per day.

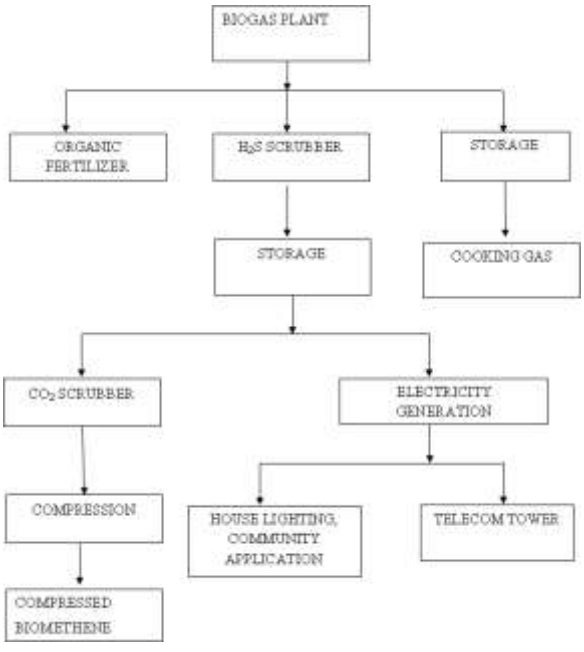

Figure 1: Energy Solutions By Biogas

II.BIOGAS PRODUCTION PROCESS

Organic substances exist in wide variety. Organic matters are composed of Carbon (C), combined with elements such as Hydrogen (H), Oxygen (O), Nitrogen (N), Sulphur (S) to form variety of organic compounds such as carbohydrates, proteins & lipids. In nature MOs (microorganisms), through digestion process breaks the complex carbon into smaller substances. There are 2 types of digestion process:

- Aerobic digestion.
- Anaerobic digestion.

The digestion process occurring in presence of Oxygen is called **Aerobic digestion** and produces mixtures of gases having carbon dioxide (CO_2), one of the main "green houses" responsible for global warming.

The digestion process occurring without (absence) oxygen is called A**naerobic Digestion** which generates mixtures of gases. The gas produced which is mainly methane produces 5200-5800 KJ/m^3 which when burned at normal room temperature and presents a viable environmentally friendly energy source to replace fossil fuels (non-renewable).

Biogas is used in cocking. It flows directly from plant to the stove. Biogas contains water, hydrogen sulphide, carbon dioxide in some quantity. Due to this compression of biogas have some difficulties. Thusremoval or reduction of these components is essential.In the studies it is found that after purification of biogas, the percentage of methane increases up to 95%.So the biogas contains mostly methane with very small percentage of carbon dioxide and negligible amount of other components. So it can be called BIOMETHANE instead of biogas.Biomethane composition is given in the table

Chemical composition of biomethane shown in following table-

Sr.No.	Element/Compound	Volumetric (in %)
1.	Methane	> 97
2.	Carbon dioxide	< 2
3.	Nitrogen	< 0.8
4.	Oxygen	< 0.2
5.	Hydrogen sulphide	< 0.00005

Table1: Chemical Composition of Bio-methane

Biogas contains about 60%-70% methane while biomethane has about 95% of it. Biomethane has higher calorific value than biogas that is more beneficial for the cocking purpose. Some purification processes are required to obtain biomethane from biogas. These processes are removing of water, sulphur and carbon as much as possible.

III. PROJECT OBJECTIVES

- To provide clean bio- gaseous fuel mainly for cooking purpose
- To provide bio-fertilizer/ organic manure to reduce use of chemical fertilizers
- To improve sanitation in villages
- To mitigate Climate change by reducing methane emissions

The Project has two parts

Ist Part

It deals in separating impurities such as moisture, Carbon dioxide and Hydrogen sulphide and generating pure Methane from Biogas.

IInd Part

It deals in compressing and filling Methane in a cylinder to use it as a cooking fuel (gas).

IV. BIOGAS PRODUCTION

A mini biogas digester is made to produce biogas at the domestic and individual level. It is effective and simple in construction. Mixture of cow dung and organic kitchen waste has been used as raw material for production of biogas.

V. PURIFICATION OF BIOGAS

Since the primary objective of an on-farm anaerobic digestion system is to produce methane, it is desirable to remove other biogas components because they represent an environmentalhazard, a processing problem, or dilute the energy density of the biogas. The sections present various ways of managing the non-methane components of biogas. The removal of these components is broken down into two steps, biogas cleaning and biogas upgrading.

Biogas cleaning refers to the removal of H_2S, water vapour, NH_3, particles, etc., whereas biogas upgrading generally is the removal of CO_2. All biogas applications have some level ofbiogas cleaning, however, co-generation requires significantly less.

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Figure 2: Mini Biogas Digester

VI. COMPRESSION OF PURIFIED BIOGAS

There are different types of compressors available. Selection among them is a difficult task, due to high compression and cost consideration. Various forms of gas compression were reviewed and are summarized in Figure 3.

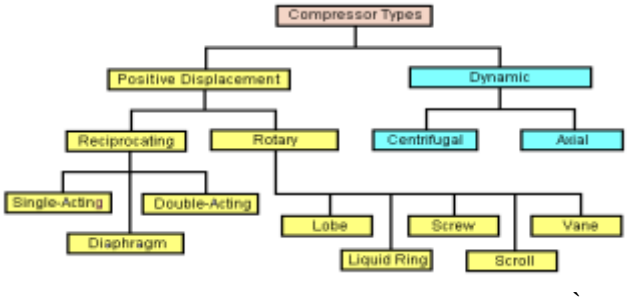

Figure3: Available Mechanisms of Gas Compression

Most favourable compression methods are rotary screw compressor, the reciprocating compressor and the scroll compressor due to their simplicity of implementation.

VII. COMPRESSOR COMPONENTS

S. No.	PRODUCT NAME	SIZE
1	Slip Tee	1”
2	2 Slip Caps	1”
3	1 Slip Cap	1-1/4”
4	26” PVC Pipe	1”
5	1 O – Ring	
6	24” PVC Pipe	1-1/4”
7	2 O – Ring	
8	1 Slip Coupling	1-1/4”
9	1 Plug	1”
10	1 PVC Bushing	1-1/4” X 3/4”
11	1 PVC Close Riser	3/4"
12	PVC FIPT x FIPT x FIPT Tee	3/4”
13	2 Male PVC Slip Adaptor	3/4”
14	2 PVC Tubing	3/4”
15	2 Crazy Rubber Ball	3/4”
16	Rubber O – Ring	

Table 2: Compressor Component

For making a gas compressor all components are assembled in different steps.

STEP- 11" pipe fits closely inside of the 1-1/4" PVC pipe. Just a little gap is required, to be air-tight to make a proper piston. The best way is to make an air-tight seal, is by using some rubber O-rings.

STEP- 2 To cut grooves for the rings, 2 grooves are cut for redundancy. One at 1” and another at 2" mark. The O-rings fit perfectly into place. This end of the pipe also needs to be capped off to seal it air tight.

STEP- 3 3/4" plug is sanded down to fit inside the end of this 1" pipe. Now this end of the tube is completely sealed.

STEP- 4 To finish the piston, a little machining work on the exterior tube. An O-ring was added into the inside of the cap around the hole, and put to the side for a minute. To insert the piston, the Orings need some lubrication or the friction on the inside walls of the pipe will damage them Petroleum jelly used but sir have suggested jelly will eat the O-rings over time, and that some type of silicon grease would be better.

STEP-5 To the bottom of the 1-1/4" pipe is cemented on the coupling, 3/4" reducer bushing, short riser, and threaded T.

STEP-6 With the 2 O-rings lubricated, the piston should push air-tight into the larger pipe. The modified slip cap can be cemented on top now, and when the piston is bottomed out, there should just be a couple of inches of pipe poking out the top.

STEP-7 This is painted the fittings black, and the pipe blue, just for contrast.

STEP-8 The handle is made from 2 pieces of 4-1/2" x 1" PVC pipe cut from the scraps off of the piston. Everything is cemented together and when the handle is complete, it cements onto those couple of inches of piston pipe sticking out of the air piston chamber.

This completes the piston, and adding 2 check valves to the threaded Tee at the bottom will complete the pump.

STEP-9 Procedure for making one way valve

For this valve, the harder rubber ball and an O-ring are used. These are made to be a little more durable.

1. Start by taking a piece of 3/4" PVC tubing (minimum 1-1/2") and measure 5/8" from the bottom.
2. Drill a hole at the mark that goes through both walls of the tubing.
3. Find a strong piece of metal, like a thick paperclip or a nail to insert into the holes.
4. Trim the head off the nail so that both ends of the nail or paperclip are flush with the outside walls of the tube.
5. Prime the inside walls of the adaptor, as well as the part of the tube that will slide into it.
6. Insert the O-ring and plastic ball into the adaptor, and check for a good fit and good seal.
7. Glue the parts that were primed, and slide the tube into the adaptor until the nail holes dip just below the surface.
8. Let the cement cure for about 2 hours before use.
9. To test valve, use it to blow up a balloon. The balloon should stay inflated even when stop blowing. The check valves are up to 90-95% efficient.

VIII. STORAGE OF BIOMETHANE

Storage of the biomethane in the small cylinders like is the purpose of project. Biomethane can be stored at low pressure for on farm uses, but for long time storage, it requires storage at high pressure of the range 150 bar-200 bar. For this purpose some important processes have been done of purification. In that we scrub hydrogen sulphide and carbon dioxide and moisture that are cause to corrosion of cylinders in storage process.The gas is stored in steel or steel alloy cylinders such as those typically used for storage of other commercial gases. Storage facilities must be adequately fitted with safety devices such as rupture disks and pressure relief valves.

In some areas of India, The upgraded biogas is being filled in CNG cylinders and supplied to support the mid-day meal scheme for cooking food. This is a proof of storage and transportation of biogas. CNG cylinders are large in size and not so easy for handling purpose. In this project plastic bottles are being used for storage and transportation of biogas. These bottles can hold pressure up to 150 psi. The plastic bottle are easy available, cheap (almost free), easy to transport. Thus this is asimpler, cheaper, lighter and more flexible system could be achieved through the use of PET drinks bottles as biogas pressure vessels.

Figure 4: Storage Bottle for Compressed Biogas

IX. ADVANTAGE OF BIOMETHANE AS COOKING GAS

HIGH CALORIFIC VALUE

Purified biogas has higher calorific value in comparison to traditional biogas. Due to this, it provides higher energy than biogas. This is an advantage that we can prepare our food in less time and safe our time.

Properties	Compressed Natural gas	Raw biogas	Upgraded biogas
Composition	CH_4 – >85% CO_2 – 4.38% C_2H_6 – 7% Other gases – 0-5%	CH_4 – 55- 65% CO_2 – 35-40% H_2S– 1000-5000ppm Other gases–0-2%	CH_4 – 95% CO_2 – 4% H_2S – 50-100 ppm Other gases-1%
Calorific value	44.39 MJ/kg	20.50 MJ/kg	42.62 MJ/kg

Table3: Comparison between compressed natural gas, traditional biogas and upgraded biogas

NON CORROSIVE

Biogas contains water vapours and H2S that cause the corrosion on the surface of the vessels using in cocking. Here purified biogas or can say biomethane in free from these impurities. So it does not leave any effect to the surface of vessels.

X. CONCLUSION

In the present scenario of energy crisis in world, compressed biogas is a strong alternative. There is no doubt that purified biogas is similar to natural gas, hence it can be used in applications like cocking, generating electricity, stationary moors and vehicles. It is proved that biogas can be compressed, stored and made portable. Establishment of the setup for the compression and made an earnest effort for the purification.The upgraded biogas is being filled in CNG cylinders.These plants prevent black carbon emissions commonly seen in biomass chulhas. Biogas is an easy and healthy cooking fuel since methane emissions from untreated cattle dung and biomass wastes can also be avoided. The enriched biogas can be bottled in CNG cylinders and used wherever CNG is being used. Since there is no pollution from biogas plants, these are one of the most potent tools for mitigating climatic change and being earth saviours.

The bottling system is a further step of utilization. At large level biogas is compressed at 200 bars in heavy cylinders. This project is at a small level .it is a simple and economic system for biogas uses and it can be utilize individually at the domestic purpose generating biogas by daily kitchen waste.

This biogas bottling project is projected to replace fuel and manure three-in-one solution of gaseousfuel generation, organic manure / fertiliser production and wet biomass waste disposal. Here in the project main purpose of compressing the biogas and use it as cocking gas is going to achieved. Other objectives besides this, as mentioned in the beginning like sanitation, and care of environment.Further study is continuing to commercial use and purification and compression instruments.

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