"Power Generation Using Animal Waste"

A

Project Report

Submitted in the partial fulfillment of the requirementsFor the Degree of

Bachelor of Engineering
In
Electrical (Electronics & Power)

By

Ms. Akanksha Nardange

Ms. Manjushri Narwade

Ms. Mayuri Kharpate

Mr. Azhar Fakira

Mr. Prajwal Deshmukh

Mr. Saqulain Nazir

Under the guidance of

Dr.Ajay Kumar Damral

DEPARTMENT OF ELECTRICAL ENGINEERING

SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
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2022-23

CERTIFICATE

Certified that the project report entitled, **"Power Generation Using Animal Waste"** is a bonafied work done under my guidance by

Akanksha Nardange
Manjushri Narwade
Mayuri Kharpate
Azhar Fakira
Prajwal Deshmukh
Saqulain Nazir

In partial fulfillment of the requirements for the award of degree of Bachelor of Engineering in Electrical (Electronics & Power).

Date: 13/05/23

Dr.Ajay Kumar Damral
Guide

Approved

(Dr. S. R. Paraskar)
Head
Department of Electrical Engg.

(Dr. S. B. Somani)
Principal

E-mail: principal@ssgmce.ac.in
hod_elpo@ssgmce.ac.in

Phone No. 07265-252116, 252216
Fax No. 07265-252346, 253602

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Akanksha Nardange
Manjushri Narwade
Mayuri Kharpate
Azhar Fakira
Prajwal Deshmukh
Saqulain Nazir

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ABSTRACT

The invention provides an antiriot shield. The antiriot shield comprises an arc-shaped insulating shield body, wherein a plurality of first metal conductive sheets are vertically fixed on the outer wall of the arc-shaped insulating shield body; a second metal conductive sheet is fixedly arranged between every two first metal conductive sheets; a plurality of positive electrode nails are fixedly arranged on the first metal conductive sheets; the second metal conductive sheets are fixedly provided with a plurality of negative electrode nails which are connected with a positive electrode and a negative electrode of a high-voltage power supply by lead wires respectively; the high-voltage power supply is arranged in an insulating handle and the insulating handle is fixed on the inner wall of the arc-shaped insulating shield body. The antiriot shield has good antiriot performance and is safe and reliable; damages on lives are not caused; the antiriot shield has light weight and is convenient to carry and easy to control.

Anti-riot electric shields are devices used by law enforcement and security personnel during riot control operations. The shields are designed to protect the user from physical harm, while also providing a non-lethal means of crowd control

The shield is typically made of a lightweight, yet durable material and has a built-in electrical charge that can be used to disperse a crowd. The application of an anti-riot electric shield involves several steps. First, the user must ensure that the shield is charged and functioning properly. This can be done by checking the battery or power source and running a quick test to ensure that the electrical charge is working. Once the shield is ready to be used, the user can approach the crowd and use the shield to push back any individuals who are attempting to breach a barricade or create a disturbance. The electrical charge can be activated by pressing a button or switch on the shield, and the charge will be delivered through the surface of the shield. The electric charge can cause discomfort or pain to individuals who come into contact with the shield, which can discourage them from continuing their behavior. It is important to note, however, that the use of an anti-riot electric shield should be done with caution and in accordance with proper training and protocols, as misuse or excessive force can lead to serious injuries or legal ramifications.

Keywords: Battery charger, charging station, electric vehicle, standards.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Energy is one of the most important factors for accelerating economic development. Due to rapid industrialization and urbanization in world over the few decades, there is a huge pressure and ever increasing demand of Electrical energy, which has resulted in a concentrated need for finding some alternative sources of energy. As all the existing energy source is from fossil fuels which are limited and are going to exhaust, so this project deals with the idea of limitation in the use of fossil fuels. Waste collection and management significantly improve in areas with biogas plants. This in turn, leads to improvements in the environment, sanitation, and hygiene.

Electricity produced from biogas fuel is a renewable energy source steadily gaining importance and leading the way for economic development. Biogas is obtained from animal waste fermentation process. Biogas generators extract by-products from organic waste which can be used to replace traditional fuels and fertilizers. The biogas is generated from the animal waste in large scale different types of animal waste are available, each animal waste has so many contents this contents has different proportions. Biogas has lots of impurities which are removing by purification process. The purified biogas is use as a fuel for generator so to operate generate on purified biogas we successfully modify the IC engine, which works smoothly without any sign of audible knocking during the entire experimentation.

1.2 OBJECTIVE

- To limit usage of fossil fuel.
- To increase renewable energy production.
- To reduce greenhouse gas emission by the consumption of renewable energy sources.
- Analysis of gases.
- Modifying existing generator to operate on biogas.

CHAPTER 2

LITERATURE REVIEW

India has the world's largest livestock population of 250 million, which produces close to 125 million tones' of cow-dung. It can produce enough methane gas to entirely replace LPG and kerosene in cooking, and substitute petrol in transportation. Methane gas can also generate enough to meet all requirements, at least in rural areas. The process can also produce excellent organic manure as byproduct, substituting chemical fertilizer's which require LNG as feedstock.

Now a day's energy crisis has taken an alarming trend and day by day energy crisis deepening. The energy used in last century is many times more than that of energy used. Put together during the known history of mankind from last 80 to 100 century. Hence due to this rapid consumption the energy crisis began to show off still more intestinally from the very beginning of 21" century for going decades will face more acute crisis of energy. Use of renewable energy can be effective solution to this need of time to come. In our country biogas program has gotten long history of 20 years of implementation on a large scale within generation of power from biogas is alternative to solve the problem energy crisis in ruler areas. Hence there is no doubt that successful implementation of an approximate technology like biogas will surely a positive way for us to face the challenges of 21st century.

Literature review is useful to understand in the depth knowledge of problem and for proper formation of problem statement. The following papers were obtainedfrom a variety of publications.

2.1 Tresor k.Kumba , " Design and Sustainability of a Biogas Plant for Domestic Use "

This paper presents a study on the design methodology of domestic mechanical anaerobic digesters. A domestic anaerobic digester was designed using a design process that consists of determining gas requirements, biomass selection and yield potentials, sizing the digester and design of additional components such as heating and mixing elements.

2.2 J.I.Huertas , "Removal of H2S and CO2 from Biogas by Amine Absorption"

This paper presents a study about the removal of H_2S and CO_2 content from gaseous streams were compared in terms of their range of applicability, removing efficiency . To design the scrubbing system based on amines it is necessary to know its H_2S and CO_2 absorbing capacity.

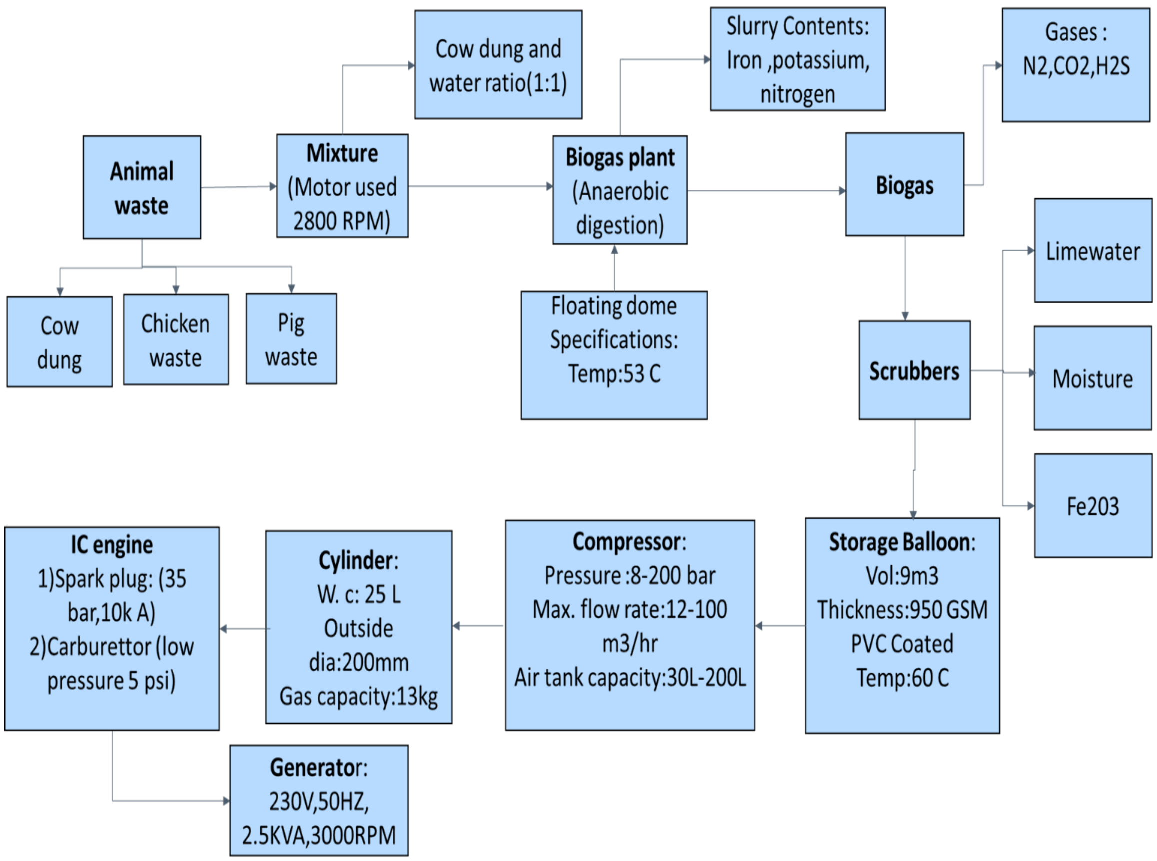
2.3 Jackson Akpojaro , "Electricity Generation From Cow Dung Biogas"

The paper reviews the potentials of biogas for power generation. A small-scale biogas generator is designed. Comparative analysis of biogas and petrol consumption with load was carried out with respect

to the quantity and load input on the power generation system.

CHAPTER 3

BLOCK DIAGRAM



CHAPTER 4

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WHAT IS BIOGAS?

1.1 Biogas:

Biogas is an environmentally-friendly, renewable energy source produced by the breakdown of organic matter such as food scraps and animal waste.

Biogas a renewable fuel that's produced when organic matter, such as food or animal waste, is broken down by microorganisms in the absence of oxygen. The process of producing biogas is also largely cyclical and fits into an overall sustainable cycle of managing agricultural waste.

1.2 Which gases does biogas contain?

Biogas consists mainly of methane and carbon dioxide. It can also include small amounts of hydrogen sulphide, siloxanes and some moisture. The relative quantities of these vary depending on the type of waste involved in the production of the resulting biogas.

1.3 What can biogas be used for?

- **To fuel vehicles –** if biogas is compressed it can be used as a vehicle fuel.
- **As a replacement for natural gas –** if biogas is cleaned up and upgraded to natural gas standards, its then known as biomethane and can be used in a similar way to methane; this can include for cooking and heating.

CHAPTER 5

BIOGAS PLANT

There are a number of designs of biogas plant – the 2 most common in small-community scale use being

1) fixed-dome

2) floating-drum

Although the designs differ in detail each has 3 common parts which will be detailed in terms of design and construction for each type of biogas plant:

1. Digester– where biomass (slurry) is stored and broken down by bacteria to produce biogas

2. Biogas holder – an area where the biogas is stored under pressure and can be tapped off (could be part of the digester)

3. Displacement tank/Slurry overflow – method of removing fully digested slurry and prevention of over pressurization of biogas

1. Fixed-dome digester:

Over-view

Waste matter is fed into the digester where it collects and is broken down, producing biogas which is stored in the gas holder part of the hemispherical digester. As the pressure of the biogas increases the more the volume of slurry which is displaced into the displacement tank. Excess slurry from the displacement tank will be removed, dried or composted and used for fertilizer or will overflow into a sewage outlet or slurry/composting bed. Biogas is removed from the gas holder and can be used for cooking, lighting and heating (as detailed). When the gas is used some of the slurry moves back from the displacement tank into the digester causing mixing. The fixed-dome generator is commonly known as the 'Chinese' design and can be used in small scale (household) or larger scale (community) systems.

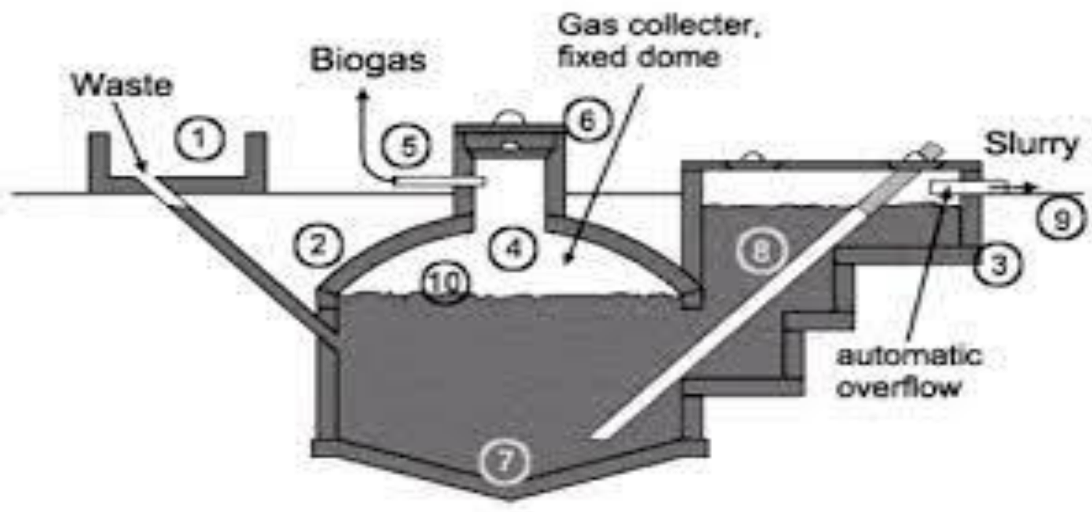

Fig.Fixed dome type plant

Construction consists of an underground digester (usually flat/bowled base with a hemispherical top) covered with earth up to the top of the gas holder so as to counteract the gas pressure. Plastic pipes or masonry tunnels provide the inlet/outlet for the digester. Bricks and mortar are used to create the structure, the inside of which must be rendered and coated in a waterproof and gas-proof coating.

Benefits of fixed-dome generators include:

- Simple design
- Simple maintenance (no moving parts, no potential of rusting, long life (20 years+))
- Lower set-up costs

Disadvantages of fixed-dome generators include:

- Fluctuating gas pressure
- Potential for leaks in mortar if not well constructed.

2. Floating dome digester:

Over-view

As with fixed-drum generators the construction consists of an underground masonry digester (often cylindrical in shape). The gas storage area consists of an upturned enclosed steel structure (drum) which floats in a water jacket which surrounds the opening of the digester (or on the slurry itself). Biogas is taped off from the top of the steel drum and used for cooking, lighting, etc. As the gas is produced and the gas pressure increases the steel drum floats higher in the water jacket – when the gas is used and the gas pressure drops the weight of the drum forces it to float lower. The floating-drum generator is known as the 'Indian' design and is widely used for small scale (household) size systems.

Fig, Floating drum type plant

Benefits of floating-drum generators include:

- Constant gas pressure
- Can see how much gas had collected clearly (by height of drum)

Disadvantages of floating drum generators include:

- Corrosion problems with steel
- Expense of steel drum
- Complex construction due to moving parts o Water jacket MUST be kept topped up to provide the gas seal

CHAPTER 6

BIOGAS PRODUCTION

Literature states that the biogas production rate of human excreta is 0.02-0.07m3/kg/days however the data varies greatly and is dependent on many variables (diet, food intake, water intake, climate, etc.). Similar variance is apparent in human waste production data. Literature suggests that an average adult can be expected to produce 1-1.3kg of urine and 0.2-0.4kg of faces per day [7] (if local figures are available then use these instead). GTZ suggest the following production rates of biogas from wastes of different animals per day in warm climates (in addition to human excreta other organic waste such as cattle dung can be added to the generator to increase biogas production).

Table.1 **:** Approximate biogas production rates of different waste

Source	**Biogas per day (m3 /day)**
1kg Cattle dung	0.04
1kg Pig dung	0.06
1kg Chicken droppings	0.07
1kg Human excreta	0.02-0.07

The amount of biogas produced in a human excreta fed plant can be increased with the addition of animal manure, however care must be taken to ensure the correct solid: liquid (and also carbon: nitrogen) ratio is applied. Water should be mixed with the manure (in a solid: liquid ratio of 1:1) in a mixing tank to create a slurry prior to being added to the digester.

1.1 Biogas mechanics

Stage 1 – Hydrolysis

Bacteria decompose long chains of complex carbohydrates and proteins in the biomass into smaller molecules.

Stage 2 – Acidification

Acid-producing bacteria convert the smaller molecules produced in the first step into acetic acid (CH_3COOH), hydrogen (H_2) and carbon dioxide (CO_2).

Stage 3 – Methane formation (Anaerobic)

Methane-producing bacteria convert the acetic acid (CH_3COOH), hydrogen (H_2) and carbon dioxide (CO_2) into methane (CH_4) and carbon dioxide (CO_2). This mixture of gas is known as biogas.

Table.2: Typical biogas composition

Compound	Symbol	Presence
Methane	CH_4	50%-70%
Carbon dioxide	CO_2	30%-40%
Hydrogen	H_2	5%-10%

Nitrogen	N_2	1%-2%
Other gases	H_2O, H_2S	Trace

1.2 Process parameters:

There are a number of parameters which effect the production of biogas which should be kept at an optimum level for human excreta biogas generators:

1. Substrate temperature – Digestion works best at around 36°c. Expected approximate gas return of 1kg of human waste over 60 days is as follows:

- 0.43m3 biogas at 35°c
- 0.3m3 biogas at 25°c
- Unsatisfactory under 15°c

Areas where the atmospheric temperature falls below 15°c seasonally should not be considered for unheated biogas generators. Within limits, low temperatures can be compensated for with a longer retention time.

2. Hydraulic retention time (HRT) – The average amount of time that the liquid part of the slurry shall be in the digester for. This should be long enough to reduce many of the pathogens and to allow the maximum amount of gas to be extracted however will increase the digester volume. The HRT should be based on a compromise of pathogen removal time and digester size. Commonly the HRT lies in the range 60-100 days if no wastewater sewage outlet is available however can be reduced to as little as 5 days in the presence of a sewage outlet.

3. Solid retention time (SRT) – The sludge (more solid part of substrate) should be stored for a relatively long retention time (anywhere between 1 and 5 years depending on digester design, waste content, digester size, etc.

4. pH – The pH of the slurry should not drop below 6.2 (this will have a toxic effect on methane-producing bacteria). A healthy digestion process is indicated by a neutral pH (7.0).

5. Agitation/mixing – Mixing of the slurry can increase gas production by ensuring an even distribution of bacteria and fresh substrate. The large scale industrial generators are often fitted with motor-driven rotating paddles whilst smaller agricultural ones are mixed with long poles by hand. There is little information on the optimum frequency of mixing in human waste fed digesters but GTZ suggest the gas production increases dramatically when mixing is undertaken (slowly and perhaps once a day or once a week). Different time intervals between mixes should be tried to identify the optimum level for any specific generator.

6. Solids content – Generally a slurry with a solids: liquids (faeces:urine) ratio of 1:1 should be aimed for. A Total Solids (TS) content of between 7-11% is ideal – since the actual liquid content of faces is quite high farces and urine should be added in approximately equal amounts to achieve this.

7. Inhibiting factors – The presence of heavy metals, antibiotics and detergents in the slurry can inhibit the biogas production process. Any addition of these to the digester should be avoided. Anything which is not biodegradable should not be added to the digester since it will take up valuable space and could lead to a blockage. It would seem that anal cleansing material (including water and paper) can be added to the digester whilst keeping in mind that the ideal solid: liquid ratio of 1:1 should be adhered to where possible.

Fig 1.1 Slurry Mixer

8. Carbon: Nitrogen ratio – The carbon: nitrogen ratio of the inlet waste should be in the region 9-25:1 for efficient biogas production (the methane producing bacteria work well with this ratio). Degradable food, agricultural and animal waste can be mixed to the correct solid: liquid ratio (1:1) in an influent collecting Pathogens & parasitic ova Thermophile fermentation (53°c -55°c) Mesospheric fermentation (35°c -37°c) Ambient fermentation (8°c -25°c) Days Fatality (100%) Days Fatality (100%) Days Fatality (100%) Salmonella 1-2 100 7 100 44 100 Shebelle 1 100 5 100 30 100 Polioviruses 9 100 E-Coli titer 2 10-1 - 10-2 21 10-4 40-60 10-4 -10-5 Schist soma ova

Several hours 100 7 100 7-22 100 Hookworm ova 1 100 10 100 30 90 Safaris ova 2 100 36 98.8 100 53 OXFAM Technical Briefs – Repairing, cleaning and disinfecting hand dug wells 4 tank prior to addition to the main digester. Different types of waste can be added to alter the C/N ratio to reach an ideal. Approximate values for C/N ratios and TS values are shown in Table

Table 3. Approximate C:N ratios of wastes

Type of waste	**C: N ratio**
Cow dung	16-25:1
Pig dung	6-14:1
Chicken droppings (fresh)	5-9:1
Sheep/goat droppings	30-33:1
Human excreta	6-10:1
Fresh grass	12-15:1
Vegetable residue	12-30:1

. CHAPTER 7

PURIFICATION OF RAW BIOGAS

Biogas is a clean environment friendly fuel. Raw biogas contains about 55–65% methane (CH_4), 30–45% carbon dioxide (CO_2), traces of hydrogen sulfide (H_2S) and fractions of water vapors. Presently, it can be used only at the place where it is produced. There is a great need to make biogas transportable. This can be done by compressing the gas in cylinders which is possible only after removing its CO_2, H_2S and water vapor components. Pilot level trials to compress the biogas have been carried out by a number of earlier investigators working on the subject. This paper reviews the efforts made to improve the quality of biogas by scrubbing CO_2 and the results obtained. There is a lot of potential if biogas could be made viable as a transport vehicle fuel like CNG by compressing it and filling into cylinders after scrubbing and drying. Thus the need emerges for a unified approach for scrubbing, compressing and subsequent storage of biogas for wider applications.

Scrubbing: One crucial step in producing biogas is scrubbing. This is the process of **removing pollutants from the gas** so that it can be used safely. Without scrubbing, the gas could cause damage to equipment and the environment.

Different process for purification of raw biogas:

1] Water Scrubbing:

2] Solvent Scrubbing:

3] Membrane Scrubbing:

4] Pressure Swing Adsorption (PSA):

1] Water Scrubbing:

It involves the physical absorption of CO_2 And H_2S in water at high pressures and Regeneration by a release in pressure with very Little change in temperature. Easiest and cheapest Method involving is use of pressurized water as An absorbent. The absorption process is, thus a Counter-current one. The dissolved CO_2 and H_2S in water are collected at the bottom of the tower.The scrubber is able to remove about 99 % of carbon dioxide present in raw biogas, when fed to the scrubber at 1.0 MPs pressure with 1.5 m^3/h flow rate against 1.2 MPs pressure of water with 1.8 m^3/h flow rate.

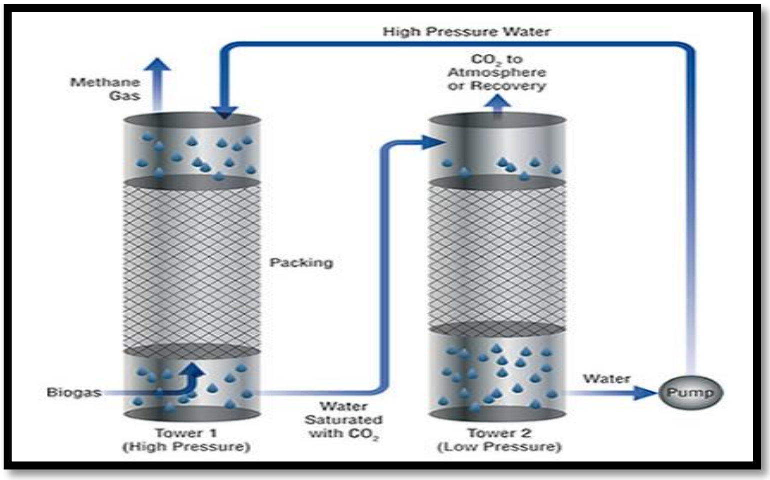

Fig.7.1 Water scrubbing

2] Solvent Scrubbing:

Solvent scrubbing is a process that uses either a chemical (eg : AMINE) or physical (eg : CA(OH)2) solvent to remove CO2 and H2S from the biogas , allowing the methane component to pass through.The most effective ways are as follows.

a) Removal of H2s From Raw Biogas:

Removal of sulfur from biogas involves oxidizing hydrogen sulfide with atmospheric oxygen. A small amount of air (3-6% volume of produced biogas) can be introduced directly into a bio-reactor filled with digested matter. This can be done by pumps that supply suitable amounts of air. Chemical reaction for this oxidation process can be stated as shown below:

2H2S+ O2 2S + 2 H2O

Hydrogen sulfide can be removed using catalyst iron oxide in the form of oxidized steel wool or chips of iron cut from lathe operation of any workshop. When raw biogas comes into contact with steel wool / chips, iron oxide gets converted to elemental sulfur. The chemical equation for this process is as shown below:

i) $Fe2O3 + 3H2S \quad Fe2S3 + 3\ H2O.$

ii) $2Fe2S3 + 3O2 \quad 2Fe2O3 + 6S.$

b) Removal of CO2 from Raw Biogas:

The most easiest and effective way of removing CO2 from biogas is by using limewater. Solution of solid calcium hydroxide (Ca(OH)2) and water can be mixed together to prepare limewater. Due to this enormous amount of heat will be generated leading to an exothermic reaction. When heat gets disappeared, raw biogas can be allowed to pass through the solution. This will reduce carbon dioxide present in biogas.

$Ca(OH)2 + CO2 \quad CaCO3 + H2O.$

It was found that the concentration of limewater plays an important role on the CO2 removal efficiency. Result reveals that for 14% concentration of limewater solution, over 71% removal efficiency could be achieved which result in CH4 enriched gas with about 21.2% purity. This could be due to increasing concentration yields a higher amount of active hydroxide ions available to diffuse toward the gas-liquid interface and react with CO2. This eventually results in an enhancement of the absorption rate, which leads to a higher CO2 removal efficiency.

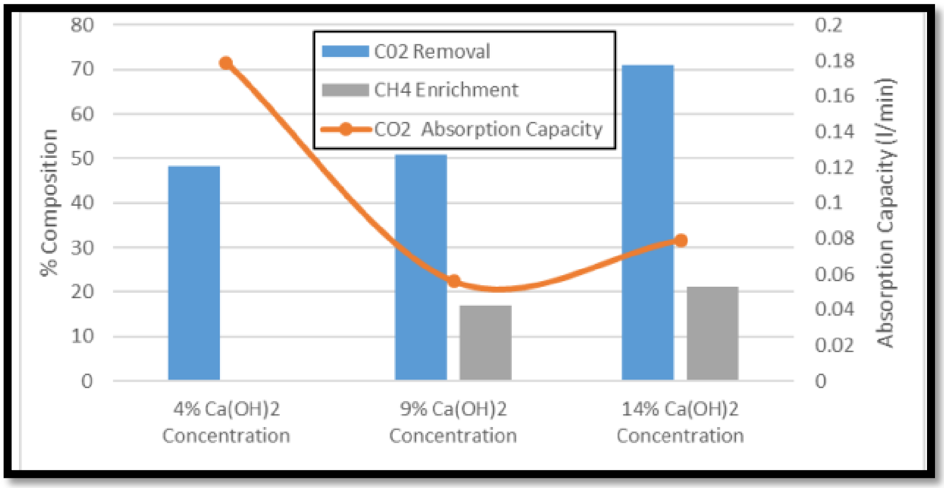

Fig. 7.2 Solvent scrubbing

3] Membrane Scrubbing:

Membrane system consists of a membrane filter that is related according to their pore size. The pores allow the biogas to penetrate, but retain any particles that are larger than the pores. Membrane systems are capable of removing carbon dioxide and other impurities from the raw biogas to meet quality requirements stipulated for RNG.

- There are two types of membrane scrubbing systems:-

i) Single pass membrane system:- It is a single passage membrane system through which we can capture approximately “65-80%” pure methane .

ii) Multi-pass membrane system:- In this process in place

of just a single passage through the membrane we use
Multiple passage which gives purified methane gas of
Around “96-99%”.

4] Pressure Swing Adsorption (PSA):

In PSA processes, biogas is compressed to a pressure between 4-10 bar and is fed to a vessel (column) where is putted in contact with a material (adsorbent) that will selectively retain CO_2. The adsorbent is a porous solid, normally with high surface area. Most of the adsorbents employed in the commercial processes are carbon molecular sieves (CMS) but also activated carbons, zeolites and other materials are employed. The purified CH_4 is recovered at the top of the column with a very small pressure drop. After certain time, the adsorbent is saturated with CO_2, and the column needs to be regenerated by reducing the pressure (normally to vacuum for biogas upgrading). The adsorption of H_2S is normally irreversible in the adsorbents and thus a process to eliminate this gas should be placed before the PSA.

CHAPTER 8

STORAGE OF PURIFIED BIOGAS

Selection of an appropriate biogas storage system makes a significant contribution to the efficiency and safety of a biogas plant.

8.1 There are basic reasons for storing biogas:

Storage for later on-site usage and storage before and/or after transportation to off-site distribution points or systems. A biogas storage system also compensates fluctuations in the production and consumption of biogas as well as temperature-related changes in volume.

Internal Biogas Storage Tanks are integrated into the anaerobic digester while External Biogas Holders are separated from the digester forming autonomous components of a biogas plant.

The simplest and least expensive storage systems for on-site applications and intermediate storage of biogas are low-pressure systems. The energy, safety, and scrubbing requirements of medium- and high-pressure storage systems make them costly and high-maintenance options for non-commercial use.

8.2 Biogas storage according to pressure

- **Low-Pressure Biogas Storage**
- **Medium-Pressure Biogas Storage**
- **High-Pressure Biogas Storage**

Low-Pressure Biogas Storage

Floating biogas holders on the digester form a low-pressure storage option for biogas systems. These systems typically *operate* at pressures below 2 psi. Floating gas holders can be made of steel, fiberglass, or a flexible fabric. A separate tank may be used with a floating gas holder for the storage of the digestive and also storage of the raw biogas.

Flexible membrane materials commonly used for these gas holders include high-density polyethylene (HDPE), low-density polyethylene (LDPE), linear low density polyethylene (LLDPE), and chlorosulfonated polyethylene covered polyester. Thicknesses for cover materials typically vary from 0.5 to 2.5 millimetres.

Medium-Pressure Biogas Storage

Biogas can also be stored at medium pressure between 2 and 200 psi. To prevent corrosion of the tank components and to ensure safe operation, the biogas must first be cleaned by removing H_2S. Next, the cleaned biogas must be slightly compressed prior to storage in tanks.

High-Pressure Biogas Storage

The typical composition of raw biogas does not meet the minimum CNG fuel specifications. In particular, the CO_2 and sulfur content in raw biogas is too high for it to be used as vehicle fuel without additional processing. Biogas that has been upgraded to biomethane by removing the H_2S, moisture, and CO_2 can be used as a vehicular fuel.

Biomethane can be stored as CBM to save space. The gas is stored in steel cylinders such as those typically used for storage of other commercial gases. The cost of compressing gas to high pressures between 2,000 and 5,000 psi is much greater than the cost of compressing gas for medium-pressure storage.

8.3 Types of Storage

1. Balloon

Factors	Fixed dome	Floating drum	Tubular design	Plastic containers
Gas storage	Internal Gas storage up to 20 m³ (large)	Internal Gas storage drum size (small)	Internal eventually external plastic bags	Internal Gas storage drum sizes (small)
Gas pressure	Between 60 and 120 mbar	Upto 20 mbar	Low, around 2 mbar	Low around 2mbar
Skills of contractor	High; masonry, plumbing	High; masonry, plumbing, welding	Medium; plumbing	Low; plumbing
Availability of Material	yes	yes	yes	yes
Durability	Very high >20 years	High; drum is weakness	Medium; Depending on chosen liner	Medium
Agitation	Self agitated by Biogas pressure	Manual steering	Not possible; plug flow type	Evtl Manual steering
Sizing	6 to 124 m³ digester vol	Up to 20 m³	Combination possible	Up to 6 m³ digester vol
Methane emission	High	Medium	Low	Medium

Table8.3 . first comparison of the different types

A balloon plant consists of a heat-sealed plastic or rubber bag (balloon), combining digester and gas-holder. The gas is stored in the upper part of the balloon. The inlet and outlet are attached directly to the skin of the balloon. Gas pressure can be increased by placing weights on the balloon.

If the gas pressure exceeds a limit that the balloon can withstand, it may damage the skin. Therefore, safety valves are required. If higher gas pressures are needed, a gas pump is required. Since the material has to be weather- and UV resistant, specially stabilized, reinforced plastic or synthetic caoutchouc is given preference.

Fig 8.3 Balloon

2. Tanks or Cylinder

Storage tanks are designed to compensate for fluctuations in production and consumption, for volume changes due to varying temperatures and for stagnating consumption; furthermore, gas holders store gas for later use the operating pressure is predetermined by the plant design and the dimensioning of the various components. We are talking about low-pressure systems, starting from zero pressure to 50 mbar.

CHAPTER 9

ALTERNATOR

9.1 What is generator?

An alternator is an electrical generator that converts mechanical energy to electrical energy in the form of alternating current. For reasons of cost and simplicity, most alternators use a rotating magnetic field with a stationary armature. Occasionally, a linear alternator or a rotating armature with a stationary magnetic field is used.

9.2 Parts of alternator:

1. Rotor Coil
2. Stator Coil
3. Brush
4. Alternator Shaft
5. Pulley
6. Fan Alternator
7. Rectifier
8. Alternator Housing
9. Bearing

9.3 Construction and working:

The construction of an alternator consists of field poles placed on the rotating fixture of the machine. An alternator is made up of two main parts: a rotor and a stator. The rotor rotates in the stator, and the field poles get projected onto the rotor body of the alternator. The armature conductors are housed on the stator. An alternating three-phase voltage represented by aa', bb', cc' is induced in the armature conductors thus resulting in the generation of three-phase electrical power. All modern electrical power generating stations use this technology for generation of three-phase power, and as a result, an alternator (also known as a synchronous generator) has made itself a subject of great importance and interest for power engineers.

An alternator is basically a type of AC generator. The field poles are made to rotate at synchronous speed N_s = 120 f/P for effective power generation. Where, f signifies the alternating current frequency and the P represent the number of poles.

In most practical construction of alternator, it is installed with a stationary armature winding and a rotating field unlike in the case of DC generator where the arrangement is exactly opposite. This modification is made to cope with the very high power of the order of few 100 Megawatts produced in an AC generator contrary to that of a DC generator. To accommodate such high power the conductor weighs and dimensions naturally have to be increased for optimum performance. For this reason is it beneficial to replace these high power armature windings by low power field windings, which is also consequently of much lighter weight, thus reducing the centrifugal force required to turn the rotor and permitting higher speed limits.

9.4 Specification of Alternator:

Sr. no	Item	Specifications
1	Rated Voltage	240 v
2	Power Factor	0.8
3	Phase	Single
4	Speed	3000
5	Frequency	50
6	KVA Rating	2.5

CHAPTER 10

IC ENGINE

10.1 What is IC Engine?

An internal combustion engine (ICE or IC engine) is a heat engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to some component of the engine. The force is typically applied to pistons (piston engine), turbine blades (gas turbine), a rotor (Wankel engine), or a nozzle (jet engine). This force moves the component over a distance, transforming chemical energy into kinetic energy which is used to propel, move or power whatever the engine is attached to.

10.2 Parts of IC Engine:

1. Spark
2. Compression
3. Ignition timing
4. Fuel systems
5. Carburetor
6. Fuel injection

7. Fuel pump
8. Naturally aspirated engines
9. Oxidizer-Air inlet system
10. Control valves
11. Piston engine valves
12. Crankshaft
13. Propelling nozzle

10.3 4 Stoke Engine:

A **four-stroke** (also **four-cycle**) **engine** is an internal combustion (IC) engine in which the piston completes four separate strokes while turning the crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are termed:

1. **Intake**: Also known as induction or suction. This stroke of the piston begins at top dead center (T.D.C.) and ends at bottom dead center (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing a partial vacuum (negative pressure) in the cylinder through its downward motion.

2. **Compression**: This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel

mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.

3. **Combustion**: Also known as power or ignition. This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 360 degree revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine) or by heat generated by high compression (diesel engines), forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.

4. **Exhaust**: Also known as outlet. During the *exhaust* stroke, the piston, once again, returns from B.D.C. to T.D.C. while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust port.

10.3 Specification of engine

Sr.no	Item	Specification
1	Power	2.2 kw
2	Speed	3000
3	s.f.c	500g/Kwh
4	Fuel	Kerosene

CHAPTER 11

POWER GENERATION

Power generation system, which consists of an internal combustion engine, a low pressure gas carburetor and a synchronous generator. The system uses the GX160 internal combustion engine. It was modified by reconfiguring the carburetor using a low pressure gas carburetor. The synchronous generator was directly coupled to the internal combustion engine. Sockets, lamp holders and switches where wired on a wooden board to get the power output from the synchronous generator. A frame was fabricated using 1.5mm angle bar to sit the internal combustion engine and the synchronous generator. Dampers were used to reduce the vibration produced by the engine.

Electricity Production from Biogas: From the biogas production and purification system, 1.565m3 of purified biogas was generated. To determine the electricity production rate of the biogas generated, the volume of biogas was converted into mega joules after which it was converted from mega joules to kilowatthour and multiplied by its percentage useful energy

11.1 Sample Calculation

Biogas production rate = 1.

Converting the volume of biogas produced to mega joules

1m3 of biogas = 19 mega joules

1.565m3 of biogas = 1.565m3 × 19 mega joules

= 29.7 mega joules

Converting to kilowatt-hour = 29.7 mega joules / 3.6 = 8.26 kWh.

When biogas was converted into electrical energy, 65% of the energy lost as heat and other mechanical losses as utilized by the electricity generator . Therefore, the electrical energy used for the generation of electricity becomes 35% of the kilowatt-hour.

35% of 8.26 kWh = 0.35 × 8.26 kWh = 2.88 kWh From the above result, 2.88kwh is the electricity generated using 1.565m3 of biogas

Comparative Analysis of Biogas and Petrol Consumption with Load: Comparative analysis of biogas and petrol consumption with load was carried out with respect to the quantity and load input on the power generation system. For biogas consumption analysis, the consumption rate was observed with respect to time. The biogas was scaled before and after it was run on the power generating system with a load input of 1400 watt. Biogas was run on the power generating system for a period of 60 minutes after which it was scaled. It was observed that 0.85kg of Electricity Generation from Cow…..

If 0.85kg run for 60 minutes, 1kg will run for x minutes

0.85kg = 60 minutes

1 kg = X minutes X minutes = 60 minutes / 0.85 = 71 minutes

From the above result, 1kg of biogas will run for 71 minutes with a load capacity of 1400 watts.

For the total biogas production of 1.8kg, 1.8kg will run for: If 0.85kg run for 60 minutes, 1.8kg will run for x minutes 0.85kg = 60 minutes 1.8 kg = X minutes X minutes = 60 minutes × 1.8 / 0.85 = 127 minutes

From the above result, 1.8kg of biogas will run for 127 minutes with a load capacity of 1400 watts.

For petrol consumption analysis, 1 liter of petrol was run on the power generating system with a load input of 1400 watt. 1 liter of petrol operated on the power generating system for a period of 42 minutes after which the system shutdown due to complete consumption of the available petrol (next work would consider other factors that might affect how long the generator set lasts, e.g., age of the engine, etc.). Therefore 1 liter of petrol will run for 42 minutes with a load capacity of 1400 watts. From the consumption analysis of biogas and petrol, biogas obtained the longer lasting time with respect to the same load input and burnt cleaner releasing even lesser heat than petrol.

Electricity Voltage Output and Load Bearing Characteristics: From the performance evaluation of the power generation system, the modified internal combustion engine worked smoothly without any sign of audible knocking during the entire load range. The observed favorable characteristic was the confirmation of a successful modification process and anti-knocking properties of biogas. At variable range of electrical loading, there was a change in modified internal combustion engine characteristics as a function of added load. The modified engine at load condition of 100W to 1400W operated smoothly with synchronous generator given a voltage output of 220V to 199V due to load increase comparable to the modified engine run on petrol at equal load level.

CHAPTER 12

RESULT AND DISCUSSION

The study's data showed that biogas generation was really slow at the beginning and finish of the process. As development rate of gas is directly inversely proportional to the particular growth of methanogen bacteria, this result was caused by the methanogen bacteria's low level of activity. 40kg of cow manure was utilized for this project. After a retention time of 30 days, the biogas production and filtration system produced 1.565 m3 of purified biogas, which was compressed into a 3 kilogram me gas cylinder using a refrigerator compressor given a mass of 1.8 kg and a total mass of 4.8 kg. The power generation system was powered by the generated biogas.

Electricity Production from Biogas:

Biogas used to Produce Electricity: 1.565 m3 of pure biogas were produced by the biogas production and purification system. The volume of the biogas was first translated into mega joules, then from mega joules to kilowatt-hour and multiplied by its percentage useable energy to establish the rate at which the biogas was turned into electricity. Rate of biogas production: 1.565 m3

Converting the amount of generated biogas to mega joules

1m3 of biogas = 19 mega joules 1.565m3 of biogas

= 1.565m3 × 19 mega joules

= 29.7 mega joules Kilowatt-hour conversion: 8.26 kWh = 29.7 mega joules / 3.6.

65% of the energy lost during the conversion of biogas into electrical energy was used by the power generator as heat and other mechanical losses.

As a result, 35% of a kilowatt-hour's electrical energy is utilized to generate electricity.

35% of 8.26 kWh = 0.35 × 8.26 kWh

= 2.88 kWh.

2.88 kWh of power were produced utilizing 1.565 m3 of biogas, according to the aforementioned result**.**

Load (watts)	Biogas	Petrol (A)
100	0.48	0.5
200	0.87	0.92
300	1.36	1.43
400	1.82	1.82
500	2.31	2.34
600	2.72	2.75
700	3.19	3.23
800	3.54	3.77
900	4.00	4.25
1000	4.56	4.64
1100	5.00	5.10
1200	5.34	5.47
1300	5.78	5.89
1400	6.17	6.34
1500	6.27	6.66

Table11.1 .Current output

Load (watts)	Biogas (v)	Petrol (V)
100	220	223.2
200	219	222.2
300	218	221.5
400	217	220.4
500	216	219.9
600	215	218.5
700	213	216.9
800	210	215.1
900	208	214.1
1000	206	212.2
1100	203	211.2
1200	202	210.2
1300	200	208.2
1400	199	206.2

Table 11.2 voltage output

CHAPTER 13

CONCLUSION

The potential of biogas for generating electricity is examined in the article. A compact biogas producing system was created and put into operation. The internal combustion engine was successfully adjusted, and it now runs without any hints of loud banging during the whole experiment. Comparatively, our results reveal that 1 liter of gasoline operates on the power producing system with a load input of 1400 Watts for 127 minutes whereas 1.8 kg of biogas runs for the same amount of time with a load capacity of 1400 Watts.The power producing system used 1 litre of gasoline for a total of 42 minutes before shutting down since all of the fuel had been used up. Aside from the fact that 1.8 kg of biogas costs far less than 1 litre of fuel, the adoption of this technology may help with waste management and give a better sustainable answer to energy self-sufficiency and economic growth.

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