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Electricity Generation through Biogas at Sanjeevan Socio Medical Foundation, Nagpur

[1] Rakesh Dhanorkar, [2] Parag Kapgate, [3] Diwakar Korasane, [4] S.S.Ambekar
[1][2][3] BE 8th Semester Electrical Engg. [4] Head, Electrical Department,
[1][2][3][4] K.D.K. College of Engineering

***Abstract*: -- A biogas is a modern energy source and is suitable for necessities of the future with the appropriate application of the digestion technology. Renewable energy based resources have traditionally considered a single technology based limited level of supply to meet the basic needs. Three renewable resources namely solar, wind & biogas energy generation plant are installed at the sanjeevan socio medical foundation is to be considered. Thus the foundation produces their own electricity via solar, wind & biogas energy generator these systems will generally have battery bank in order to store the electricity for use when needed. Thus by considering biogas electricity generation system biogas is a modern energy source and is suitable for necessities of the future with the appropriate application of the digestion technology. Biogas is the gas resulting from an anaerobic process. A biogas can convert animal manure green plants, agriculture waste. In a method of utilizing a methane-containing biogas by feeding the methane-containing biogas to a gas engine of a gas engine/generator assembly generating electricity, the steps of passing the biogas through a membrane separating installation to divide the biogas into a first gas stream having a higher methane content than the biogas fed thereto and a second gas stream enriched in CO2, feeding the first gas stream to the gas engine as fuel, and returning the second gas stream to the source of the biogas.**

***Keywords* Environmental Biogas, Electricity, Methane, Organic Waste, Anaerobic digester, Manure, biomass.**

I. INTRODUCTION

Biogas is a type of gas that is formed by the biological breakdown of organic matter in an oxygen deficient environment. It is counted as an eco-friendly bio-fuel. Biogas contains 60% methane and carbon dioxide. It can be employed for generating electricity and also as automotive fuel. Biogas can be used as a substitute for compressed natural gas (CNG) or liquid petroleum gas (LPG). The present invention provides a process for the production of electric power, using a biogas as a fuel in an electric power producing turbine, wherein the biogas produced from a biomass in a gas generator is not subjected to a wet scrubbing step; and the biogas, after treatment according to the process, may be directly charged to an electric power producing combustion turbine. Biogas is a combustible gas mixture produced during the anaerobic digestion of organic matter in an anaerobic biogas reactor (e.g. small-scale digester, biogas settler, digestion of organic waste, anaerobic baffled reactor, etc. see also anaerobic digestion, general factsheet). During anaerobic digestion, wastes are treated and degraded and biogas is produced. Anaerobic treatment also has the advantage over aerobic treatment of a smaller emission of greenhouse gases. Therefore, biogas is a renewable green energy source. Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, plant materials, sewage green waste or food waste. Biogas is a renewable energy source. Biogas can be produced by anaerobic digestion with anaerobic organism, which digest material inside a closed system, or fermentation of biodegradable materials. Biogas is primarily methane (CH4) and carbon dioxide (CO2) and may have small amounts of hydrogen sulfide (H2S), 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 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 used for electricity production on sewage works in a CHP gas engine, where the waste heat from the engine is conveniently used for heating the digester; cooking; space heating; water heating; and process heating. If compressed, it can replace compressed natural gas for use in vehicles, where it can fuel an internal combustion chamberor fuel cells and is a much more effective displacer of carbon dioxide than the normal use in on-site CHP plants.

BIOGAS

Biogas is produced by the breaking down of organic, biodegradable waste or material (also known as biomass) such as vegetables, leaves, grass. When this organic breakdown happens it produces a gas, called biogas. Biogas is a mixture of carbon dioxide and methane, and resembles liquid petroleum gas. And like natural gas, biogas is used as a fuel to produce electricity to power farm equipment, for

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lighting applications, in gas cookers for cooking, and even for transportation. Biogas is widely used in many homes around the world, especially in countries where this technology has been widely available and used. Biogas consists mostly of methane (CH4, around 65-70%) carbon dioxide (CO2, around 25-30%) and varying quantities of water (H2O) and hydrogen sulphide (H2S) and some trace amounts of other compounds, which can be found, especially in waste dump biogas (e.g. ammonia, NH3, hydrogen H2, nitrogen N2, and carbon monoxide, CO). The amount of each gas in the mixture depends on many factors such as the type of digester and the kind of organic matter. Diverse sludge composition requires diverse/specialized reactor designs to achieve a high conversion. Methane is the valuable component under the aspect of using biogas fuel. The calorific value of biogas is about 6 kWh/m3, which corresponds to abouthalf a liter of diesel oil and can be utilized directly as a heat source or to produce electricity. In all cases, the biogas must be dehumidified and purified before combustion; otherwise it can damage the gas engine.

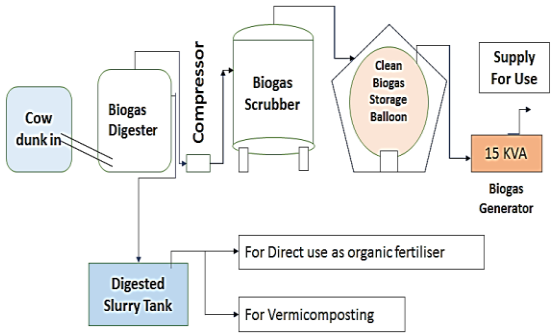

Fig.1 Block diagram of biogas plant

Generation of electricity

In most of the cases in combustion engines biogas can be used as a fuel, in which mechanical energy is converted into electrical energy using electric generator to produce electricity. Appropriate electric generators are available in all countries with different outputs and sizes. This technology is well known and maintenance for this type of engines is simple. In most case 3-phase electric motors can also be used for generation of electricity. Far more challenging is the first stage of the generator set that is the combustion engine using the biogas as fuel. In all types of combustion engines biogas can be used as fuel. Combustion engine includesdiesel engines,gas engines (Otto motor) and Sterling motors etc. Gas turbines are mostly used as biogas engines, because they are very small and can have strict exhaust emissions requirements. motors have the advantage of being tolerant of fuel composition and quality because they are External combustion engines and they are low efficient. Due to the low efficiency used for small applications. Internal combustion motors have become the standard technology either as gas or diesel motors in most commercially run biogas power plants

CONVERTING TECHNOLOGIES

Various technologies to generate electricity from biogas on a household level are available. In principle, the chemical energy of the combustible gases is converted to mechanical energy in a controlled combustion system by a heat engine. This mechanical energy then activates a generator to produce electrical power. The most common heat engines used in for biogas energy conversion are gas turbines and combustion engines. Combustion engines can be either internal combustion engine or external combustion engine. Combustion engines are popular as they are more efficient and less expensive than small gas turbines. However, gas turbines may be more efficient when operating in a cogeneration cycle producing heat and electricity. Cogeneration or Combined Heat and Power describe the simultaneous generation of both electricity and useful heat. . In most cases, a bit more than half is lost as excess heat. By capturing the excess heat, CHP use heat that would be wasted in a conventional power plant, potentially reaching an efficiency of up to 89%, compared with 55% for the best conventional plants. This means that less fuel needs to be consumed to produce the same amount of useful energy. By-product heat at moderate temperatures can also be used in absorption chillers for cooling. A plant producing electricity, heat and cold is sometimes called trigeneration or more generally a polygeneration plant.

BIOGAS DIGESTER

A biogas digester (also known as a biogas plant) is a large tank where inside Biogas is produced through the decomposition/breakdown of organic matter through a process called anaerobic digestion. It's called a digester because organic material is eaten and digested by bacteria to produce biogas. A biogas digester forms the most critical part of biogas production because without it, no biogas would be produced without the breakdown of organic waste or material.

COMPOSITION OF A BIOGAS DIGESTER

To understand how biogas is produced, it's important to understand the components of a biogas digester, which itself is part of a biogas electric generator plant. A typical biogas digester has a container that holds organic matter and water. This mixture of water and organic matter is called slurry. A

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digester has another container that holds the gas that has been produced after the organic matter is broken down. The digester has connecting systems in the form of pipes that feed the digester with slurry and connect the container holding slurry to the container that is holding the gas. There is also a transport system to take the biogas to where it will be used. The digester also has a mechanism for ejecting the residue.

FIXED DOME BIOGAS DIGESTER

This type of biogas digester is very common. In this design, the container collecting the slurry and the container collecting the gas are combined. The gas collects on top of the slurry. As the gas accumulates, the slurry is forced into another container. After the gas is removed the slurry will flow back into the container it was in initially. In addition to plant matter and vegetation, other types of organic matter that can be broken down is human sewage and cow dung.

Fig.2 Steam Digester Tank

COMPRESSOR

Raw biogas from a digester is produced at quasi-atmospheric pressures and often contains a lot of carbon dioxide, hydrogen sulphide and water, making these gases acidic and corrosive. Apart from these 'normal' biogas characteristics, the raw biogas is often contaminated with all sorts of trace elements which all have a harmful impact on the installation. For compressing raw biogas to low/medium pressures, CSH deploys lubricated screw compressors that have proven to be resilient to these gases. Upgraded biogas can be used as fuel for a gas engine or turbine, or it can be compressed to high pressure by a reciprocating compressor for injection into a gas pipeline.

BIOGAS SCRUBBERS

Biogas is produced by the anaerobic digestion or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops. Biogas comprises primarily methane (CH4), carbon dioxide (CO2) and small amounts of hydrogen sulfide (H2S), moisture and siloxane.

Fig.3 H2S Scrubber

Hydrogen sulfide (H2S) is a colourless, very poisonous, flammable gas with the characteristic foul odour of rotten eggs. Hydrogen sulphide is formed in the biogas plant by the transformation of sulphur-containing protein, which can be from plants and fodder residues. Inorganic sulphur, particularly sulphates, can also be biochemically converted to H2S in the fermentation chamber. While plant material introduces little H2S into biogas, poultry droppings introduce, on average, up to 0.5 volume percent of H2S, cattle and pig manure about 0.3 volume/percent. Protein-rich waste (e.g. molasses, etc.) can produce large amounts of hydrogen sulphide (up to 3 vol. %). If untreated biogas is burnt as fuel in a gas engine, the H2S will form a weak sulphuric acid. This weak acid will quickly contaminate the engine lubrication oil and lead to corrosion of the combustion chamber, exhaust system and in various bearings. This is enhanced by frequent starts, short running times and the relatively low temperatures when starting up and after cutting off the engine. Running engines with gas containing H2S can reduce the service time to the first general overhaul by about 10 – 15%. SO2 from combustion and water vapour both dissolve in the lubricating oil. Under continuous operating conditions, the interval between oil changes is reduced to 200 – 250 hours. Gas-engine manufacturers normally request 250 ppm in the clean biogas for offering full warranty. Since the engine is one of the most expensive & components of any biogas plant, controlling the H2S can be critically important. There are several techniques for biogas desulphurisation, the three most common being ferric chloride dosing, the installation of activated carbon filters & biological treatment. Each type of scrubber has its own advantages & disadvantages.

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BIOGAS GENERATOR

Biogas generator has the components including engine, alternator, mounting frame, control panel, accessories and others. The specifications of these are given below:

ENGINE

The engine part has the specification of 4-stroke, spark ignition, water cooled, 1500 rpm, continuous rating, heavy duty, multi-cylinder, 100% bio gas engine. This is specially designed and engineered to operate with gases obtained form bio methane plants or gasiefiers. An automatic (adjustable as per Gasifier) air and fuel controller and mixing system are provided to ensure efficient, smooth working of engine from no load to full load. These engines operates smoothly at vast combinations of bio gases at negative suction up to 80 mm of water column hence root blower is not required and gases can be feed at normal available pressure. The engine also includes:

Battery Charging Alternator
12 V Starter
Radiator with Fan and water Pump
Air / gas mixture regulator
Lub Oil Filter
Heavy Duty Air Filter
Flywheel suitable for Genset(Heavy)
Industrial Silencer
Panel with Charging Ammeter
Oil Pressure gauge
Water temperature gauge and starting switch

ALTERNATOR:

The alternators are self excited, highly efficient, self regulated, drip proof, screen protected and are suitable for continuous operation, 1 or 3 Phase 230 415 Volts, 0.8 pf, 50 Hz, Class F insulation alternator confirming to IS:4722/IS:13364/BS:5000. These are provided with IP 21 protection, 10 % overloading and capability of starting the motors at 3 times the rated current of alternator.

MOUNTING FRAME

Engine and Alternator are mounted, coupled, aligned on a common rigid base frame, having provision for anti vibration mounting and holes for safely lifting of complete D. G. Set.

CONTROL PANEL

A superior Quality control panel of suitable CRC sheet, powder coated for long life and better finish complete with followings, M.C.B./M.C.C.B. Voltmeter, Ammeter Frequency Meter, Incoming / Outgoing terminals, Phase Indicator Lamps «Hour meter

ACCESSORIES

A.V.M. Pads, Tool Kit, Manuals and Drawings, Battery leads

REQUEST FOR QUOTATION

Biogas/CNG genset

Gas Genset - Biomass Gas Diesel Generator Supported by a team of skilled personnel .

Following are the specifications our gas genset:

Range 15 KVA to 82.5 KVA
Fuel-Natural gas/ Bio-gas/ LPG/ Bio-mass
Dual pressure gas regulator
Very low running cost.
Low noise
Eco Friendly
Alternator specification as per IS: 13364

BIOGAS GENERATORS

These Engines operate with gases obtained from bio methane plants or biogas (Gober) Plants. Biogas plant generates methane gas by anaerobic digestion of organic matter, traditionally animal manures and industrial, agricultural wastes are used for biogas generation. The gas obtained from methane gas plant is an environment friendly, cheaper and is a continuous source. The raw gas has to be cleaned from toxic gases and moisture. The appropriate equipment should be removed to the harmful gases.

Fig.4 Biogas Generation

RATING OF GENERATORS

Genset Model	PNG – 15-BG
Rated power KVA (KW)	15 (12)
Rated current (Amps/Ph)	21
Gas consumption (Scum/hr)*	-
Dimensions L * W * H (cm)	140*70*125

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Dry Weight (Kgs)	725
Engine model	PN 2-BM
Power at 1500 RPM (BHP)	22
No. of Cylinders	2
Bore * Stroke (mm)	110 * 125
Swept volume (Lts)	2376
Aspiration	Natural
Lub Oil Sump Capacity	5
Governor	MICO RSV Class A-2 (Mechanical)

ADVANTAGES

1. Generation of renewable, green electricity
2. Low operating costs
3. Underground construction minimizes land use
4. Long life span
5. Reduces greenhouse gases
6. Biogas generation produces organic fertilizer

II. CONCLUSION

The micro-grid is implemented currently in Sanjeevan foundation, consist of solar plant, Wind Plant and Biogas plant whose collective generation capacity is 15 KW. Aamong these biogas has total generation of 10 KW. Biogas can be produced from raw materials such as cow dung, agricultural waste, manure, plant materials, sewage green waste or food waste. Biogas is a renewable energy source. The biogas is used as a fuel to a combustion engine which produces mechanical power, this mechanical power then supplied to the Biogas generator to produce electricity. Energy is mostly produced from fossil fuels which are not only finite and expensive to extract but also contribute towards environmental pollution. Renewable energy technologies areenvironmentally friendly and now getting economically attractive with every passing day. Biomass energy can serve as a viable alternative to meet the basic need of electricity in sanjeevan socio medical foundation Nagpur. Biomass power plants are decentralized and resources are widely available all over the country. If theseresources are utilized to their full extent for power production, can provide in the total electric power generation in the current scenario.

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