A Review of Methane Power: An Alternative Source of Fuel and Fertilizer

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Abstract

Recently attention has turn to methane digesters as source of fuel gas and fertilizers. The interest is understandable in view of the mounting shortage of energy sources and their increasing desire.

Biogas can be used as fuel in the kitchens, for lighting and for running combustion engine. It is also possible to use gas if available in sufficiently as fuel in an industry and in automobiles.

If adequate gas is available it can be used for commercial heating process like boiling of water in industry, in laundry, or in boiling of soap pan in small-scale soap industry.

Sludge leaving the digester contains nitrogen, phosphorus, potassium and small metallic salts (trace elements) indispensable for plant growth such as boron, calcium, copper, iron, magnesium, sulfur, zinc, etc.

Time and again a question is raised whether bio-gas can be bottled like refinery gas. At least at present the answer is definitely 'NO'. Firstly biogas is not liquefiable like refinery gases. It can be liquefied only at temperature of minus 96° F (at more than minus 180° C) after liquefaction it acquires large volume which is not possible practically.

KEYWORDS: -Biogas, Bio-Fuels, Bio-Power, Fertilizer

Introduction:

During the world war 2nd the shortage of fuel in Germany led to development of Methane plant in rural area where gas was used to power the tractors. The idea spread into Western Europe, but died out when fossil fuel ones again became available.

But the first attempt to build the digester for biogas production that is methane from organic waste appears to have been in Bombay, India in 1900 from cow dung.

Currently the focus of biogas research is primarily in India. India's impetus has been the overwhelming need of developing country to raise the standard of living of rural poor peoples. Cow's in India produces over 800 million tons on manure per year over half of this is burned for a fuel and thus lost as much needed crop fertilizer.

One of the important aspects i.e. is it possible to run internal combustion engine on the methane gas? Yes, but due to its low calorific value traces of carbon dioxide and H_2S gases, it is difficult. We are focusing on the removal of these gases from biogas using cheap and less complicated methods.

Applications of methane gas:-

Methane gas has following important applications,

1. Provide light and heat to rural villages eliminating the need to import fuel, to burn cow dung, to deforest the land.
2. Byproduct from the methane plant i.e. sludge can be use as fertilizer in the farms and the gardening.
3. Methane gas is used as fuel for cooking food in kitchens of rural areas.

4. In automobiles as a fuel, an alternative to fossil fuels, such as diesel, petrol, L.P.G. gas, C.N.G. etc.
5. Methane is used in commercial heating process like boiling of water in laundry or boiling of soap pan in small-scale industries.

Role of methane gas as an alternative fuel source:

Total dependence on conventional fuels, especially in rural areas, is likely to become a serious handicap in the years to come as a reserved shortage and specialized technologies like the cost of the fossil and nuclear fuel but by producing energy from local resources, it is possible to be partially freed from remote source of increasingly expensive fuel supplies.

The natural gas requirement of the person of the U.S. standard of living is about 60 ft^3/day, which is equivalent to methane gas produced from 10 pound of chicken, pig manure per day or 20 pound of horse manure per day.

Methane, lightest organic gas has relatively low fuel value and for efficient working it requires specially designed stoves when used as fuel for cooking gas in the stove designed for L.P.G., but it's efficiency decreased rapidly and flame temp also decreases form 800°C to 400°C.

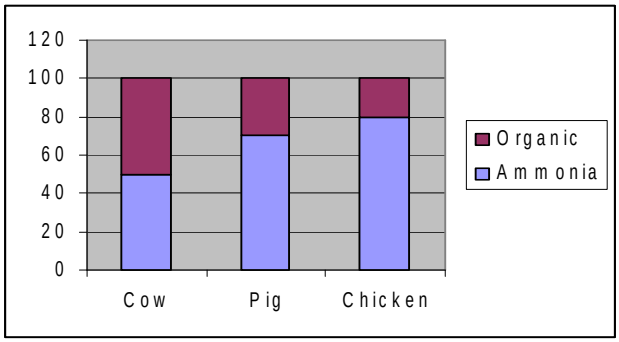
In running diesel engine it is necessary to feed 15% to 20% diesel along with gas and in the situation the consumption of the gas is about 42 ton.50 M^3 per horsepower per hour. In petrol engine however it is not necessary to burn petrol as it can be entirely on biogas. In the both cases the starting must be done either by diesel or petrol unless one has very large size gas plant i.e. of the capacity not less than 20 m^3 (700cft). It is not advisable to attach an engine.

Role of methane in fertilizers:-

India is plagued for several decades with the problem of food shortage. This is not due to inadequacy of land but due to poor yield per hector. Infect the green revolution appears to have became stagnant. There are many reasons for this. Inadequacy and high cost of chemical fertilizers, inadequate irrigation facility etc. may contribute to this stagnation.

However, one important cause is insufficient use of organic manure to the soil. Most of the solids are not converted into methane gas settle out in the digester as liquid sludge. The liquid sludge depending upon raw material use and conditions of digestion, this sludge many element essential to plant life i.e. nitrogen, phosphorus, potassium plus small amount of metallic salts (trace element) indispensable for plant growth such as boron, calcium, copper, iron, magnesium, sulfur, zinc etc.

Nitrogen is considered especially important because it's vital role on the plants nutrition and growth. Digested sludge contains nitrogen mainly in the form of ammonia (NH_4).



As this sludge is rich in nitrogen it may exported to various countries around the world because of the vast demand of the organic fertilizers in the world. To avoid adverse effect of harmful chemicals of the chemical fertilizers on living organisms, use of organic bio-fertilizers in the crops is the best alternative. Also there is vast demand for the agricultural product grown on bio-fertilizers in the present and future which ensure best quality with no harm to you in terms of side effects

Experimental method

Production of the methane gas:-

1. Raw material:-

Raw material used for biogas production is enlisted as follows;

a. Night soil
b. Cow dung
c. Pig dung
d. Chicken
e. Municipal waste (sewage)
f. Agricultural biodegradable waste etc.

2. Manufacturing Process:-

The digester is fed with mixture of water and waste (raw material as above), called as slurry. When confined in a place, out of contact with oxygen gives rise to large no. of bacteria. Broadly these bacteria are divided in to two groups,

a. Acid forming bacteria
b. Gasifying bacteria.

The first group converts carbohydrates, proteins, fats into volatile acids and in this process produces carbon dioxide. This phase may also be called the phase of liquefaction. Without this phase the subsequent gasification will not possible. Liquefaction is brought about by saprophytic bacteria by means of extra cellular enzymes. These bacteria are not very sensitive and thrive in wide range of circumstances.

Where the first set of bacteria leave the work the second set of bacteria takes over. These are called methane bacteria. They now work upon this material with the help of intracellular enzyme and convert it into the methane and carbon dioxide. The basic gas production reaction is as given below,

$2C + 2H_2O \rightarrow CH_4 + CO_2$

General composition of biogas is as given below,

a. CH_4 54-70%
b. CO_2 27-45%
c. N_2 0.5-3%

d. H_2 01-10%

The gas from the digester is passed through the scum trap in order to remove scum from the gas. The scum is collected in tank in which hydroponics grasses are grown. The methane gas is stored in the storage tank, before that condensation trap is provided in order to remove any traces of the condensable matter. Gas storage tank is available for kitchen fuel, for lighting etc.

Removal of H_2S and CO_2 from biogas

We can't use methane gas directly in the engine because it contains H_2S and CO_2. In market the equipment available for the removal of above gases from biogas are very expensive. Making use of biogas in an engine also became expensive. In order to make use of biogas in an engine cost effective there is one method which is simple, non-complicated and less expensive. This method is used by **John Crossly** to power the diesel engine on the biogas produced from pig manure.

In order to remove H_2S, which is corrosive in nature to engine the biogas is allowed to pass through the bed of iron filings, where H_2Sreacts with iron filings and leaving behind methane andCO2**.**

CO_2 is removed by scrubbing the gas with lime water, leaving behind pure methane gas.

Operating conditions:-

As matter of fact the entire process is governed by some set of factors .these factors can be enumerated as under,

a. Temp of the substrate
b. Loading rate
c. Solid concentration
d. Detention time
e. pH
f. Nutrients concentration
g. Toxic substances etc.

a) Temperature of the substrate:-

It is found that the process of digestion and gasification proceeds at highest rate when the temperature is around 35°C. When the temperature falls, the process of digestion is retarded and below the temp 15°C it is reduced so much that the gad plant produces very little gas; that is why it is experienced that in winter the gas production is considerably decreased.

b)Loading rate:-

Normally the loading rate depends upon the capacity of the plant and also on the retention period should be kept constant. For a given capacity of digester of loading rate is increased the period of retention is considerably decreased i.e. the period of fermentation is curtailed.

c)Solid concentration:-

Ordinarily 7-9% concentration, i.e. 7 to 9 part of solid in 100 parts of the slurry is considered ideal. If it is diluted further or if it is concentrated, the fermentation is some what retarded and i.e. why we recommend 4 part of the cattle dung to be mixed with 5 parts of water.

d) Retention time:-

The retention time is the time for which fermentable material remain inside the digester. Ordinarily it is observed the maximum gas production takes place within the first 4 weeks and then it tapers off gradually. In the major part of the country 30-40 days is the optimum and thereafter the production is so small in quantity that it is not worthwhile making larger investment on bigger digester. It may noted that retention period could be considerably reduced if the temp. could be raised or content of digester could be agitated or the supply of nutrients in the digester is augmented. For a very broad idea some figures given by some research workers on the rate of gas production per week may be of interest.

Weeks	Rate of gas production per week(%)
1st	37.00%
2nd	26.50%
3rd	17.50%
4th	10.00%
5th	05.75%
6th	03.25%

e)pH:-

pH is the term which denotes acidity and alkalinity of the substrate. The gas formation is optimum between the pH 7 to 8. If appreciably below this, the gas production may be stopped.

g) Nutrients concentration:-

For bacteria nutrients consist of NPK, major elements and some hormone etc. it is noticed that when sufficient amount of nutrients are available fermentation is to establish addition of oil cake gives stimulus for gas production. The best stimulus in this behalf of the animal urine. Chemical fertilizers for stimulation of gas production can also be used.

h)Toxic substances;-

Toxic substances like copper which some times fed to pigs may, found in excess quantity, inhibit gas production but such occurrences are very rare.

Environmental impact and Benefits:-

As the methane gas is totally manufactured from the waste (biodegradable), it is eco-friendly and having no adverse effect on the surrounding environment.

In addition it fulfills the demand of fuel and fertilizers of the rural areas of country. Indirectly helping in control of pollution and plays the major role in the minimizing the deforestation of land and keeping the blue planet green and pollution free.

a) Reduction in greenhouse gas emission.
b) Sustainability in the context of decreasing global reserves of fossil fuels.
c) Indigenous availability.
d) Sustainability in meeting diffused and decentralized needs of rural areas.
e) Employment generation.

Conclusion:-

Research and development of new processes can be extensively made the scope of this field is wide and highly prospective. Care should be taken that the new developed methods should be economical, eco-friendly and reliable.

Chemical and environmental engineers can contribute largely in extending the prospects of the **"Methane Power: for Fuel and Fertilizers".**

Future Prospects:-

Biogas technology is an important option to meet the growing energy demand of the rural areas of the developing country. The far most factor in the favor of this technology is its environment friendliness as it helps effective utilization of waste and nutrients recycling. Biogas technology can be put to use at both community and domestic level. Biogas is the versatile source of energy, which can be used to meet several end uses such as lightening, cooking, bio-fertilizers, motive power (electricity) generation and fuel for automobiles.

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