Performance Test on Single Cylinder IC Engine by Using Cow Dunk as a Biogas

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Abstract— Biogas is a mixture of 50 – 55% of methane and 35 – 45% of carbon dioxide and up to 5% of hydrogen sulfide and other traces gases. Biogas can derived from organic waste is considered as a good alternative fuel. It can easily use in IC Engine, because it’s better mixing ability with air and clean burning nature. Biogas is produced by anaerobic digestion of various substances such as kitchen waste, cow dung, bagasse and agricultural waste etc., in absence of air. Biogas mainly contains methane (55%), carbon dioxide (30%) and small amount of hydrogen sulfide. Carbon dioxide and hydrogen sulfide causes reduced the ignition and corrosion the engine parts. In case of reducing CO₂ and H₂S content by purification method for significantly improve quality of biogas. Finally we analysis the engine performance while compared to biogas and diesel.

Keywords—Anaerobic digestion, biogas, purification, diesel engine performance.

I. INTRODUCTION

Biogas can’t use directly in IC engine, because its auto ignition temperature is low while compared to diesel. Diesel engine can be modified to single fuel mode for supplying biogas to engine. Diesel ca Biogas plant is simple, cost effective design and highly available fuel supply. Biogas also produced organic fertilizer to the plant. Biogas is particularly significant because of possibility of use in internal combustion engines, which are the main power source for transport vehicles and also commonly used for powering of generators of electrical energy. The use of methane separated from biogas as a fuel will substantially reduce harmful engine emission and will help to keep the environment clean.

Materials and methods:

Cow dung:

Cow dung, also known as cow pats, cow pies or cow manure, is the waste product of bovine animal species. These species include domestic cattle ("cows"), bison ("buffalo"), yak, and water buffalo. Cow dung is the undigested residue of plant matter which has passed through the animal's gut.

The resultant faecal matter is rich in minerals. Colour ranges from greenish to blackish, often darkening soon after exposure to air.

Cow dung, which is usually a dark brown color (usually combined with soiled bedding and urine), is often used as manure (agricultural fertilizer). If not recycled into the soil by species such as earthworms and dung beetles, cow dung can dry out and remain on the pasture, creating an area of grazing land which is unpalatable to livestock. In many parts of the developing world, and in the past in mountain regions of Europe, caked and dried cow dung is used as fuel. Dung may also be collected and used to produce biogas to generate electricity and heat [6]. The gas is rich in methane and is used in rural areas of India and Pakistan and elsewhere to provide a renewable and stable source of electricity.

Dung from one Cow/Buffalo=15-25kg
Cow Dung Required to Produce 1 m³ of Bio Gas=20 kg
Electricity Generated from one cubic meter Bio Gas per day=2kw

Preparation:

Cow dung manure mixed with water at correct ratio to create slurry. Slurry is put into the airtight digester. After couples of days anaerobic decomposition will take place. Biogas is to be formed by anaerobic digestion and collected from plant [5].

Production:

Biogas is produced by extracting chemical energy from organic materials in a sealed container called a digester. The generation of biogas is the concept of anaerobic digestion, also called biological gasification. [2] It is a naturally occurring, microbial process that converts organic matter to methane and carbon dioxide. Cow dung manure mixed with water at correct ratio to create slurry. Slurry is put into the airtight digester. After couples of days anaerobic decomposition will take place. Biogas is to be formed by anaerobic digestion and collected from plant.[3]
Biogas has following two methods conventional and modern for produce biogas. In conventional method has following two types are domed shape and floating type. In our biogas plant is floating type method fig 1, 2[9].

**Design Parameters:**

- Total volume drum =1.069 m³
- Volumes of cow dung fill per drum =0.1663 m³
- Total volume of cow dung =0.8315 m³

Nowadays consumption rate of biogas for running IC engine is 0.45 – 0.54 m³/hour (16 to 19 ft³/hour) per hp. Consumption rate of biogas

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\text{Consumption rate of biogas} = \frac{\text{Volume of cow dung fill}}{\text{Hours HP}}
\]

\[
0.45 = \frac{0.8315}{\text{Hours 5hp}}
\]

Biogas running of per hour

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=0.36955 \text{ hour (22.17min)}
\]

In our biogas plant have consumption rate of biogas for running IC engine is 0.8315 m³/hour (29.341 ft³/hour) per 5hp, so our biogas can be run the engine up to 0.3695 hour (22.17 min).

It is being noted that even 5 hp engines for 8.86 hourly operation required gas supply from a biogas plant of 704 ft³/day (19.956m³/day).

**Purification:**

Unpurified biogas has less thermal efficiency due to presence of other gases. So purification process involves for removal of CO₂ and H₂S with increase methane concentration. The purification process can be done by chemical solvent.

**CO₂ and H₂S Scrubbing:**

CO₂ removal from biogas can be done by using chemical solvents like mono-ethanolamine (MEA), di-ethanolamine and tri-ethanolamine or aqueous solution of alkaline salts, i.e. Sodium, calcium hydroxide and potassium. Biogas bubbled through 10% aqueous solution of MEA can reduce the CO₂ content from 40 to 0.5-1.0% by volume. Chemical agents like NaOH, Ca(OH)₂, and KOH can be used for CO₂ scrubbing from biogas.[8] In alkaline solution the CO₂ absorption is assisted by agitation. NaOH solution having a rapid CO₂ absorption of 2.5-3.0% and the rate of absorption is affected by the concentration of solution. Table 3 shows the biogas composition before and after treatment with NaOH, Ca(OH)₂, and MEA. Fig.3. shows the biomethane scrubbing by chemical solvent method.
Experimental and analysis:

Biogas engine application:

Biogas can be used in both heavy duty and light duty vehicles. Light duty vehicles can normally run on biogas without any modifications whereas, heavy duty vehicles without closed loop control may have to be adjusted, if they run on biogas. [4] Biogas provides a clean fuel for both SI (petrol) and CI (diesel) engines. Diesel engines require combination of biogas and diesel, while petrol engines run fully on biogas. [7] Use of biogas as an engine fuel offers several advantages. Being a clean fuel biogas causes clean combustion and recesses contamination of engine oil. Biogas cannot be directly used in automobiles as it contains some other gases like CO2, H2S and water vapor. For use of biogas as a vehicle fuel, it is first upgraded by removing impurities like CO2, H2S and water vapor. After removal of impurities it is compressed in a three or four stage compressor up to a pressure of 20 MPa and stored in a gas cascade, which helps to facilitate quick refueling of cylinders. If the biogas is not compressed than the volume of gas contained in the cylinder will be less hence the engine will run for a short duration of time.

Biogas CI Engine Applications:

Biogas generally has a high self-ignition temperature hence; it cannot be directly used in a CI engine. So it is useful in dual fuel engines. The dual fuel engine is a modified diesel engine in which usually a gaseous fuel called the primary fuel is inducted with air into the engine cylinder. This fuel and air mixture does not auto ignite due to high octane number. A small amount of diesel, Usually called pilot fuel is injected for promoting combustion. The primary fuel in dual fuelling system is homogeneously mixed with air that leads to very low level of smoke. Dual fuel engine can use a wide variety of primary and pilot fuels. The pilot fuels are generally of high cetane fuel Biogas can also be used in dual fuel mode with vegetable oils as pilot fuels in diesel engines. Fig.4. Introduction of
Biogas normally leads to deterioration in performance and emission characteristics. The performance of engine depends on the amount of biogas and the pilot fuel used. Measures like addition of biogas, LPG, removal of CO2 etc. have shown significant improvements in the performance of biogas dual fuel engines. [10] The ignition delay of the pilot fuel generally increases with the introduction of biogas and this will lead to advance the injection timing.

Injectors opening pressure and rate of injection also are found to play important role in the case of biogas fuelled engine, where vegetables oil is used as a pilot fuel. The CO2 percentage in biogas acts as diluent to slow down the combustion process in Homogenous charged compression ignition (HCCI) engines. However, it also affects ignition. Thus a fuel with low self-ignition temperature could be used along with biogas to help its ignition. This kind of engine has shown a superior performance as compared to a dual fuel mode of operation.

**Performance of diesel & biogas:**

![Graph 1](Image)

From this graph for our engine the maximum efficiency for pure diesel mode was found as 32.23% for brake power 3.56 KW, where’s, with biogas mode, the maximum efficiency was found to be 37.12 for brake power of 3.52 KW.

![Graph 2](Image)

From this graph for our engine the maximum Mechanical efficiency biogas mode seems to be 74.7% at 3.56 KW, where maximum efficiency for pure diesel mode is seems to be 85.4% at 3.52 KW.
From this graph for the indicated thermal efficiency seems to be slightly lesser for the biogas mode then the indicated thermal efficiency for pure diesel mode at higher loads.

II. CONCLUSION

The biogas is a renewable fuel that can be used as fuel in the diesel engine without any modification to an engine. In addition to being available easily, renewable and cheap, biogas can make a good substitute for diesel fuel. Emission of carbon monoxide, oxides of nitrogen and smoke are decreased. Initially its start the engine with small amount of diesel for ignition and later it was run by the purified biogas and runs successfully without fail. For this same brake power, brake thermal efficiency and mechanical efficiency seems to be higher for biogas mode then with diesel. For the same brake power, brake thermal efficiency seems to be slightly lesser in diesel mode under higher loads. At the same time indicated thermal efficiency for the biogas is slightly lesser then diesel. Fuel consumption seems to be drastically reduced to nearly 50% when run under biogas mode.

The research on this area aims in making biogas as a fuel, which can improve our economy, by reducing the import of diesel and India can become one of the developed countries in a future, by these success of the research of running a diesel engine with the fully biogas with minimum diesel or even without diesel the research on the biogas from the purification of chemical scrubber needs to be given greater importance.

REFERENCES


