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TO EVALUATE THE PERFORMANCE AND MEASUREMENT OF POLLUTION IN I.C. ENGINE USING BIOGAS

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Abstract

The project aim is studying about various performance parameters of I.C engine by using biogas. Biogas derived from organic waste materials is a promising alternative and renewable gaseous fuel for internal combustion (IC) engines and could substitute for conventional fossil fuels. The aims of this study are to review the past researches on biogas fuelled IC engines and from this review, to identify current research needs. A detailed analysis of the previous results of biogas fuelling on the emissions and performance of dual fuel spark ignition (SI) engines is presented. The literature review reveals that the published research on biogas fuelled IC engines are not rich in number and the scenario of biogas-petrol dual fuel engines is even worse. Now in performance analysis we measure Brake power, mechanical efficiency, fuel consumption, specific power output, and exhaust gas analysis or pollution from engine.

Keywords- Biogas, SI Engine, Rope Brake Dynamometer, Tachometer, Air box and Manometer.

I. INTRODUCTION

Biogas found its way from developing countries to developed countries. In 2008 the biogas production in Europe exceeded 7.5 million tons of oil equivalents. Germany is, in this respect, a leading country in Europe with 4500 biogas plants and 1650 MW installed electric power in 2009 and is expanding for more capacity. Norway started lately but has a growing trend in biogas production.

"Utilizing biogas in the engines avoids any additional greenhouse gas emission. Due to organic nature of the components of biogas, burning it in a gas engine for power generation emits the same amount of CO2 into the atmosphere as was originally absorbed during the process of photosynthesis in the natural CO2 cycle".

To illuminate technological as well as techno-economical corners regarding the best way of power generation from biogas, a research project funded by the Research Council of Norway has been established to address the today's challenges of the different technologies. In this project internal combustion engines, gas turbines and fuel cells will be studied theoretically and experimentally to identify existing limitation and investigate possible solutions. The energy conversions technologist used in this study are developed for natural gas, but during the project they will be operated by both natural gas and biogas. Experimental will be carried out to generate data to develop and train an Artificial Neural Network (ANN) model for monitoring purposes and at the same time to validate the theoretical results.

Availability and economical viability of three conversion technologies will be investigated at a comparative basis. Performance and component degradations also will be considered and maintenance cost and lifetime will be established for each technology.

In this paper it is tried to investigate previous works on using biogas in internal combustion engines and find the road map for further development.

Biogas is produced by the anaerobic digestion or fermentation of biodegradable materials such as biomass, manure, sewage, municipal waste, green waste, plant material, and crops. Biogas comprises primarily methane (CH4) and carbon dioxide (CO2) and may have small amounts of hydrogen sulphide (H_2S), 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. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, much like natural gas, and used to power motor vehicles.

II. MATERIAL AND METHODOLOGY

Biogas is practically produced as landfill gas (LFG) or digested gas. A bio gas plant is the name often given to an anaerobic digester that treats farm wastes or energy crops. Bio gas can be produced using anaerobic digesters. These plants can be fed with energy crops such as maize silage or biodegradable wastes including sewage sludge and food waste. During the process, as an air-tight tank transforms biomass waste into methane producing renewable energy that can be used for heating, electricity, and many other operations that use any variation of an internal combustion engine, such as GE Backbencher gas engines. There are two key processes: Mesolithic and Thermophile digestion. In experimental work at University of Alaska Fairbanks, a 1000-litre digester using psychrophiles harvested from "mud from a frozen lake in Alaska" has produced 200–300 litres of methane per day, about 20–30% of the output from digesters in warmer climates.

Chemical reactions involved in biogas production:

C6H12O6 → 3CO2 + 3CH4
CO2 + 4H2 > CH4 + 2H2O
CH3COOH > CH4 + CO2

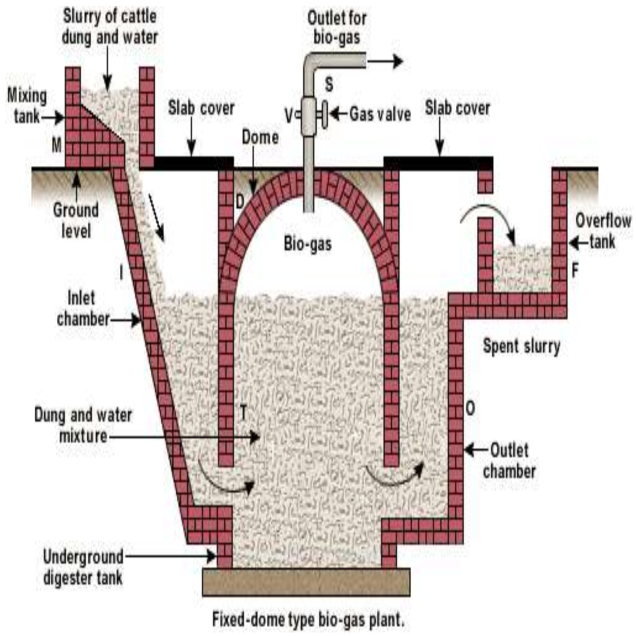

Figure 1. Biogas Production Process

Compound	Formula	Percentage (%)
Methane	CH4	50 – 75
Carbon Dioxide	CO2	25 – 50
Nitrogen	N2	0 – 10
Hydrogen	H2	0 -1
Hydrogen Sulphide	H2S	0 – 3
Oxygen	O2	-

Table1. Typical Composition of Biogas

A. Specification of Engine

Model	Hero Honda CD100 ss
Year	2006
Category	Sport
Rating	62.9 out of 100
Displacement	97.20 cc (5.93 cubic inches)
Engine type	Single cylinder, four-stroke
Power	9.65 HP(7.0 kW) @ 8000 RPM
Compression ratio	8.8:1
Ignition	Electronic
Gearbox	4-speed
Transmission type, final drive	Chain
Starter	Kick

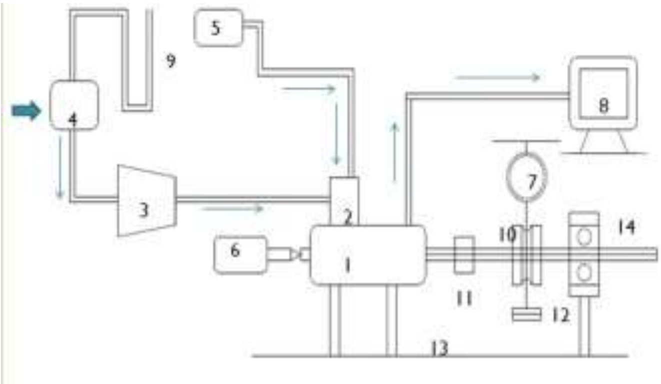

Figure 2. Line Diagram of Experimental Setup

1. Engine
2. Carburetors
3. Air Filter
4. Air Box
5. Gas Tank
6. Tachometer
7. Weight
8. Exhaust Gas Analyzer
9. Manometer
10. Rope Belt Pulley
11. Universal Joint
12. Block of Weigh
13. Engine Base
14. Supporting bearing

Figure 3. Original Experimental Setup

III. TEST PROCEDURE

The experiment on petrol fuel was carried out in the original engine. Stand was prepared for engine itself as vibration of the engine found much more. Rope break dynamometer arrangement was done. Steps followed are,

1. Start petrol engine on petrol fuel only and run for 25 minutes for warm upend system stabilization.
2. Reading of exhaust temperature, ambient condition, suction pressure difference, fuel consumption for 10 cc fuel consumption and exhaust were taken with suitable measuring instruments mentioned.
3. Then each of this readings were measured as per IS standard and variation of load in steps of no load, 1, 2, 3, 4, kg. All the conditions other than load were almost same during the experiment. All this readings were taken at rated load. i.e. 1500, 3000 rpm.
4. After taking all the readings, engine was stopped after removal of load and run for 20 minutes before stopping.

Biogas fuel was used for engine after the modifications and the pure Biogas run was taken with the following steps.

1. Start of engine with the start up coil installed with the ignition systems and run engine for 25 minutes.
2. Reading of exhaust temperature, ambient condition, suction pressure difference, fuel consumption was measured with weighing machine and the cylinder weight which was under observation during the experiment. Exhaust readings were taken with suitable measuring instruments mentioned.
3. Then each of this readings were measured as per IS standard and variation of load in steps of no load, 1, 2, 3, 4 kg. All the conditions other than load were almost same during the experiment. All this readings were taken at rated load. i.e. 1500, 3000 rpm.
4. After taking all the readings, engine was stopped after removal of load and run for 20 minutes before stopping.

IV RESULTS AND TABLES

A. PERFORMANCE CHARACTERISTICS:

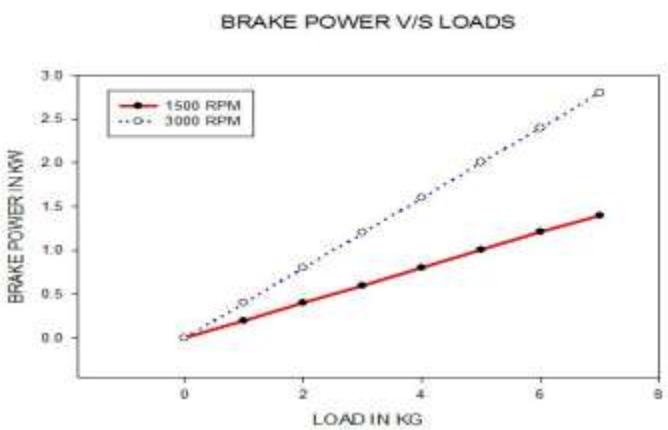

Figure 4: Variation of Brake power vs Load

Effect on Brake Power:-The effect of Biogas on the brake power is shown in fig.4. When Load increase on the engine, the Brake Power is also increase as shown in figure. The nature brake power curve increasing with the increasing in engine speed. The brake power increases with increasing percentage of methane in Biogas at constant engine speed 1500 rpm.

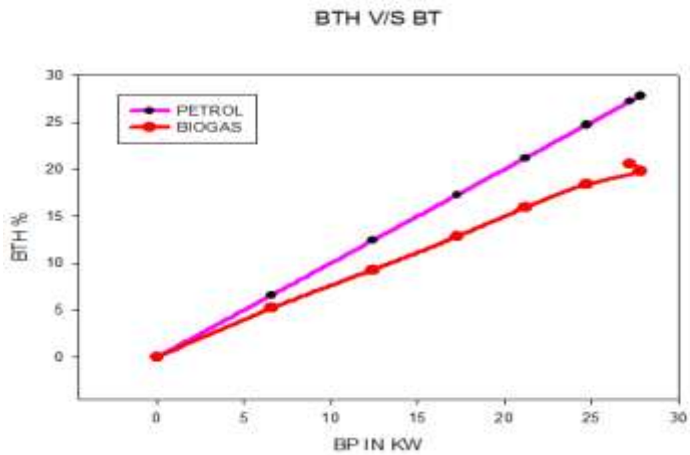

Figure 5: Variation of Brake thermal efficiency with Break Power

Effect on Brake Thermal Efficiency:-Brake thermal efficiency is the ratio of output per hour to the heat energy of fuel supplied per hour. Fig. 5 shows the comparison of the brake thermal efficiency with brake power for the tested fuels. It can be observe from the fig. thermal efficiency of petrol fuel increasing with increasing in load. It can be seen from the graph that thermal efficiency of biogas fuel engine is approximately 10 percentages less than the petrol fuel may be due to reduction of volumetric efficiency of the engine with respect to Biogas.

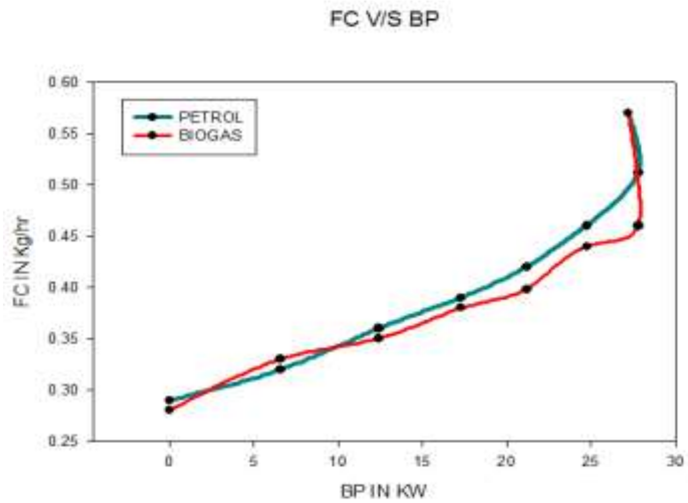

Figure 6: Variation of Fuel consumption with Break Power

Effect of Specific Fuel Consumption:-Fig.6 shows the comparison of the specific fuel consumption with brake power for the tested fuels. It can be observed from the fig. that the specific fuel consumption of petrol fuel varies 1.67kg/kwh at 20 percentages load to o.41 kg/kwh at full load. Whereas for the Biogas fuel Varies from 1.65 kg/kwh at 20% load to 0.40 kg/kwh at full load. It can be seen from the graph that specific fuel consumption of biogas is lower than petrol fuel in all load condition. This behavior is obvious since the engine will consume less amount of fuel to gain the same power output due to high calorific value of biogas fuel with that of petrol fuel.

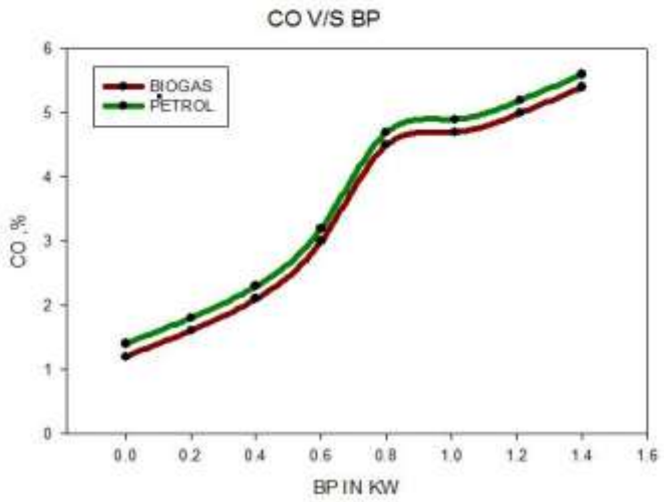

Figure 7: Variation of CO with Brake Power

Effect on Carbon Monoxide:-Fig. 7 shows the comparison of carbon monoxide emission with brake power for tested fuels. Generally SI engine operate with lean mixtures and hence the CO emission would be low. CO emission for the petrol fuel increases with increase in load from 0.4% at the no load to 1% at full load whereas for Biogas it varies from 0.5% to 1.1% from the table it is clear CO emission is almost comparable for biogas as well as petrol fuel.

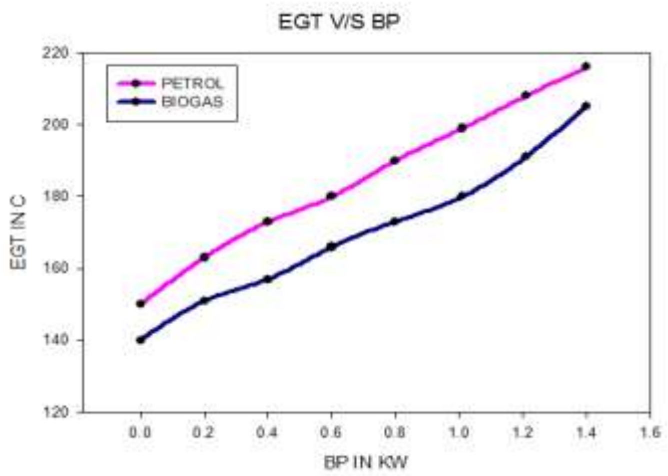

Figure 8: Variation of EGT with Break Power

Effect on Exhaust Gas Temperature:-Exhaust gas temperature represents the exact temperature of the fuel mixture after it combusted in the cylinder. Fig.8 shows the variation of exhaust gas temperature with brake power for the tested fuels. It can be observed from the fig. that exhaust gas temperature Of petrol increasing with 150 C° at no load to 216 C° at full load. Whereas for the Biogas fuel it varies from 140 C° at no load to 205 C° at full load. It can be seen from the graph that exhaust gas temperature Biogas is quite lower than that of petrol fuel. The reason for low exhaust gas temperature due to low release rate of biogas has the calorific value of biogas is almost 20% higher than that of the petrol engine.

V. CONCLUSION

It can be conclude from the experimental comparison that thermal efficiency of biogas fuel engine is approximately 10% less than the petrol fuel may be due to reduction of volumetric efficiency of the engine with respect biogas.
It can be seen from experimental comparison that specific fuel consumption of biogas is lower than petrol fuel in all load condition. This behavior is obvious since the engine will consume less amount of fuel to gain the same power output due to high calorific value of biogas fuel with that of biogas Fuel.
That the Exhaust gas temperature of petrol is quite higher than that of biogas fuel. The reasons for high exhaust gas temperatures due to high release rate of biogas have the calorific value of biogas are almost 20% higher than that of petrol engine.
HC emission is higher at all the load conditions for petrol Spark Ignition Engine probably due to higher air fuel ratio as compared to petrol fuel.

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