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RESEARCH ARTICLE

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FEASIBILITY OF DUEL FUEL (LPG-BIOGAS) ENGINE TO OPTIMIZE THE PERFORMANCE AND EMISSIONS OF SI ENGINE

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ABSTRACT

Also Oil reserve all over the world is depleting at an alarming rate which is one of the major concern from energy point of view. Operation of IC engines emits sulphur dioxide, hydrocarbons, carbon monoxide, NO_x, lead etc. which can cause serious harm to living organisms. This has encouraged various researchers to find ways to reduce these emissions. And in the quest to do so researchers have identified various alternative fuels suited for spark ignition (SI) engines and categorised them as some of them are synthetic gasoline, alcohols, and gaseous fuels. Gaseous fuels in general are much more promising alternative fuels to SI engines due to their low cost, high calorific values, high octane number and lower polluting exhaust emissions when compared to conventional petrol. Gaseous fuels such as liquefied petroleum gas (LPG) have been widely used in commercial vehicles for last decade and promising results have been obtained in terms of the fuel economy and exhaust emissions. India is one of the countries seriously affected by pollution and one of the major cause exhaust emission from automobile. Understanding the problem and sensing the alarming rate of increase in pollutants in atmosphere, the Government of India has taken an encouraging step towards the reduction of atmospheric pollution by directing its attention towards the use of LPG as an automobile fuel. Similarly Biogas which is derived from organic wastes is also considered as good alternative to petroleum fuels. It can be used in spark ignition (SI) engines, because of its better mixing ability with air and clean burning nature. This fuel offers low cost and low emissions than any other secondary fuels. It can be a supplemented to liquefied petroleum gas (LPG), if it is used in compressed form in cylinders.

Keywords— Alternate fuel, Biogas, Liquefied petroleum gas (LPG), Petrol

INTRODUCTION

Biogas is an alternative fuel made up of renewable biological source such as kitchen waste and municipal waste. It is a biodegradable, comparatively nontoxic and possesses low emission profile. In order to resolve global environmental issues such as global climate change and vehicular pollution, it is vital to search the renewable alternative fuels from bio origin, which are eco-friendly such as biogas. India is largest cattle breeding country where raw material for producing Biogas is in abundance. Also kitchen wastes and municipal wastes can be used for this purpose. The use of methane (CH_4) from biogas as a fuel will substantially reduce harmful engine emission and will reduce emissions. The main advantage of biogas

is that it can be produced in rural areas from readily available materials. Biogas consist mainly methane and carbon dioxide is low but its knock resistance is high.

LPG is already being considered and used as an alternative fuel and is also proven a better option in terms of emission. Biogas and LPG both have comparable energy density, octane number, heat of vaporization and stoichiometric air/fuel ratio when compared to petrol.

Since the commencement of industrial revolution in the late 18th and early 19th century, energy has become an indispensible factor for mankind to preserve economic growth and maintain standard of living.

Developing alternative energy is an evitable choice for sustainable economic growth in human society. In addition it is also important for the harmonious coexistence of human environment as well as for the sustainable development. Considerable attention was focused on the development of Bio fuel with particular referring to biogas.

The key to use biogas as an alternate fuel can be dividing into three points as follows:

1. With global energy crisis approaching biogas as fuel will play a more important role in strengthening a nations energy security
2. As a renewable energy, biogas is derived from plants and animal waste which can contribute to the reduction of greenhouse gas emissions when replacing fossil fuels.
3. Its production is based on agricultural waste, waste cooking products and from cow dungs. Increased consumption of biogas creates economic development and additional markets for agricultural products. This creates new jobs in rural communities and keeps money circulating in rural economy. Manufacturing a fraction of fuel at home increases our nation's energy independence.
4. 1 biogas plant is computed to save 32 litres of kerosene and 4 tons of firewood every year. The organic chemical plant also contributes indirectly to the protection of soil.

Experimental Work

A. Equipment

TABLE I: ENGINE SPECIFICATION

Displacement	145.45 cc
Max Power	6.6 kW at 5000 rpm
Max Torque	15.5 Nm @ 3300 rpm
Ignition Type	CDI
Transmission Type	4 forward and one reverse
Clutch Type	Wet multidisc type

B. Experimental Setup

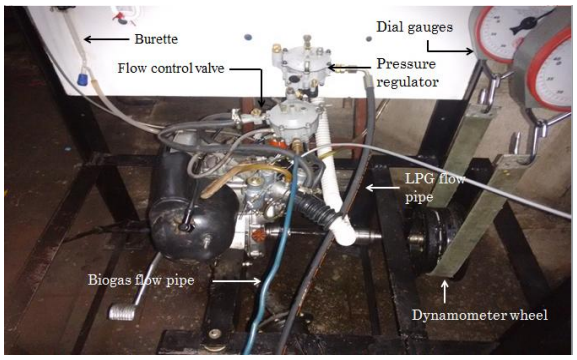

Fig.1 Two stroke single cylinder petrol engine test rig with rope brake Dynamometer

- Rope brake dynamometer coupled to the engine.
- Measurement of Fuel consumption (burette for petrol and Weight Bridge for LPG and BIOGAS)
- Air tank with an orifice and water manometer for measuring air intake.
- Optical tachometer for measuring speed.

C. Specifications Of Engine Test Setup

- No. Of cylinder n= 1
- Orifice diameter $d_0=23\times10^{-3}$ m
- Brake drum diameter $D=200\times10^{-3}$ m

D. Values (For Air, Petrol, LPG) Considered For Calculation

- Atmospheric pressure Pa=1.01325 bar
- Co-efficient of discharge Cd=0.73
- Density of fuel (petrol) ρ_{fuel}=740 kg/m3

- Density of fuel (Biogas) ϑ_{fuel}=630 kg/m3
- Calorific value of petrol C.V. =46900 kJ/kg
- Calorific value of LPG C.V. =49789.6 kJ/kg
- Gas constant R=0.287 kJ/kgK

Biogas:

- CH_4 in Biogas = 65 %,
- CO_2 in Compressed Purified Biogas = 30%,
- Miscellaneous (H_2S, CO etc.) = 5%
- Calorific Value of Biogas = 32500 kJ/kg.

RESULTS AND DISCUSSIONS:

Auto-rickshaw petrol engine was operated under variable load condition by using petrol, LPG, Biogas and blend of LPG-Biogas of different proportion mix (25%, 50%, 75%) respectively and found the fuel consumption for variable loading condition for all the above fuel.

Plotting the graph between Load (kg) and Brake specific Fuel Consumption (BSFC) for blend, Biogas, LPG and petrol we can compare and investigate the fuel consumption for all of the above fuel.

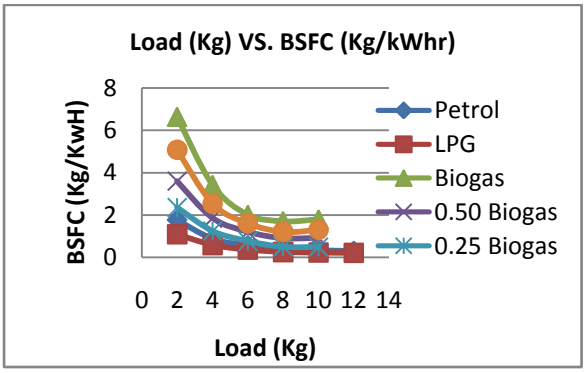

Fig. 1 Load (Kg) Vs. BSFC (Kg/kWhr.)

Similarly graphs were plotted for Brake thermal efficiency (η_{bth}) vs. load (Kg) and found out that LPG has maximum brake thermal efficiency of all the fuels used and Biogas when used alone had minimum thermal efficiency. Whereas blend with 25%Biogas had efficiency similar to that of petrol but began to fall at 66% of the full load condition.

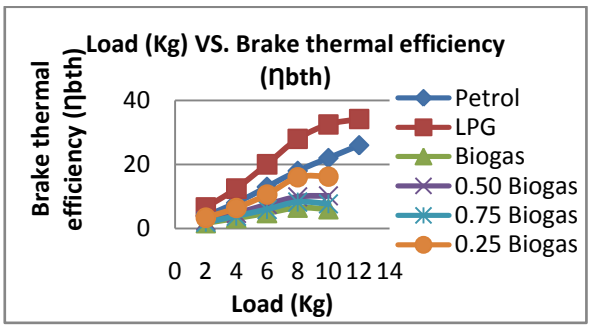

Fig. 3 Load (Kg) Vs. Brake thermal efficiency (η_{bth})

After plotting a graph between load and brake power it was observed that petrol and LPG produced similar amount of power but when the engine was run on Biogas and its blend it was observed that there was a fall in the power produced by the engine. Moreover engines load carrying capacity was also decreased to 83% of the full load condition.

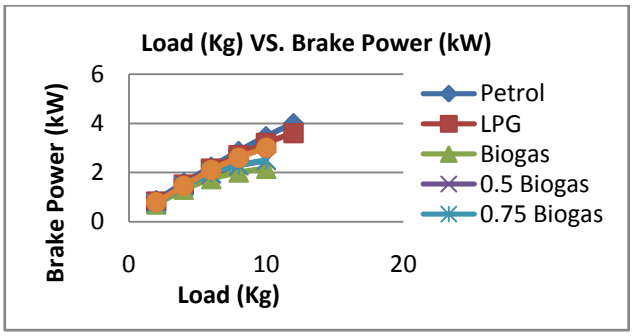

Fig. 4 Load (Kg) Vs. Brake power (kW)

Simultaneously engine was tested for emissions when the above tests were carried out. Graph was plotted between CO% and load. It was observed that Biogas when used alone produced the maximum amount of CO when compared to its blend condition and other fuels.

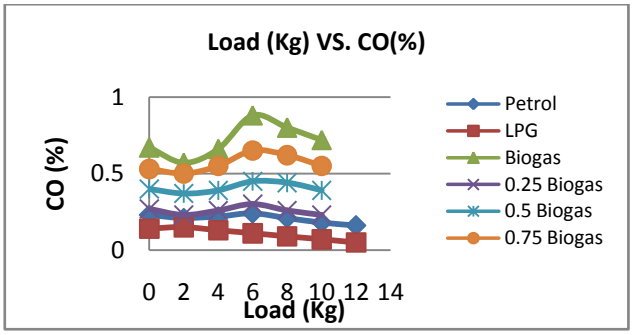

Fig. 5 Load (Kg) Vs. CO (%)

Similarly between CO_2 and Load and as similar to CO, CO_2 emission were higher in case when onlu Biogas was used alone, followed by

75%Biogas blend. And least CO_2 emission was observed in when LPG was used alone.

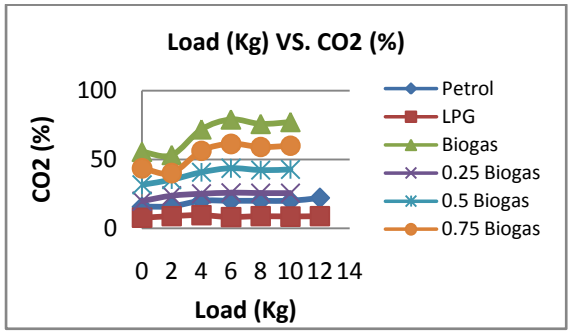

Fig. 6 Load (Kg) Vs. CO_2 (%)

On the contrary HC emissions were higher than petrol while using alternative fuels, neither blend nor did the individual gases result in reduced HC emissions. In this case LPG produced maximum amount of HC emission.

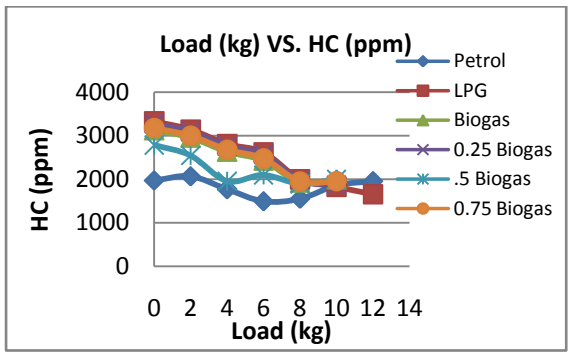

Fig. 7 Load (Kg) Vs. HC (ppm)

CONCLUSION

On the basis of test conducted following conclusion can be drawn:

- Consumption of LPG is also low compared to Biogas and petrol when engine is operated at variable loading conditions. Fuel consumption decreases with the increase in load and is minimum when load on engine is 50% of the full load and then again goes on increasing as the load increases for all the fuels.
- Brake Specific Fuel Consumption (BSFC) is low for LPG when compared to Biogas and Petrol. BSFC for all fuels are approximately same after 65% of the loading on the engine. Before 65% of the loading on engine, BSFC of LPG is low than that of Biogas and Petrol.
- Brake thermal efficiency of LPG is also more than that of Biogas and petrol at same loading conditions.
- Results obtained from the test indicate characteristics of LPG are more superior to that of Biogas and Petrol. It can be easily one of the better alternate fuels for SI which is cheap and gives satisfactory performance.

REFERENCES

[1] Venkata Ramesh Mamilla, V.Gopinath, C.V.Subba Rao, Dr.G.Lakshmi Narayana Rao performance and emission characteristics of 4 stroke petrol engine fuelled with biogas / l.p.g blends International Journal of Advanced Engineering Technology E-ISSN 0976-3945

[2] K.A. Subramanian, Vinaya C. Mathad , V.K. Vijay , P.M.V. Subbarao Comparative evaluation of emission and fuel economy of an automotive spark ignition vehicle fuelled with methane enriched biogas and CNG using chassis dynamometer journal.

[3] K.F. Mustafa, H.W. Gitano-Briggs,"Liquefied Petroleum Gas (LPG) as an Alternative Fuel in Spark Ignition Engine: Performance and emission characteristics," in International Conference on Energy and Environment,, Malacca, 2009.

[4] Mr. Sanjay D Bisen, Mr. Yogesh R. Suple, "Performance evaluation of four stroke SI engine by direct injection of LPG," vol. 1, no. 2, ISSN: 2321-8134, 10 October 2013.

[5] Debabrata Barik, S. Murugan Production and Application of Biogas as a Gaseous Fuel for Internal Combustion Engines. International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 7, September – 2012

[6] Shankar K. S, Mohanan P, MPFI gasoline engine combustion, performance and emission characteristics with LPG injection, international journal of Energy and environment vol.2, no. 4, pp. 761-770, 2011.

[7] S. M. Lawankar, Dr L. P. Dhamande , Dr S. S. Khandare, Experimental study of effect of ignition timing and compression ratio on NOx

emission of LPG fuelled engine, International Journal of Scientific & Engineering Research, October-2012 1 ISSN 2229-5518 vol. 3, no. 10, 2012.

[8] Debabrata barik, Sudhirsah, S.Murugan Effects of Varying Injection Timing on Performance and Emission Characteristics of Dual Fuel Engine Fuelled with Biogas International Journal of Scientific & Engineering Research, Volume 4, Issue 12, December-2013 97 ISSN 2229-5518

[9] S. D.Meghare, N. R. Kannake, S. S. Sontakke Experimental Investigation on LPG as Alternative Fuel for Two Wheelers International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 1, July 2012.