ISSN 2395-1621

Feasibility of Duel Fuel (LPG-Biogas) Engine to Optimize the Performance of SI Engine

#1SagarPajankar, #2Prof. V.R. Patil

[1]sagar.pajankar@gmail.com
[2]patilvijayr@yahoo.com

[1]ME Automotive Engineering, AISSMS College of Engineering, Pune, SPPU
[2]Department of Mechanical Engineering, AISSMS College of Engineering, SPPU
AISSMS College of Engineering, Pune, India

ABSTRACT

IC engines are considered as real benefactors to the disintegration of the earth's environment, subsequently there is an expanding demand to go for alternate fuels for both SI and CI engines to keep up the ecological balance as well as reduce dependency on petroleum from economy point of view.The gaseous fuel such as LPG has been widely used throughout the world in SI engines as it impacts greenhouse emissions less than any other fossil fuel.In the study carried out during literature survey it was found that the levels of CO, HC and CO_2 were on the lower side for LPG as compared to gasoline for the same power output. Likewise Biogas which is derived from organic wastes is considered as great option for petroleum fills. It can be used in spark ignition (SI) engines, because of its better blending capacity with air and clean burning nature. This fuel offers minimal cost and low emissions than any other alternative fuels. It can be a supplemented to liquefied petroleum gas (LPG), in the event if it is used in compressed form in cylinders. The proposed work incorporates use of LPG fuel mixed with Biogas in different ratios. This paper also gives a brief about the assembling of two stroke auto-rickshaw engine on test rig and testing on it. At first engine will be tried with petrol at typical working conditions later same engine will tried out with LPG and Biogas. The recommended work will be completed on a commercial engine to discover whether we can execute the progressions on-going engine and enhance its performance.

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

ARTICLE INFO

Article History

Received :18th November 2015

Received in revised form :

19th November 2015

Accepted : 21st November , 2015

Published online :

22nd November 2015

I. INTRODUCTION

Petrol is a fossil fuel made out of crude oil supply of which is limited in India. India mainly depends on Arab countries for their fuel supplies and this situation has raised the interest of scientist and research workers towards alternative fuels for vehicle. While alcohol is used as a fuel but it's feasibility as motor fuel depends on the successful cultivation and processing of sugarcane. Gaseous fuels appear to be the simplest immediate choice present in the market. These are mainly liquefied petroleum gas (LPG) and Compressed natural gas (CNG).

LPG is obtained from natural gas and crude oil extraction as aby-product. Primarily it is a mixture of propane and butane and has a higher octane number (105) than petrol (90-98).The use of LPG in IC engines resulted in higher thermal efficiency and better fuel economy when compared to unleaded Petrol. This is because of higher octane number which permits greater engine compression ratio with absences of knock. Fuels such as LPG and liquefied natural gas (LNG) have been commercially used in vehicles and promising results were obtained in terms of fuel economy and exhaust emissions. It has low carbon emission and high octane number because of which it produces lower carbon dioxide (CO_2) when compared to Petrol. Many investigators have reported positive results from emission point of view when LPG is used as an alternative fuel. LPG operated vehicle reported reducedcarbon monoxide (CO) of 60%, hydrocarbon (HC) emissions of 40%andsubstantially reduced carbon dioxide (CO_2).

India is largest cattle breeding countrywhere 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.

II. SIGNIFICANCE OF BIOGAS

- 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 fractionof fuel at home increases our nation's energy independence.
- Biogas improves engine lubrication, clean ups fuel systemand reduces particulate emissions all of which help to extend the life of engine equipment.
- Use of biogas instead of petrol decreases hydro carbon emission nearly by 65%.

III. PROBLEMS TO USE BIOGAS IN SI ENGNE

- Biogas contains high CO_2content reduces the power output, simply making it an uneconomical option as transport fuel. It is possible to removethe CO_2 by washing the gas with water. Pressurized water can be used as absorbent, as CO_2 is water soluble agents. The rate of CO2 absorption depends upon the factors such as, gas flow pressure, composition of biogas, water flow rates, and purity of water. Chemical agents like NaOH, $Ca(OH)_2$, and KOH can also be used for CO_2 scrubbing from biogas.
- Biogas also contains H_2S which is acidic in nature and if not removed can cause corrosion of engine parts. H_2S is easy to remove by passing the gas through iron oxide (Fe_20_3 -rusty nails are a good source) or zinc oxide (ZnO).
- There is high residual moisture which can cause starting problems.Silica gel can be used to absorb moisture content also alumina or are the most common technique. These techniques are usually applied at elevated pressures. At atmospheric pressure only a small amount of water is removed by the absorption and adsorption techniques.

IV. STORAGE AND TRANSPORTATION

Biogas can be stored at low, medium and high pressure of 0.137bar, 13.78barand 344.73bar respectively. Medium pressure compression can be done by compressing with a two stage compressor having an intercooler. Biogas can be stored in typical LPG gas tanks at 17.23 bar pressure or even lower. After removal of CO_2, H_2S and water vapor from the biogas, the product remains is called as Bio-methane.

V. 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

- 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.

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

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, Water, Petrol, LPG) Considered For Calculation

- Atmospheric pressure Pa=1.01325 bar
- Co-efficient of discharge Cd=0.73
- Density of water ϱ_{water} = 1000 kg/m3
- Density of fuel (petrol) ϱ_{fuel}=750 kg/m3
- Calorific value of petrol C.V. =43000 kJ/kg
- Calorific value of LPG C.V. =46500
- Gas constant R=0.287 kJ/kgK

Compressed Purified Biogas:

- CH_4 in Compressed Purified Biogas = 90.3 %,
- CO_2 in Compressed Purified Biogas = 2.3%,
- Calorific Value of Compressed Purified Biogas = 41300 kJ/kg.

VI. RESULTS AND DISCUSSIONS:

Two stroke stationary petrol engine was operated under variable speed at no load condition by using petrol, LPG and Biogas respectively and found the speed (rpm) at which minimum fuel consumption takes place in all cases.Plotting the graph between speed (rpm) and Fuel Consumption (FC) for Biogas, LPG and petrol we can compare and investigate the fuel consumption for all of the above fuel.

By investigating the graph we found out that minimum fuel consumption takes place at 3000 rpm for all the fuels. Again operating engine at variable loading condition and at steady state speed of 4500 rpm various performance parameters like Fuel Consumption (FC), Brake Specific Fuel Consumption (BSFC) and brake thermal efficiency were determined. By plotting graphs between load and fuel consumption, load and BSFC and load and brake thermal efficiency and then comparing the performance for Biogas, LPG and petrol, we found that LPG becomes better substitute of petrol.

The results were obtained by conducting experiment on the Engine by using Petrol, LPG and Biogas respectively at constant speed and variable loading condition. In the present investigation the fuel consumption (in case of Petrol) increases with the speed (RPM). It becomes lowest at 3000 rpm and then increase with speed up to maximum speed limit of 4500 rpm.When LPG is used as fuel same trend of fuel consumption is observed as in case of Petrol but in case of Biogas the condition changes, consumption of fuel increases than that of petrol. Variation of Fuel Consumption (FC) with speed (RPM) is shown in the graph.

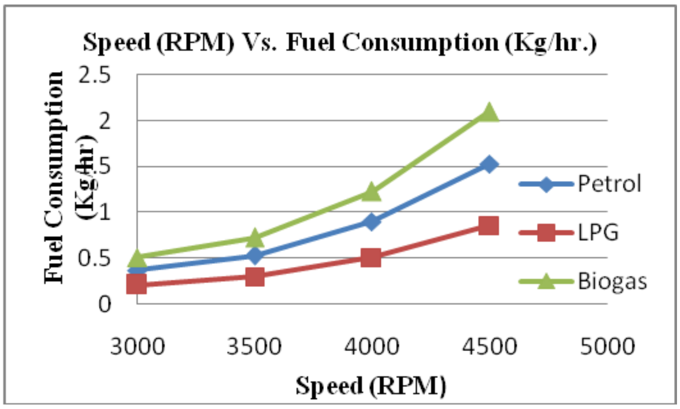

Fig.1 Speed (rpm) Vs. Fuel consumption (Kg/hr.)

Later engine is operated at variable loading condition keeping speed (RPM) constant (4500rpm) for the same. For variable loading condition of engine we can also find Fuel Consumption (FC), Brake Specific Fuel Consumption (BSFC) and brake thermal efficiency.

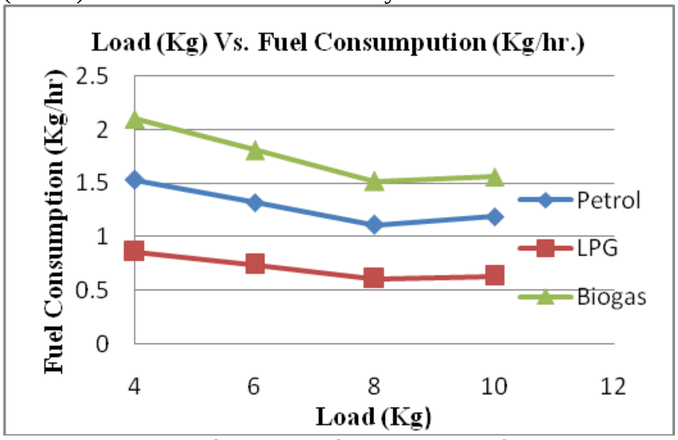

Fig. 2 Load (Kg) Vs. Fuel consumption (Kg/hr.)

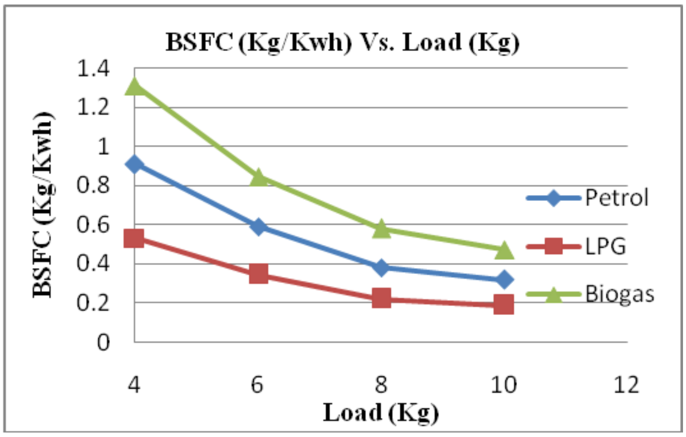

Fig. 3 BSFC (Kg/KwH) Vs. Load (Kg)

When the engine is tested for BSFC on variable loading condition keeping speed constant at 4500rpm it is found that break specific fuel consumption of LPG goes on decreasing up to a certain load and after that the break specific fuel consumption goes on increasing similar case is for Biogas. But Biogas when compared to LPG shows increased fuel consumption at similar loading conditions. It can be seen that the fuel consumption is more than that of petrol for similar conditions.

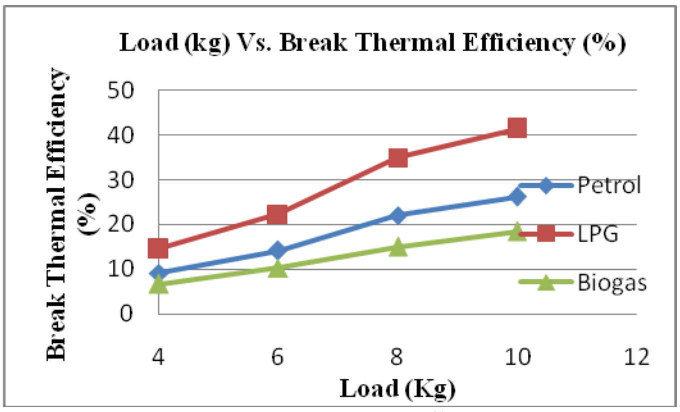

Fig. 4 Load (Kg) Vs. Break thermal efficiency (%)

By studying the above graphs and comparing performance of the SI engine operated with Biogas, LPG and petrol we found that operation of engine is better, efficient and economical by the use of LPG than Biogas and petrol.

VII. CONCLUSION

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

- Consumption of LPG is slightly lower than that of Biogas and Petrolat no load conditions. Also it is minimum at 3000 RPM when compared to Biogas and Petrol.
- Consumption of LPG is also low compared toBiogas 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 indicatecharacteristics of LPG are more superior to that of Biogas and Petrol. It can be easily one of the better alternate fuels for SIwhich is cheap and gives satisfactory performance.

REFRENCES

[1] Venkata Ramesh Mamilla, V.Gopinath, C.V.SubbaRao, Dr.G.LakshmiNarayanaRao 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] DebabrataBarik, 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] Debabratabarik, Sudhirsah, S.MuruganEffects 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 WheelersInternational Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 1, July 2012.

