Performance Optimization of single Cylinder Four Stroke S.I. Engine using Tri-Fuel Blending - An Experimental Investigation

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Abstract

Pollution from the petroleum oil increases day by day in terms of CO2, CO, NOX, PM and many other gases and particles. Price difference and economy leads people toward the use of alternative fuels. To overcome this problem Tri-fuel is the best suitable fuel for the IC engine because of its clean emission characteristics. It is found that power produced by the Tri-fuelled engine is more and lower NOx emissions compare to Gasoline engine because of the high volumetric efficiency, high compression ratio.
Keywords: Tri Fuels, Butanol, CNG, SI Engine, Emission, Performance

I. INTRODUCTION

The use of fossil fuel is increasing drastically due to its consumption in all consumer activities. The high utility of fossil fuel depleted its existence, degraded the environment and led to reduction in underground carbon resources. Hence the search for alternative fuels is paying attention for making, sustainable development, energy conservation, efficiency and environmental preservation, has become highly pronounced now a days [1-3]. The worldwide reduction of underground carbon resources can be substituted by the bio-fuels. The SI and CI engines are the major contributors of the GHG. The main researchers around the world are finding the alternate fuel that should have the least impact on the environmental degradation. Rudolf Diesel patented an engine design for used dual fuel system. The present fuel system involves the adaptation of Rudolf with diesel as a single fuel. The emission of NO_X is unavoidable in fuel combustion systems. An attempt has been made to develop a tri fuel system without additives in conventional C.I engines to achieve biofuel and to reduce emission of Pollutants [4-5].

II. NEED OF THE EXPERIMENT

Amidst ever decreasing fuel resources and constantly increasing air pollution, the fundamental sustainability of present energy system has been put into question. The present reserve of petroleum products is slowly dying out, widening the gap between global energy supply and energy consumption. As per 2008, energy used on a global scale is about 142.3 Terawatt-Hour, which is about 39% higher than that of 1990 . Moreover, in order to meet the stringent EUROeVI standards, automobile manufacturers are compelled to try out emission, more precisely NOx and smok reducing alternatives like LPG,ethanol, CNG (compressed natural gas) etc. As a result a lot of the research studies are now oriented toward finding a cleaner burning fuel with satisfactory combustion and performance signatures.

I am attempting to develop a tri fuel system without additives in conventional S.I engine to achieve biofuel and to reduce emission of pollutants.

Finally I have decided to use following fuel as a tri-fuel in engine to increase the performance and reducing the emission of a engine:

1) GASOLINE
2) BUTANOL

3) LPG

III. OBJECTIVE OF EXPERIMENT

1) To modify single cylinder petrol engine into Tri-fuel S.I engine
2) Lowering gaseous pollutants like CO_2 , CO, NO_x .
3) To carry out emission and performance tests of single cylinder SI engine and comparing it with modified single cylinder Tri-fuel S.I engine.

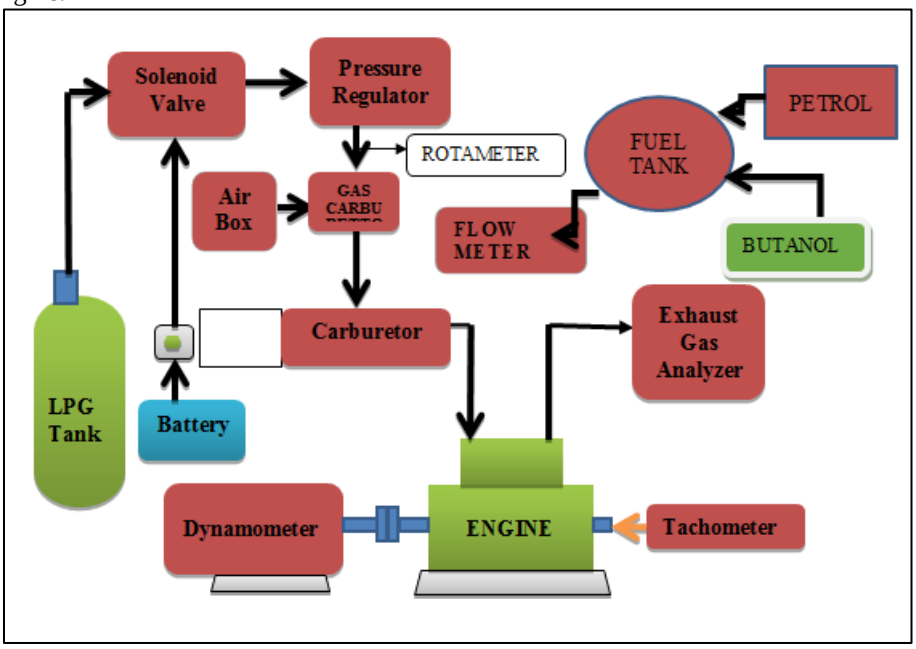

Fig. 1:

A Single Cylinder, four stroke, naturally aspirated (GX-160) Petrol engine has been used for the purpose of experimentation. The engine is then coupled with A.C. Electrical Dynamometer. Output of A.C. dynamometer is connected with Electrical Lamp type load bank. Inlet manifold is connected with air box which is also attached with U-tube manometer. Fuel supply to the engine is from the tank via burette in case of Petrol + butanol and from Rotameter in case of LPG cylinder. Rotameter is used to measure the fuel consumption of LPG.

Necessary provisions are made to measure the flow rates of fuel, air flow to the engine cylinder, rpm of dynamometer, generated voltage and ampere, inlet and exhaust gas temp. Gas analyzer used to measure exhaust gas parameters.

Thus, after establishing the Experimental Test Set-up, the experimental work towards engine performance evaluation is carried out in the following steps:

1) Carburettor for supply of LPG-Air mixture.
2) Installing gas carburettor in series with oil carburettor.
3) LPG conversion kit

In the dedicated tri fuel spark ignition engine the fuel delivery system of petrol engine is carburettor. Carburettor is provided for easy mixture formation of air-gas and the maintaining the correct air supply into the mixture. In a carburettor throttle valve is provided which directly varies with the accelerator and maintain the correct air supply in venturi for homogenous mixture formation. Both the carburettors are shown in Fig.

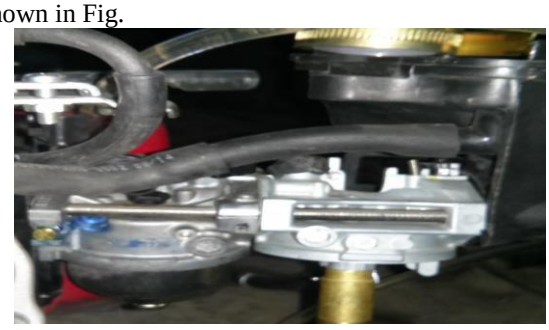

Fig. 2: Gas Carburetor and Carburetor in Series

IV. EFFECT ON PERFORMANCE AND EXHAUST EMISSIONS @ 3600 RPM

A. BSFC (Brake Specific Fuel Consumption):

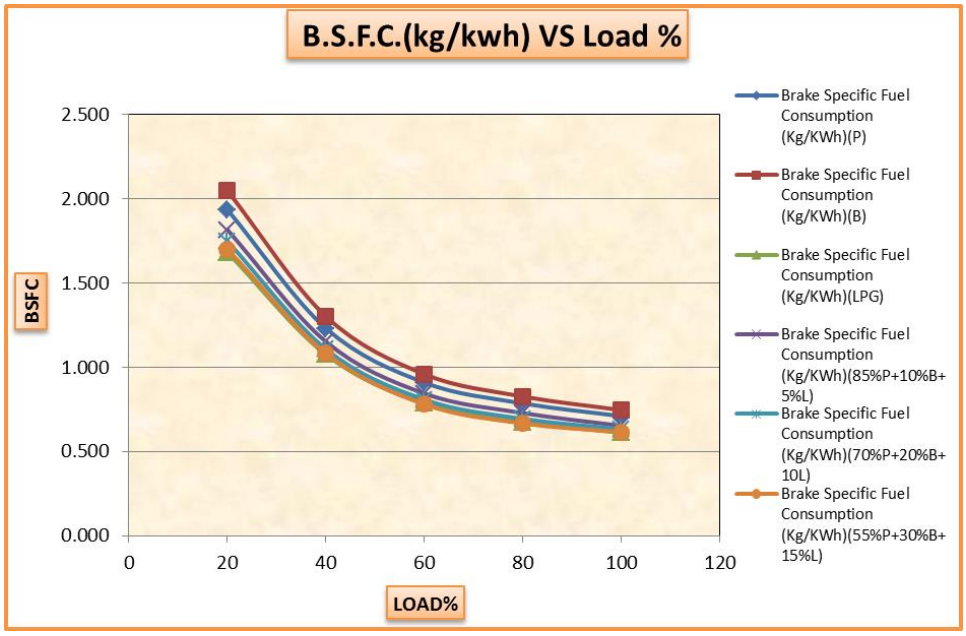

Fig. 3: Brake Specific Fuel Consumption

Figure show the Brake Specific Fuel Consumption of engine with different load. In graphs, it is observed that BSFC decreases as load increases from 20% to 100% respectively. It is less than petro and petrol+butanol blends.

B. BTE (BRAKE THERMAL EFFICIENCY):

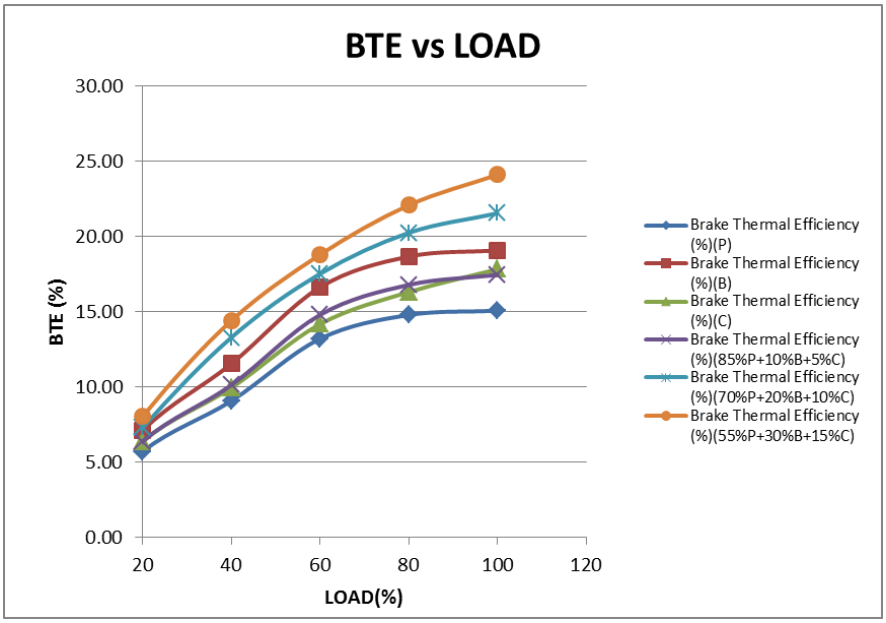

Fig. 4: BTE vs Load

Figure 6.3 show the Brake Thermal Efficiency of engine with different load and fuel blends. BTE of CNG+Petrol+Butanol is found maximum than petrol and gasoline blends.

C. Volumetric Efficiency:

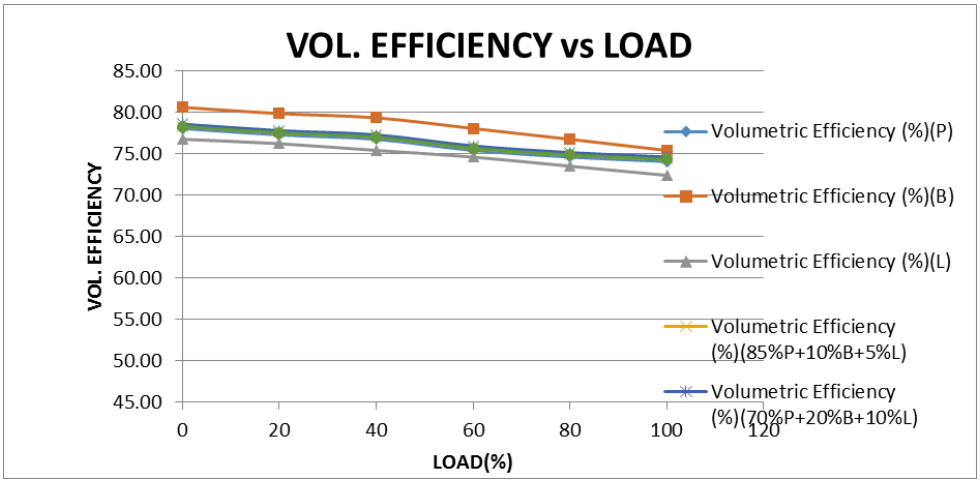

Fig. 5: Volumetric Efficiency of Engine With Different Load And Gasoline Blends

Figure show the Volumetric Efficiency of engine with different load and gasoline blends. Volumetric Efficiency of CNG + Petrol + Butanol is less than Petrol and gasoline blends.

D. CO Emissions:

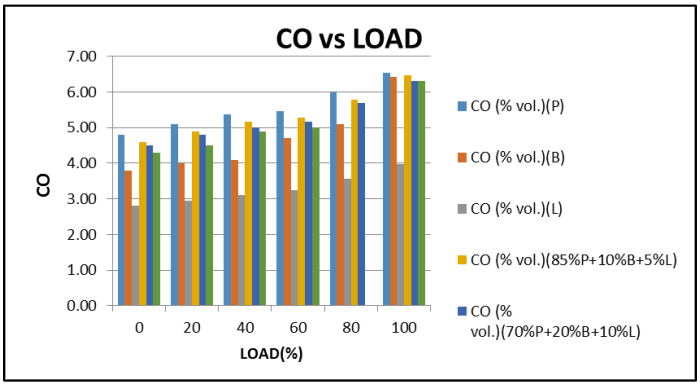

Fig. 6: CO vs Load

Graph shows that CO is increasing with increasing load. But emission on same load CNG + petrol+butalol is producing always less compare to petrol and gasoline blends.

E. HC Emissions:

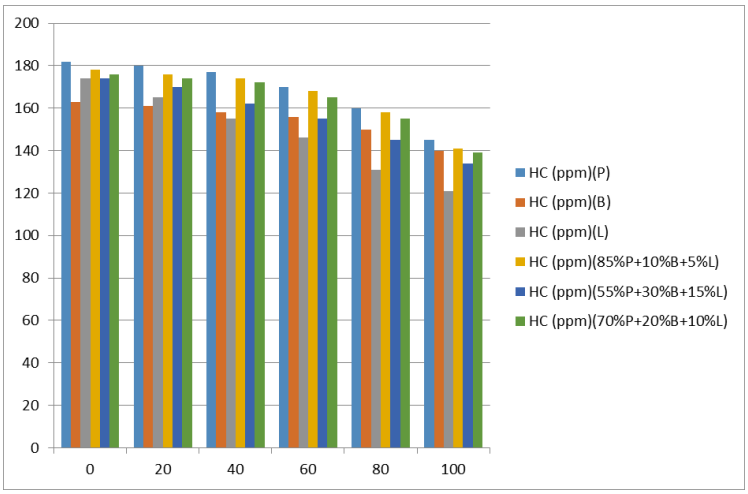

Fig. 7: HC is decreasing with Increasing Load

Graph shows that HC is decreasing with increasing load. But emission on same load CNG +petrol+butalol is producing always less compare to petrol and gasoline blends.

F. NO_X Emissions:

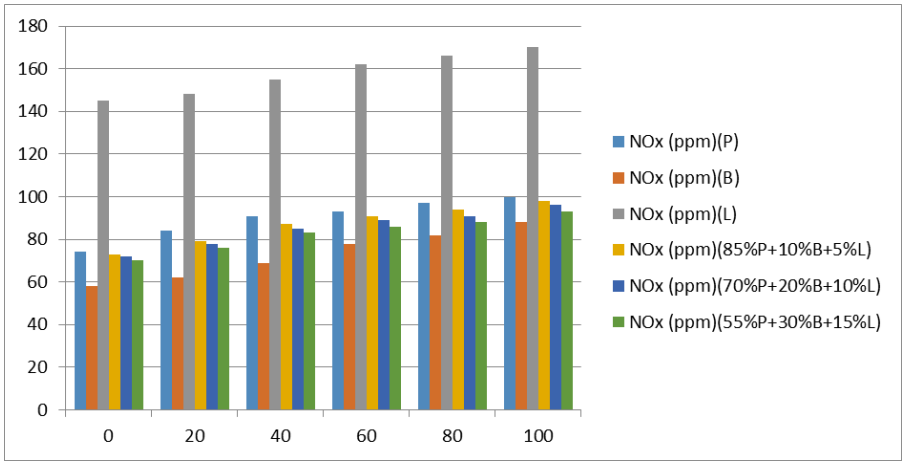

Fig. 8: NO_X is increasing with Increasing Load

Graph shows that NO_X is increasing with increasing load. But emission on same load LPG +petrol+butanol is producing always less compare to petrol and more than gasoline blends.

V. RESULTS

Following are the results which have been found out with help of above graphs.

1) Blend of butanol with petrol increases BP and increasing load on engine is also increases BP.
2) BSFC decreases as load increases from 20% to 100% respectively. It is less than petrol and petrol + butanol blends.
3) BTE of LPG+Petrol+Butanol is found more than petrol and gasoline blends.
4) Volumetric Efficiency of LPG + Petrol + Butanol is less than Petrol and gasoline blends.
5) CO increases with increasing load. But on same load, emission produced by LPG + petrol + butanol is less as compared to petrol and gasoline blends.
6) HC decreases with increasing load. But on same load, LPG + petrol + butanol produces less emission as compared to petrol and gasoline blends.
7) NO_X increases with increasing load. But on same load, LPG + petrol + butanol produces less emission as compared to petrol and gasoline blends.

VI. CONCLUSION

In this research ,Petrol engine has been converted into Tri fuel engine to minimize the exhaust gas emissions and increase engine performance. For increasing performance of the Tri-fuel engine, the effect of various percentages of fuel blending has been studied. Various performance parameters and engine exhaust emissions has been measured. Research work has been carried out at different rpms with varying load conditions.

Here, BP, BTE increases and BSFC decreases, but it is always less than petrol. HC decreases as the load increases. Adding butanol increases O2 but it becomes low when LPG is blended.

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