Engineering and Technology Journal for Research and Innovation (ETJRI)
ISSN 2581-8678, Volume II, Issue II

Performance of a Spark Ignition Engine Using Gasoline and LPG Fuels

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***Abstract*—Conventional fuels like gasoline and diesel are putting the serious threat to environmental health as they emit greater amount of pollutant. Human body is adversely affected by the exhaust emissions. To reduce the level of harmful exhaust emissions to safer level some alternative fuels such as LPG and gasoline are being explored to replace the conventional petroleum fuels. In this paper experimental investigations were made to know the influence of these fuels on spark engine's performance. The engine was tested using LPG and gasoline LPG is found more economical but in most of the cases it results in about 10 -15% power loss. There is reduction in emission level.**

***Keywords*—exhaust emissions, gasoline, liquefied petroleum gas, SI engine.**

I. INTRODUCTION

In the last few decades attention has been focused on the substitution of gasoline fuel by the natural gas and other alternative fuels. Gasoline fuels sources are getting depleted rapidly due to increasing number of automotive vehicles. Exhaust emissions from gasoline engines is putting serious threat to the environment which in turn affecting the health of human beings. Owing to these effects there is an urgent need for exploring the fuels which can mitigate the problem of environmental issues as well sharing the load of conventional fuels. Due to the combined effects of increasing energy demand, depleting fossil fuel reserves and increasing environmental pollution, there is an urgent need for identifying alternative fuels. Researchers from all corners of the world doing intensive work to meet the challenges being put the use of conventional fuels in automotive engines. Ever increasing use of automotive vehicles for passengers and good transportation, depleting resources of crude oil, safeguarding features to save the environment from pollution, severe and strict norms for emission regulation norms have generated curiosity among researchers to find out feasible alternative fuels for automotive including SI engines have been found in research domain since the invention of IC engines. These alternative fuels can be named as gasoline, alcohols and other gaseous fuels [1-2]. Experiments have been carried out of NG and liquid petroleum gas (LPG) in SI engines and have been proved the promising alternative fuels in the future as these fuels possesses very high calorific values, less pollution through emissions and their high thermal efficiency [3-4]. These mentioned findings have been supplemented by many research works [8].

LPG is obtained during the refining process of crude oil as well as from natural gas also; it can also be obtained in the form byproduct of gas/oil mining [6]. The various constituents of LPG are propane, butane, propene and n-butane but it is rich in propane. LPG has approximate 65-70% of propane as its constituent and other constituents also found in different proportions [7]. The main properties of LPG which make it suitable alternative fuel for SI engines are higher density than air, possess latent heat of vaporization, and contain low percentage of carbon, relatively low cost and clean combustible fuel in comparison to gasoline [8].

Lower emission of pollutants and increased thermal efficiency of CNG run engines in contrast to gasoline and diesel fuel run engines make CNG as a feasible alternative fuel for IC engines [9]. Gharehghani [4] have carried out experimental study to know the effects of gasoline and natural gas upon the performance of SI engines. It was found that NG operated engine produced higher thermal efficiency by an average of 5.5 %, reduction in CO emissions level but emissions level of nitrous oxides were higher in comparison to gasoline fuel operated engines. Aslam et al [10] carried out experiment using CNG and gasoline as engine fuels. It was found that with CNG fuel in spark ignition engine there is a loss of brake mean effective pressure (BMEP) by 16% and a *saving* in brake specific fuel consumption (BSFC) by 17-18% however pollutants such as CO, CO_2 and UHC emissions of CNG operated engines are less in comparison to the gasoline operated engines.

Generally, there is power loss in CNG fuel operated engines and NOx emissions increases [11]. The engine power decreases as a result of reduction in volumetric efficiency and combustion rate of fuel is weaker in comparison to the liquid fuel, while NO_x emissions increase because of the increasing combustion temperature. Shamekhi [12] have conducted test to know the performance as well as exhaust emissions of a CNG/gasoline bi-fuel engine. It was found that there is a loss of 9-13% in volumetic efficiency engine with CNG in comparison to gasoline operated engines and brake power also occur when compared to gasoline operation. Zeng [13] conducted another experiment and found that pollutant emissions particularly NO_x emissions increase around 30% in comparison to gasoline operated engines.

II. EXPERIMENTAL SET UP AND PROCEDURE

This experimental study is aimed at finding out the influence of pure LPG and pure gasoline in spark ignition engine. The engine used for the test is four stroke engine single cylinder engines. Some modifications were made in the engine to make adaptable of other fuels. Table 1 is showing the specifications of the test rig. To have variation in engine power, engine test rig has been attached to an electrical circuit consists of electrical bulbs with switches. Engine performance was tested with the varying engine loads. The performances of an engine with pure gasoline have been compared with the performance of engine with pure LPG. Similarly pollutants emissions of the engine with different fuels have been. To measure the combustion parameters engine was fitted with suitable measuring devices .Pictorial view of test rig has been shown in figure 1.

LPG fuel used for testing contains nearly 65 % butane and remaining 35 % is propane. For vaporization of liquid fuel i.e. LPG a vaporizer is used. At the required pressure, the fuel is supplied to injector which is installed in supply line. Before supplying to engine gaseous fuel are weighted by using electronic weighting machine. To avoid any possible error in measurement the weighing machine used for fuel was calibrated each time during the test.

TABLE I: ENGINE SPECIFICATIONS

Parameter	Quantity
model	Briggs & Stratton Model 20 INTK
displacement	305 cm^3
Bore	79.25 mm
stroke	61.67 mm
No of cylinder	1
No of stroke	4
Compression ratio	8.0:1
Power	5.96 kW /7.46 kW
torque	19.66 N-m @ 2800 RPM
Fuel tank	(3.875 liters) polymer
Engine cooling	Water cooled
muffler	Lo-Tone Small (Super Lo-Tone optional)

Fig. 1. Pictorial view of test rig set up

III. RESULTS AND DISCUSSION

The type fuel used affects the combustion and emission features of engines. Prominent advantages of using fuels such as LPG are the mitigation of emissions which are responsible for greenhouse effect. The chemical and physical properties of LPG led to a better combustion and reduction in pollutant emissions in comparison to gasoline. The results obtained for LPG and gasoline individually are analyzed below.

A. Thermal efficiency vs. load

This is the ratio of output to input. The chemical energy of the fuel is released when combustion takes place. Pressure and temperature rises. It depends upon the compression ratio and the type of fuel used. Limitation on the thermal efficiency is put by several parameters. From the graph it is clear that as the load on the engine increases combustion efficiency increases because at part load cylinder temperature is less with the increase in load on the system, cylinder temperature and pressures both increases simultaneously.

On comparing the Petrol with the Pure LPG Fuel we find that the Thermal Efficiency of LPG is better than that of petrol because of the following reasons:

1) Higher octane rating of the gaseous fuel allows higher compression ratio in comparison to pure gasoline mode.
2) Since LPG enters the cylinder in a gaseous state it allows more proper mixing of fuel and air. Proper mixing means proper combustion and less fuel goes unburnt into exhaust, giving more thermal efficiency.

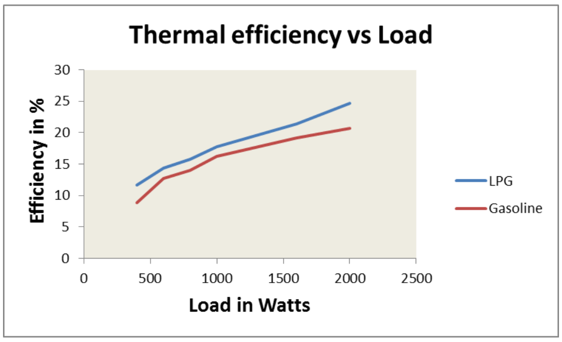

Fig. 2. Thermal efficiency vs. load diagram for LPG & gasoline

B. Brake specific fuel consumption (BSFC) vs. load

This is amount of fuel used by the engine generate one kilo watt hour energy.

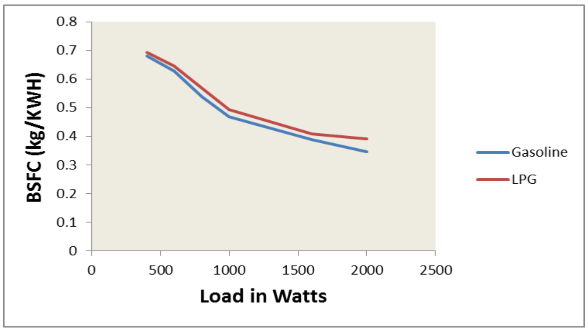

Fig. 3. Brake specific fuel consumption vs. load diagram for LPG & gasoline

Graph above gives variation of BSFC with the Load and comparison between LPG and Petrol. Though the BSFC continuously decreases with the load but fuel consumption rate is higher in case of LPG fuel because LPG is a gaseous fuel its volume is more thus in the induction stroke less quantity of LPG is drawn. In other words it reduces the volumetric efficiency. Lower the volumetric efficiency lower the power output or we can say for the same power output fuel consumption is increased.

IV. CONCLUSION

Thermal efficiency of liquefied petroleum gas operated engine is higher than gasoline operated engine by 14.2%. Brake specific fuel consumption rate of gasoline operated engine is less then LPG operated engine by 3.81%.

LPG and gasoline emit less pollutant in comparison to conventional fuel, so these alternative fuels may be suggested for use.

Burning of LPG in SI engine greatly reduces harmful emissions 0.5115 ppm of CO with respect to gasoline.

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