An Experimental Analysis on Performance Characteristic of Four Stroke Diesel Engine Blend with LPG in Variable Proportion with Diesel

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Abstract— Environmental degradation and depleting oil reserves are matter of great concern round the globe. This study aim to investigate the performance characteristic of mixed fuel LPG and Diesel under compression ignition in an effort to develop highly efficient and low brake specific fuel consumption based CI engine. An experimental investigation was made to evaluate the performance and combustion characteristics of a four stroke, single cylinder C.I. engine with LPG and diesel fuel was blended with diesel in proportions of 10%, 20% and 30% by volume and studied for the load range of No load to Max. load (15 kg), with the engine operated at constant speed. The performance parameters considered for comparing are brake power, brake specific fuel consumption, brake specific energy consumption, brake thermal efficiency etc. of the engine. The performance parameters were found to be very close to that of pure diesel. The brake thermal efficiency were better than pure diesel for the blend B20 under certain loads. From the investigation it may be concluded that B20 (20% LPG + 80% Diesel) gives better performance in comparison to other modified oil. It is also concluded that either blending up to 20% or LPG can be used in diesel engines in rural areas for stationary applications like irrigation, processing of agricultural products and electric generation. From all these observations, it is recommended that the blends LPG with diesel up to 20% by volume is a replacement to diesel fuel for running the diesel engine without sacrificing the power output.

Keywords: LPG, Biodiesel, Duel Fuel Engine, Performance

I. INTRODUCTION

Environmental concerns and depletion in petroleum resources have forced researchers to concentrate on finding alternatives to conventional petroleum fuels. One of the solutions to accomplish this is the use of gaseous fuels in addition to the liquid diesel in CI engine. The utilization of option vaporous fills e.g. flammable gas, condensed oil gas (LPG), etc. is a promising approach for lowering the dependence on petroleum based liquid fuels and to reduce the emissions of CO_2 and other pollutants from diesel engine.

LPG is a viable alternative gaseous fuel (also known as "Auto gas") which is a gas result of petroleum refining basically comprising of propane, propylene, butane and other light hydrocarbons .It can be liquefied in a low pressure range of 0.7–0.8 Mpa at atmospheric temperature. So, storage and transportation of LPG is easier than other gaseous fuels. LPG has high calorific value compared to other gaseous fuels and also it has high octane number but a low cetane number. In contrast, the low cetane number of LPG makes it difficult to be used in large proportions in compression ignition engines, mainly due to high cyclic variation. Thus it can be utilized as a part of the CI engine in the double fuel mode just and in this mode it has been broadly examined. It prompts better execution, low particulate and smoke emanations.

The engine, which uses conventional diesel fuel and LPG fuel, is referred to as 'LPG–Diesel dual fuel engine'. In this engine, LPG fuel is mixed with the air in the engine cylinders either through direct mixing in the intake manifold with air or through injection clearly into the cylinder.

LPG is prepared by refining petroleum or "wet" natural gas, and is almost entirely derived from fossil fuel sources, being manufactured during the refining of petroleum (crude oil), or extracted from petroleum or natural gas streams as they emerge from the ground. LPG has a regular particular calorific value of 46.1 MJ/kg contrasted and 42.5 MJ/kg for fuel oil and 43.5 MJ/kg for premium review oil (gas). Nonetheless, its vitality thickness per volume unit of 26 MJ/L is lower than either that of petroleum or fuel oil, as its relative thickness is lower (around 0.5– 0.58 kg/L, contrasted with 0.71– 0.77 kg/L for gas). As its boiling point is below room temperature, LPG will evaporate quickly at normal temperatures and pressures and is usually supplied in pressurised steel vessels. They are typically filled to 80–85% of their capacity to allow for thermal expansion of the contained liquid. The pressure at which LPG becomes liquid, called its vapour pressure, likewise varies depending on composition and temperature; LPG is heavier than air, unlike natural gas, and thus will flow along floors and tend to settle in low spots, such as basements.

II. LITERATURE REVIEW

A. A.Kumaraswamy et al. [1]

Expressed that the yield of LPG-diesel double fuel engine was not diminished when contrasted with diesel engine. The smoke outflow of the LPG-diesel double fuel engine at high loads was fundamentally decreased, then again, at low loads, SFC and also HC and NOx discharges was expanded. In this way, an electronically controlled plan was produced to control the consuming qualities of the motor such that it would consume just diesel fuel at low loads while LPG-diesel mixes would consume after the motor came to the pre-set point of confinement.

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Studies carried out by the various scientists showed that use of LPG in the diesel engine as dual fuel operation is one of the prominent and effective measures to overcome the fossil fuel scarcity and exhaust emissions. The performance, combustion and emission characteristics of the LPG diesel dual fuel engine have been reviewed from the various experimental studies and indicate that the part load

characteristic can be improved by optimizing the engine operating parameters and design factors such as engine speed, load, pilot fuel quantity, injection timing, intake manifold condition and intake gaseous fuel compositions. The following conclusions are drawn based on the present work on an LPG–diesel dual fuel engine.

C. Roberto Ianniello 1, , Gabriele Di Blasio 1 , Renato Marialto 1 , Carlo Beatrice 1 and Massimo Cardone 2 (Accepted: 15 July 2020; Published: 18 July 2020) (3)*

A comprehensive engine test investigation using LPG–diesel blends was carried out. The approach and the tests were designed and aimed at demonstrating the feasibility and the potential of the application of a new concept using LPG–diesel blends with any injection system modifications. • The first part of the activity was devoted to analyzing the effects of using LPG diesel blends with a conventional common rail diesel injector. The hydraulic characterization assessed the effects of the different compressibility and viscosity of the blends, causing an increase in the injection duration, estimated to be approximately 0.1 ms for both tests carried out. On the other hand, a reduction of the hydraulic delay of 0.35–0.4 ms, and proportionally to the LPG content in the blend, was noted. Therefore, fuel-injected values for almost double the diesel amounts are observed, at the same ET, by using the LPG blend. In general, the blends do not alter the injector performance except for the different opening and closing delays, which can be solved through an appropriate calibration of the engine map.

D. K. Monha Kumar, Dr. D. Azad [2014]*

An extensive exploratory work on the execution and discharge estimation of diesel genset and to change over it into double fuel genset with the help of LPG unit has been conveyed effectively. The results got amid try indicated the feasibility of LPG as double fuel with diesel fuel to replace traditional diesel are high. It has been observed that double fuel has demonstrated a superior over all genset execution and diminishment of NOX. Important conclusion from the investigation is 70% Diesel and 30% LP Gas.

III. METHODOLOGY

In case of LPG– diesel double fuel engine, the air-to-LPG blend from the admission is drawn into the cylinder, and this blend is packed keeping in mind the end goal to expand the temperature and pressure. Toward the finish of the pressure stroke the blend is lighted by the infusion of little amount of pilot diesel fuel. The amount of diesel fuel utilized will be differed relying on the motor working conditions and its design parameters, and generally the amount of pilot diesel required for the ignition is between 10%, 20%, 30%, 40% and 50% of operation on the diesel fuel alone at normal working loads.

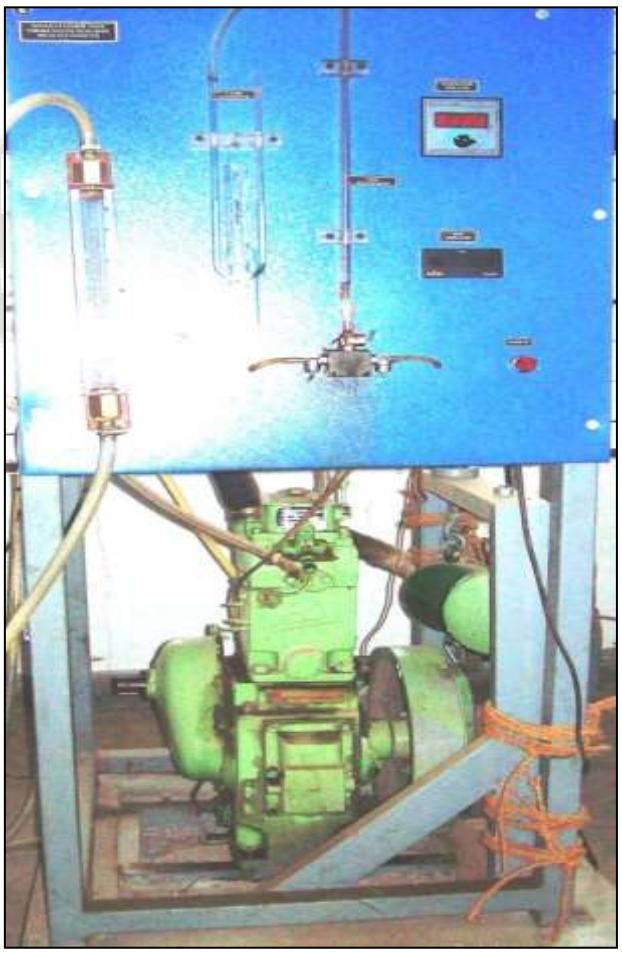
The mass fraction of the LPG used in dual fuel mode is calculated by using the following expression, 'Z':

$$Z = \frac{\text{Mass flow rate of LPG}}{\text{Mass flow rate of Diesel} + \text{Mass flow rate of LPG}} \times 100\%$$

Where Z = 0% represents diesel operation, z = 10%, 20%, 30%, 40%, 50% represent the LPG mass fraction used in dual fuel mode.

The engine was coupled to a dynamometer to provide load to the engine. A sensor is connected near the flywheel to measure the speed. Air intake was measured by air flow sensor that is fitted in an air box. A burette was used to measure fuel flow to the engine via fuel pump. A thermocouple with a temperature indicator measures the exhaust gas temperature. Combustion parameters such as mechanical efficiency, brake thermal efficiency, brake specific fuel consumption, and maximum rate of heat release and emission parameters like exhaust gas concentrations and temperature were evaluated. The experiments were carried out by using various blends (B0, B10, B20, B30) of LPG with diesel at different load conditions on the engine keeping all the independent variables same. For every 5 cc fall in the oil level in the burette, the corresponding time has been noted down. From these data, the values of Fuel consumption, Power measurement , Break mean effective pressure, Break specific fuel consumption, Break thermal efficiency, Air fuel ratio and Volumetric efficiency has been calculated using different formulae.

IV. EXPERIMENTAL SETUP



V. RESULT AND DISCUSSION

The results in this work pertain to LPG-Diesel blend having 20% LPG and 80% Diesel oil (B20). Engine performance at constant speed and variable load are covered in this experimental investigation.

VI. ENGINE PERFORMANCE

A. *Brake Power (kW):*

The brake power produced in case of PB10 and PB20 were slightly better than that of diesel.

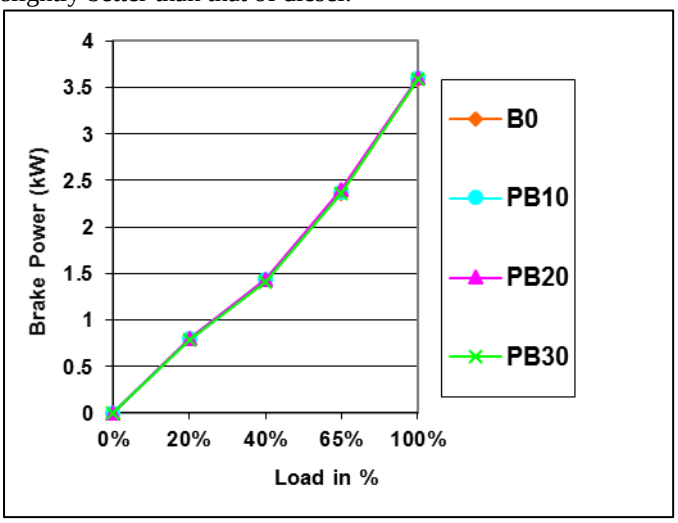


Figure 6.1 – Variation of brake Power with % of load.

B. *Brake Specific Fuel Consumption (BSFC):*

The BSFC for B10 and B20 was lower than that of diesel fuel at lower load conditions.

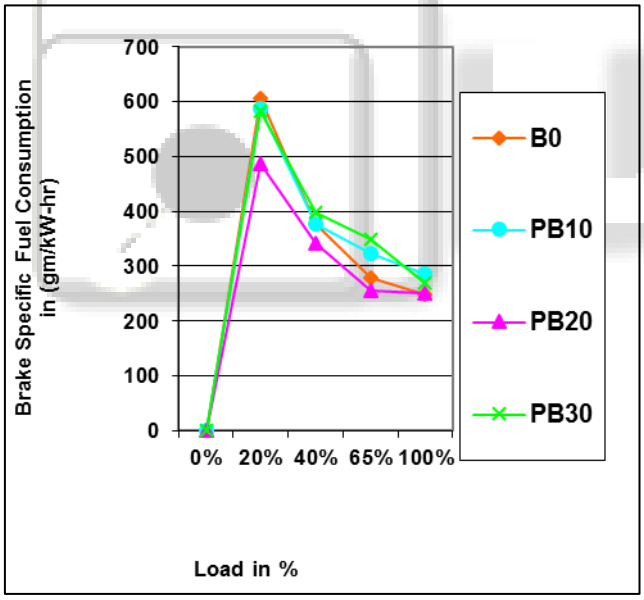


Figure 6.2 – Variation of brake specific fuel consumption with % of load.

C. *Brake Thermal Efficiency (η_B):*

B20 shows higher brake thermal efficiency at lower load conditions compared to that of diesel fuel.

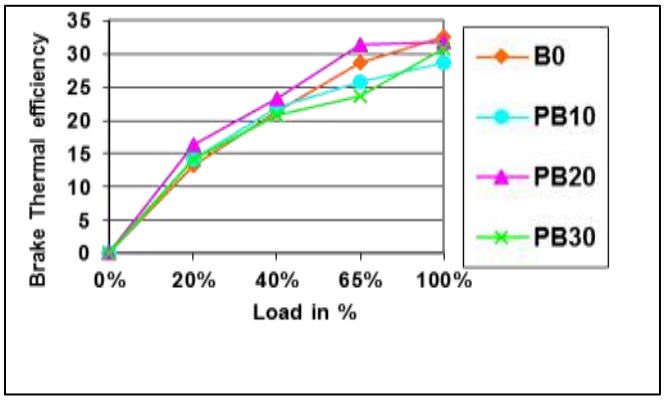


Figure 6.3 – Variation of brake thermal efficiency with % of load.

D. *Volumetric Efficiency ($\eta_{vol.}$):*

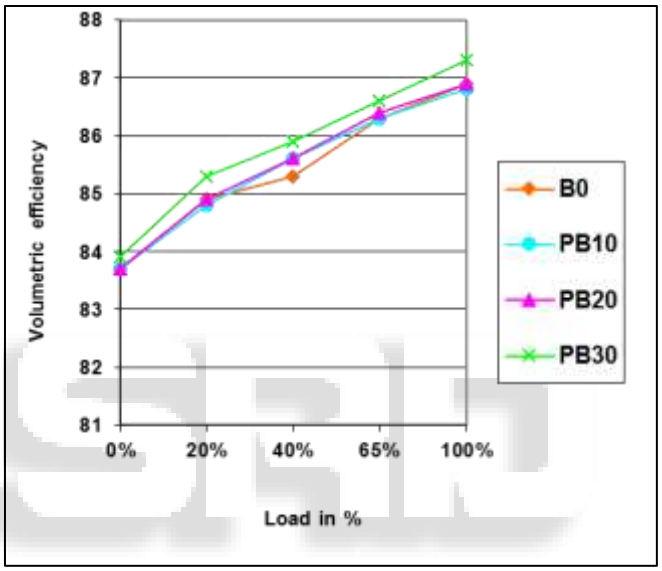


Figure 6.4 Variation of volumetric efficiency with % of load.

E. *Brake Specific Energy Consumption (BSEC):*

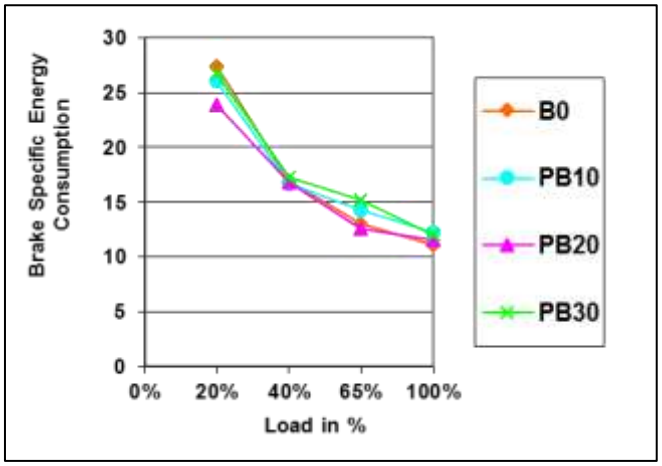


Figure 6.5 – Variation of Brake Specific energy consumption with % of load

VII. CONCLUSION

In the present work, an experimental investigation has been conducted to examine the effects of induction of LPG into

the engine manifold. From the analysis of the experimental data, it is observed that BSFC and BTE improved for the CI engine with B-10 and B-20 as compared with diesel. While at part load, the BSFC increases as well as BTE decreases with increase in LPG substitution, but an improvement was observed for both the parameters at higher loads.

LPG seems to have a potential to use as alternative fuel in diesel engines. On the basis of the observations and the results of the experimental investigations on a single cylinder, four strokes, constant speed, stationary, water cooled, CI engine, run on LPG-Diesel blend and Diesel fuel at different load conditions.

From all these observations, it is recommended that the blends of LPG with diesel up to 20% by volume is a replacement to diesel fuel for running the diesel engine without sacrificing the power output.

VIII. Scope of Future Work

In the present research work conversion of single fuel into dual fuel has yielded promising results. LPG with some type of additives can be tried as a dual fuel with diesel.

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