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Comparative Performance Analysis of Compression Ignition Engine using Biodiesel and LPG as Additive

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Abstract

Increase urbanization of the world leads to increase in fuel demand. Crude oil based fuel such as diesel fuel; petrol and natural gas are the main fuels. Moreover natural resource reservoirs are in specific regions of the world. Many countries of the world along with Pakistan are facing shortage of the petroleum products. Therefore alternative energy resource must be explored in order to cope with the fuel demand. In this research work, a 60 hours endurance test has been carried out on horizontal type single cylinder diesel engine. During endurance test, three fuel samples such as D100 (%diesel as a baseline), B25 (waste cooking oil biodiesel 25% and 75% diesel fuel) and B25+LPG (liquefied petroleum gas and waste cooking oil biodiesel) respectively have been taken to determine the engine performance and noise emission level. Engine performance and noise emission level were taken at constant rpm of 1300 with variable loads from 0.0(no load) to 1.6kg-m at an interval of 0.2kg-m. however analysis of results show that the brake specific fuel Consumption (BSFC) of B25+LPG decrease with increasing the brake power and the brake thermal efficiency increase as increasing the brake power. However, engine noise emission level from three directions such as front back and left show lower noise emission in case of biodiesel and LPG blended as compared to diesel fuel.

Keywords: biodiesed; diesel and LPG.

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1. Introduction

As the natural resource of fossil fuel are decreasing price of crude oil is going to be increased. Therefore it will not be economical to use the products of crude oil such as petrol, diesel etc. The alternative resources must be renewable and green, which can reduce harm full effects in the life of living creatures in the world. The research and scientists are trying to come up with the solution of bio-fuels. Biodiesel and its related blends are known as clean and alternative fuel because the properties of these fuels are similar to that of diesel [1]. Liquefied petroleum gas is another better substitution of diesel fuel in CI engine. The use of LPG in CI engine reduce the environmental pollutant emission, increasing agricultural wealth, fulfill. LPG pre mixed with diesel fuel through air intake valve of CI engine and also reduces the emission pollutants [2]. The transport sector in Pakistan, It consumes 48%, whereas power generation sector 38%, industrial sector has 12% and 2% consumed residential sector as shown in Figure2-1 [3].

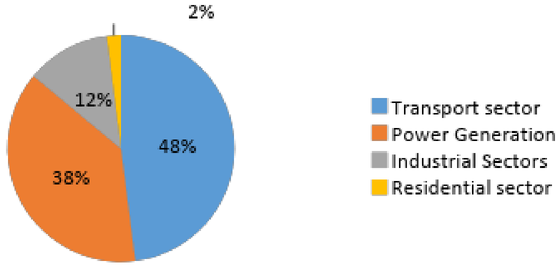

Figure 1: Consumption of crude oil products in Pakistan

2.1. Biodiesel blending

Biodiesel has well miscible with diesel fuel. Biodiesel blended with diesel to improve the quality of the fuel. The physicochemical properties of fuel can be impacted on engine parameters at different fuel percentage of biodiesel blend with diesel fuel [4, 5]. LPG cylinder connected with engine intake valve. In this method, reduced the pollutant emission of the compression ignition engine and increase the combustion process LPG pre mixed with diesel through intake of air valve diesel/LPG fuel increase the efficiency by 8 % at 60% to 80% [6].

2.2. Diesel engine performance characteristics

The performance characteristics of CI engine are a conventional graphical representation the engine performance results collected during run of the engine and compression between different fuel samples. When load increase break specific fuel consumptions increase and increase the smoke with high fuel air ratios. At lower load BSFC increases due to decreased mechanical efficiency [7].

2.2.1. Power and Torque

Some of researchers are investigating that, using biodiesel in compression ignition engine less power is produced because of its lower calorific value [8, 9].

2.2.2. Brake specific fuel consumption

Some researchers have investigated that diesel has lower brake specific fuel consumption (BSFC) than biodiesel fuel. It is because of its lower calorific value [8– 9].Due to high density and viscosity of biodiesel it is increase the brake specific fuel consumption as compared with diesel [10].

2.2.3. The Brake Thermal Efficiency

Brake thermal efficiency can be achieved by the ratio of the brake power and the fuel supplied to the engine. Biodiesel has higher combustion process because of higher level oxygen of content.

3. Research methodology

In this chapter, experimental setup and research methodology have been discussed in detail. The endurance test has been carried for 60hours on each fuel samples. During test, engine performance and noise level have been analysed

3.1. Performance and noise level ci engine

The engine performance tests have been carried out in thermodynamics Lab Mechanical Engineering Department QUEST Nawabshah. In this regards, single cylinder 4 stroke diesel engine is used for performance analysis parameters. The Model name of the test bed is DWE-6/10-JS-DV which is fully equipped with different instruments, engine specification are given in Table 3.1

Table 3.1: Diesel engine test bed specifications

Number of cylinders	1
Cooling System	Water cooled
Type	Horizontal
Piston size (Bore)	80mm
Displacement of piston (Strokes)	95mm (477cc)
Compression Ratio	23:1
Starting Method	Manual
Output/rotational speed	8.5PS/2200 rpm(max)

Two fuel tanks are attached to a diesel engine test bed. One common pipe has been used to supply fuel to the engine. Both fuel tanks connected with common line; however flow can be controlled with two separate valves as shown in Figure 3-2. One tank is filled with diesel fuel (D100) and another is filled on the basis of fuel selection and LPG cylinder has been connected with bypass air intake valve of CI engine. In this research, three fuel samples have been tested named as (DF, B25 and B25+LPG) and LPG has been taken through bypass valve of air intake. In the case of engine performance, engine torque, brake power, brake thermal efficiency and brake specific fuel consumption have been tested. These parameters are determined at constant rpm and variable load. The load varying were selected from 0.2 to 1.6 Kg-m at 1300 rpm

4. Results and discussion

4.1. Fuel properties

The fuel properties are important parameters which effect on combustion process of engine [11]. Biodiesel properties depend on composition of fatty acids. Some properties like cetane number, viscosity and density are depending on the structure of fatty compounds [12]. Some of properties of biodiesel effect on engine noise emission, performance and depositions on injector. It has been investigated that by varying the bio-fuel in diesel fuel, it produces its own in distinguishable properties. In this work, Blend is prepared by the percentage of volume.

Table 4.1: Properties of fuels (diesel and B25)

Properties	**Unit**	**D100**	**B25**	**ASTM Standard**
Kinematic Viscosity 40°C mm2/2 or cSt	mm^2/s	1.98	0.861	D-445
Density kg/m3	Kg/m^3	0.852	0.862	D-1298
Cetane Number		56.9	54.1	D-976
Flash point °C	°C	103	123	D-93
Calorific Value MJ/Kg		44.8	43.6	D-240
Fire Point °C	°C	112	118	D-93
Specific Gravity		0.835	0.848	D-891

Table 4.2: Properties of LPG

Properties	Unit	LPG
Density	Kg/m^3	0.56
	Mj/kg	46.3
Specific gravity at 25C	……… ..	0.495
Boiling point	……… ….	-42.1
Flash point		-104

4.2. ENGINE PERFORMANCE ANALYSIS

The engine performance tests are carried out on a single cylinder diesel engine test. On the same structure dynamometer has also mounted which is also directly coupled with a diesel engine. It can control the brake load on the engine. The dynamometer controller is attached to the panel of the test bed. The engine performance parameters have been divided into 8 discreet points from 0.2 kg-m to 1.6 kg-m load. The performance parameters measured during this work are, brake power, brake specific fuel consumption, brake thermal efficiency and mass of fuel consumption. Three fuel tanks have been attached to a one common line, with separate control valve connected with a diesel engine. One tank is filled with diesel fuel, where as another is filled with prepared biodiesel blended fuel and third one connected through bypass of air intake valve of engine. The Brake thermal efficiency (BTE) is defined as the brake power of a heat engine as a part of heat supplied by the fuel. It has been found that by increasing the percentage of the biodiesel blend the calorific value would be decreased therefore increases consumption of the fuel for a same power output. In this research work, the deviation in BTE was observed as shown in the Fig. 4-1. The thermal brake efficiency of D100 has been rising with increasing load from 0.2KWto 1.6KW of the engine. The BTE of D100 higher then B25 and B25+LPG. The Average BTE of B25+LPG is slightly less than that D100 and B25. It is due to the reason of increases in the percentage of oxygen contents which help to improve the combustion process, therefore due to a higher percentage of oxygen content, it may produce faster combustion process moreover. LPG has higher colorific value which may improve the combustion process.The brake specific fuel consumptions (BSFC) is defined as the brake power of a heat engine as a part of heat supplied by the fuel. The variation of BSFC is depending on engine load, speed and blending ratio of biodiesel and LPG. In this research three fuel samples were used like D100, B25 and B25+LPG. LPG was provided through intake of air valve. BSFC has been calculated from the average of fuel consumption of B25 and LPG. It was observed that Brake specific fuel consumption of B25+LPG is higher than D100 and B25 because of high oxygen content in B25 and high calorific and combustion rate of LPG and B25 high BSFC as compared with D100 because B25 content high oxygen which results lower heating value[13,14].

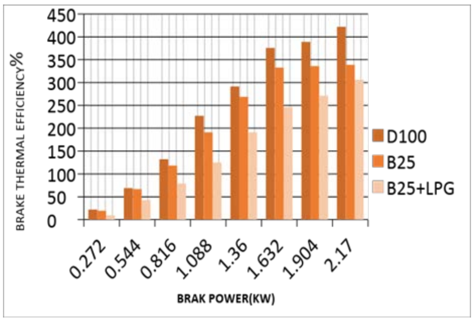

Figure 2: Break thermal efficiency

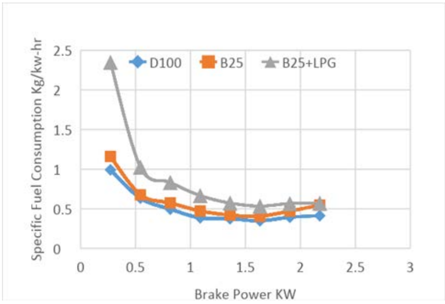

Figure 3: Specific fuel consumption

4.3. Sound pressure level analysis

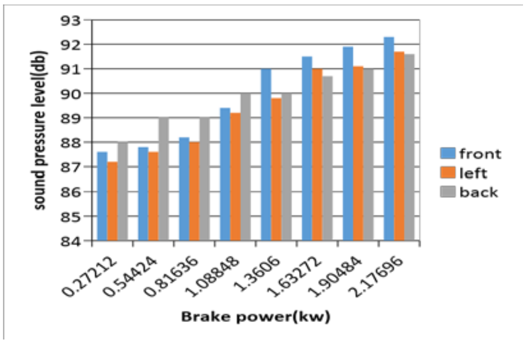

Figure 4: Sound pressure level of D100 at different locations

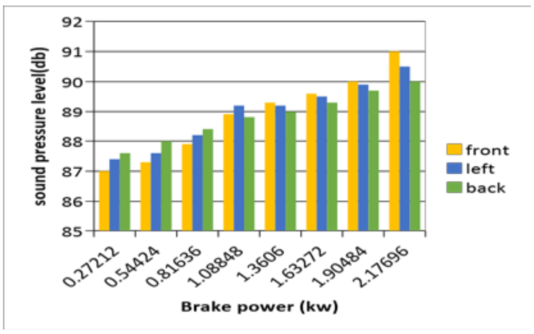

Figure 5: Sound pressure level of B25 at different locations

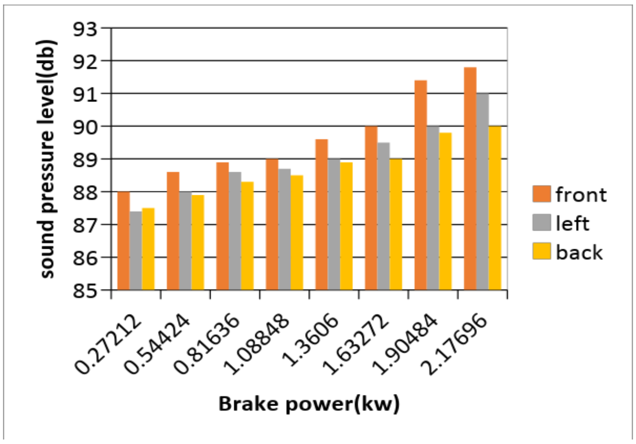

Figure 6: sound pressure level of B25+LPG at different locations

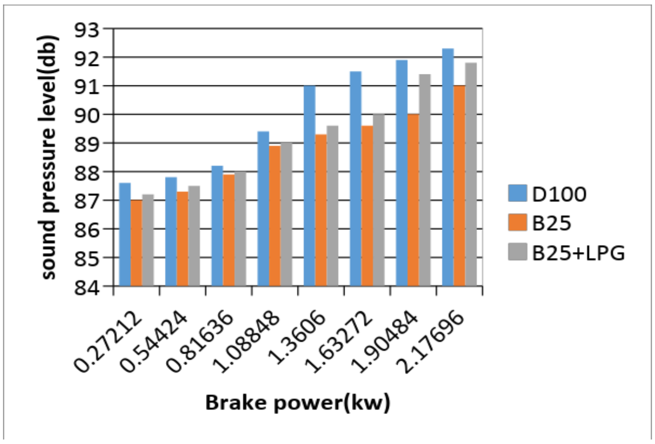

Figure 7: Comparative results of sound pressure level at front positions

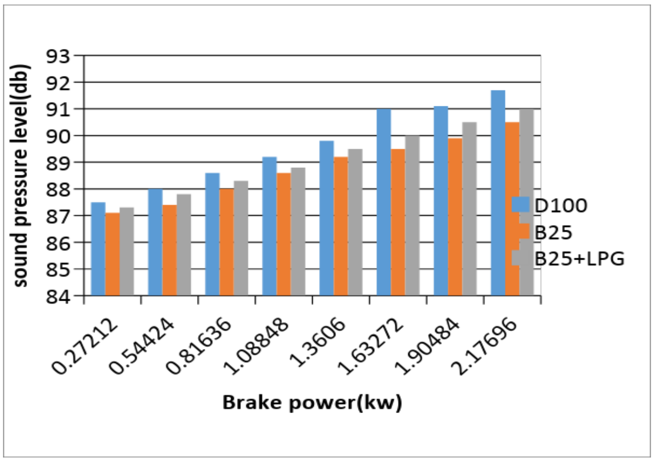

Figure 8: Comparative results sound pressure level left position

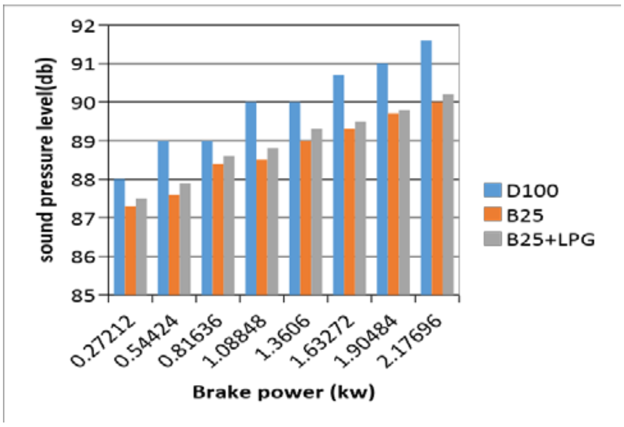

Figure 9: Comparative results of sound pressure level at back positions

All the results of sound pressure level are determined at variable brake loads (0.27212, 0.54424,0.81636, 1.08848, 1.3606, 1.63272, 1.90484 and 2.17696) and constant rpm of 1300. As shown in the Fig. 4-8, position of Front side showed a higher sound pressure level as compared to the Back and left side. In this work results show that while using diesel fuel (D100) in the engine, it has emitted highest sound pressure level than biodiesel blend (B25). But, while using biodiesel blends with additive of B25 + LPG it reduces further sound pressure level because of higher oxygen contents present in the fuel and high combustion rate of LPG and calorific value of LPG. The cetane number is an important parameter to be known as ignition delay. Cetane number takes an important role during compression ignition. With this number (cetane number), if the cetane number is higher it produces shortest ignition delay [15].B25 have less sound pressure because of more oxygen available as compared with diesel fuel on other hand LPG produced lower noise emission due to high colorific value and high combustion.

5.1. Conclusions

- The results of fuel properties show that, B25 has less heating value than D100 and B25+LPGbecause B25 contain higher oxygen level compared to other two fuel samples. Whereas Kinematic viscosity, Cetane number, flash point, Fire point and Specific gravity are higher than D100 and B25+LPG
- The brake specific fuel consumption (BSFC) of D100 and B25 is lower than B25+LPG, where as BSFC of B25 is increasing at initial load After 1KW of load BSFC shows similar behaviour like diesel fuel.
- The BTE of diesel is higher than B25 and B25+LPG fuels.
- The results of sound pressure level show that, D100 results higher sound pressure level due to its higher heating value, less Cetane number, low lubricity and low oxygen contents. Whereas B25 resulted higher than B25+LPG.

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