Influences Of Fuel Injection Pressure On CI Engine Performance And Emission Of Lemon Grass Methyl Ester As Fuel

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Abstract— The compression ignition engine widely used in industrial and automobile sector, this engine operates by using fossil fuel and emits the harmful emission from engine exhaust the harmful exhaust emission are affected human and environment also. So, reducing exhaust emission researcher are moves in to fuel modification and some engine modification. It causes significantly reduces emission and increasing the performance of engine. The fuel modification is required to CI engine for improving performance. The alternate fuel lemon grass methyl ester is suitable fuel for diesel engine. In order to improve the performance some changes required in the diesel engine, so varying the injection parameter like fuel injection pressure. The fuel injection pressure is one of the most parameter for engine modifications. This investigation is carried out find the optimum injection pressure in the diesel engine by using lemon grass methyl ester. The lemon grass plants sample is collected, dried and powdered. The powdered samples are subjected in to chemical solvent such as N-Hexane. Thus solvent are extracted oil from the sample. The Extracted oil converted in to methyl ester by transesterification process. Thus the lemon grass methyl ester (LGME) is blended with neat diesel in proportion of 20% of LGME and 80% of diesel. The blended LGME are investigate in Kirlosker-AV1 and compared to diesel. The investigation to be carried out in modified fuel injection pressure from 210 bars to 240 bars steps in 10 bars with variable load. According to the results, the performance wise best fuel injection pressure is 240 bar has been obtained for all loads, 240 bar fuel injection pressure gives lower smoke and HC, 210 bar fuel injection pressure shows lower NO_X.

Keywords: LGME, Fuel Injection Pressure, Transesterification, UBHC, NOx.

1. INTRODUCTION

The compression ignition engine is a type of internal combustion engine and its operation in diesel and Otto cycle. Spark ignition engine low efficient when compared to diesel engine. The diesel engine is generating more torque and more emission than the spark ignition engine. So further development is required for improve performance change some fuel injection parameter such as fuel injection pressure. This modification is essential for high viscosity fuel whenever high viscosity fuel generate poor spraying and atomization that causes increase hydrocarbon emission and reduces performance of engines. Lemon grass is naturally and artificially cultivated in many of state in India. It has oil content and commercially available so this most one of the best feed stock for biodiesel production. The lemon grass biodiesel are used in diesel engine. It has higher viscosity compared to diesel. The fuel injection system in a direct injection diesel engine is to achieve a high degree of atomization in order to enable sufficient evaporation in a very short time and to achieve sufficient spray penetration in order to utilize the full air charge (1). Diesel fuelled vehicles discharge significant amount of pollutants like CO, UHC, NOx lead, soot, which are harmful for environment and society. However, to overcome this menace, the bio-fuels are being used as alternative fuels in IC engines. For complete combustion of the fuel in the cylinder the fuel injection parameters are play a major role in engine.

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The major parameters are mainly fuel nozzle holes, fuel droplet size and fuel injection pressure (2).The modification fuel injection pressure happening in the diesel engine improve the atomization of fuel (3). The oxygen content and high cetane number of biodiesel can reduce the production of exhaust pollutants by improving the combustion, but its high viscosity deteriorates the atomization of the injected fuel. Particularly at low engine speed conditions like idle, poor atomization and low air-flow in the cylinder deteriorates the combustion efficiency. Increasing the fuel injection pressure is one of the effective methods to improve fuel atomization (4). Nowadays researchers have reported the possibility for the production of biodiesel from algae oil because of its high lipid content in nature. In the present study, algae methyl ester is used as the biodiesel in the direct injection (DI) diesel engine (5). The general optimum biodiesel blend AME20 was used in diesel engine. The optimum blends further investigation to be carried out in diesel engine with varying fuel injection pressure, which gives better results. Ester of honge oil was used in CRDI engine which gives higher break thermal efficiency in the increasing fuel injection pressure (6). Mahua biodiesel were used in diesel engine blend of B25 (75% Diesel+25% Mahua biodiesel) at various fuel injection pressures and also added nano additives in mahua B 25 (7). Investigation was carried out on the engine at constant speed 240bar pressure which shows higher BTE. Simarouba biodiesel were used in CRDI engine with combination of three fuel injection pressures like 600 bars, 800 bars and 1000 bars. The simarouba biodiesel in 1000bar fuel injection pressure increase the performance and reducing emission (8). Most of alternate fuel such as biodiesel having higher viscosity that is affects fuel atomization. The waste cooking oil (9) are used IC engine with higher injection pressure in order to increase break thermal efficiency. Canola (10) biodiesel are used in IC engine will gives better performance compared to diesel, further investigation is carried out in canola biodiesel with various fuel injection pressure 1% to 2% break thermal efficiency is increased. Mahua (B50) was used as an alternative fuel. Metal oxide Nano-particles were then added to mahua biodiesel to prepare novel hybrid fuel blends. Biodiesel-nanoparticles blends were prepared with the aid of an ultra-sonicator and the nanoparticles used in the mass fraction of 100 ppm. Experimental investigations were carried out on a single cylinder four-stroke diesel-engine fuelled with biodiesel - nanoparticle blends at different fuel injection pressures (11). In this study lemon grass methyl ester as fuel for CI engine in the modified fuel injection pressure and to analyze optimum fuel injection pressure.

2. Material and Methods

Lemon grass biomass sample was harvested and collected, collected sample dried in the shadow dry about 3 to 4 days, then the dried sample converted in to powder. Powdered sample are filled in container and chemical solvent N-Hexane are added in the sample, after 70 to 80hrs the oil extracted from the sample. The extracted lemon grass oil converted in to lemon grass methyl ester (LGME) through the transestrification process and physio-chemical properties were analyzed as shown in Table.1 and compared to diesel. The LGME blended with diesel is 20% of LGME and 80% of diesel (B20). The Blended LGME can utilized in Kirlosker AV-I diesel engine with various injection pressure and study the performance, emission and combustion characteristics.

Properties Table -1

Properties	Diesel	**LGME(100)**
Specific gravity @ 15/15°C	0.8235	0.8866
Kinematic viscosity at 40°C (CSt)	3.06	4.11
Flash Point (°C)	44	56
Fire Point (°C)	48	61
Pour point (°C)	-22	-20
Gross calorific value (kJ/kg)	44000	43942
Density at 15°C (gm/cc)	0.8381	0.8858
Cetane number index number	52	50.3

3. EXPERIMENTAL SETUP

The experimental investigations were conducted in a Kirloskar TV-I DI diesel engine. The specification of the test engine was given in table 2. A single cylinder 4-stroke water cooled diesel engine with 3.2 kW brake power at constant of 1500 rpm was used in this study. The engine was coupled to an eddy current dynamometer with control systems. The engine is equipped with crank angle sensor, piezo-type cylinder pressure sensor, thermocouples to measure the temperature of the water, air and exhaust gas. Di-gas analyzer was used to measure the emissions from the exhaust gas. AVL smoke meter was used to the smoke density from the engine exhaust gas. The schematic view of the experimental setup was shown in the figure 1.

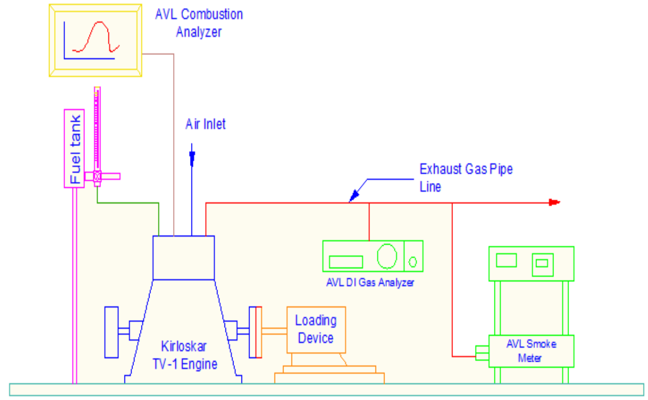

Figure-1 *Experimental Setup*

Table-2 *Specification of Test Engine*

TYPE	**Vertical, water cooled, Four stroke**
Number of Cylinder	One
Bore	87.5mm
Stroke	110mm
Compression ratio	17.5:1
Maximum Power	5.2kw
Speed	1500rev/min
Dynamometer	Eddy current
Injection timing	23(before TDC)
Injection pressure	230kgf/cm^2

4. RESULT AND DISCUSSION

The experiment is carried out in the single cylinder, four-stroke, water cooled diesel engine. The experiment is conducted with neat diesel fuel and with lemon grass methyl ester blend (B20) with various injection pressure such as, 210bar, 220bar230bar (std) and 240bar.

4.1. Performance Characteristics

4.1.1. Break Thermal Efficiency

The figure 2 shows break thermal efficiency against break power, when increasing break power with increases break thermal efficiency. Break thermal efficiency of diesel is26.5%, LGME B20@230bar fuel injection pressure is 27% in the maximum load and theLGMEB20@240bar fuel injection pressure is 28%. LGMEB20@240bar is higher break thermal efficiency compare to other fuel injection pressure reason is better spraying, atomization and complete combustion of fuel.

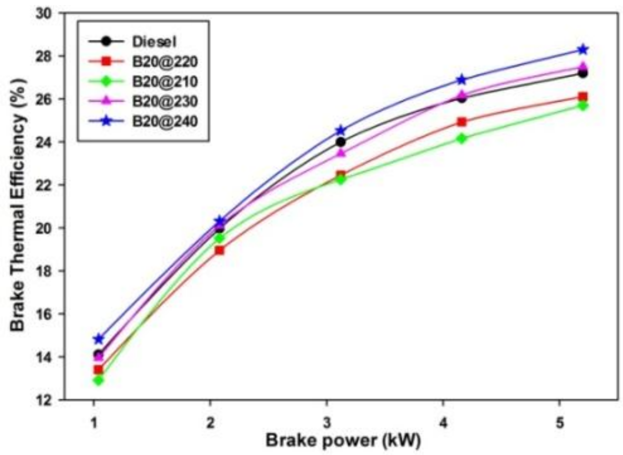

***Figure-2**. Brake Power Vs Break Thermal Efficiency*

4.1.2.Break Specific Fuel Consumption

The break specific fuel consumption is reduced with increasing break power at different fuel injection pressures for diesel was presented in fig 3.The LGM E B20240bar fuel injection pressure lower fuel consumption compare to other fuel injection pressure and diesel .This result due to when increasing fuel injection pressure the fuel drplets size decreases and then fuel drplet momentum also decrease causes reducing fuel consumption.

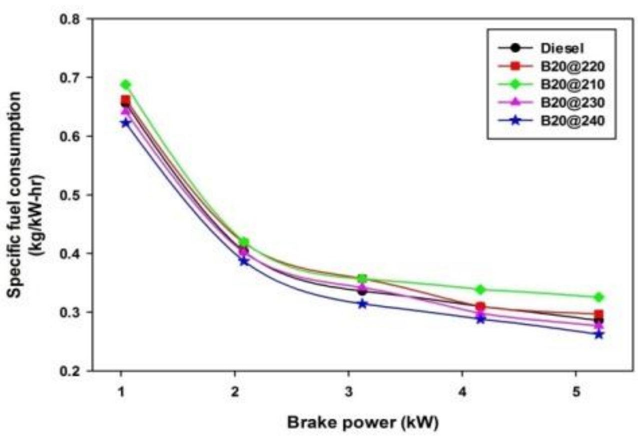

***Figure-3**. Brake power Vs. Specific Fuel consumption*

4.2.Emission Charecteristics

4.2.1.Unbuened Hydrocarbon Emission

The Figure-4 shows unburned hydrocarbon against break power,while increasing break power with increases unburned hydro carbon emission (UBHC). The UBHC diesel is 137 ppm, LGME B20@230 bar fuel injection pressure UBHC is 119ppm and LGME B20@240bar fuel injection pressure UBHC is 110 ppm that is maximum reduction compared to advanced fuel injection pressure of LGME.The increasing fuel injection pressure lead to improvefuel spray, reduced physical delay of fuel due to proper diffusion and comlete combustion which results lower emission.

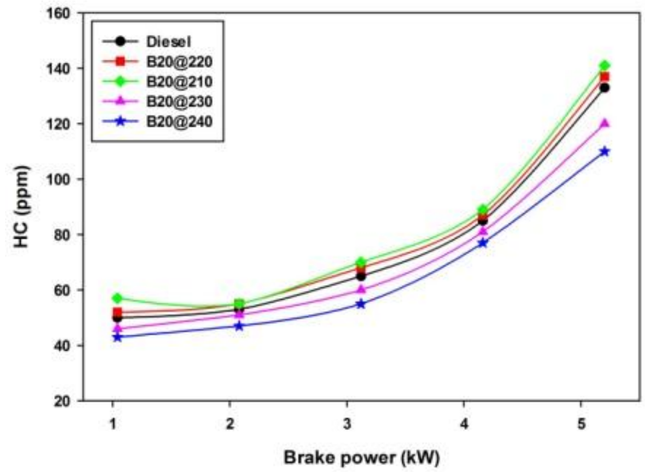

***Figure-4** Brake Power Vs. Hydrocarbon*

4.2.2.Carbon monoxide

The carbonmonoxide emissions against break power at different fuel injection pressure of LGME B20 and diesel as shown in Figure-5. Decreasing injector opening fuel injection pressure like 220 bar and 210 bar increases carbon monoxide emission dueto poor atomization and poor mixing process. The increasing fuel opening injector pressure of LGME B20@240bar the carbon monoxide emission is reduced and compared to diesel,thehigher viscosity of LGME B20 increases injection pressure improved better mixing, atomization and greater combustion efficiency of fuel.the LGME is produced higher break thermal efficiency lead to lower CO emissions.

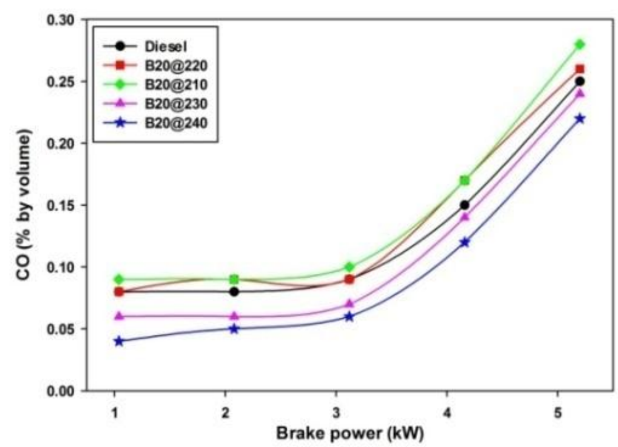

***Figure-5** Brake Power Vs. Carbon monoxide*

4.2.3.Oxides of Nitrogen

In the Figure-6 shows NOx variation with increasing break power at all fuel injection pressures for LGME B20 and pure diesel. Inthis graph when increases NOx emission wifh increasing break power.The LGME B20 in advanced fuel injection pressures shows lower NOx emissions than that of other fuel injection pressure and diesel this may due to higher viscosity of LGME fuel is generate lower combustion tempetrature.The retarded fuel injection pressure 240 bar is shows higher NOx emission leads to comlete combustion and higher combustion temperature of fuel.

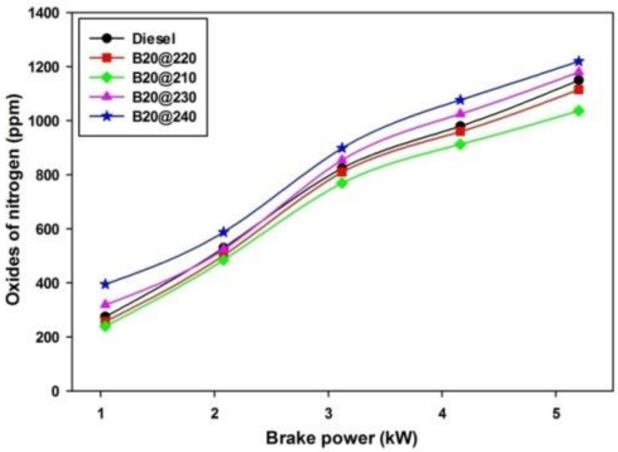

Figure-6 *Brake Power Vs. NO_X*

4.2.4. Smoke Density

Smoke Density has increased with increase in engine break power as shown Figure-7. This is because of the amounts of fuel per unit time increases as the engine load increases consequently, smoke increases. The smoke density of diesel fuel is 78HSU at maximum break power. The advanced fuel injection pressures of LGME B20 shows higher compare to diesel this may due to incomplete combustion. The retarded fuel injection pressure (240bar) of LGME B20 smoke density is 70HSU is lower than that of diesel and advanced fuel injection pressures. The reduced smoke density lead to complete combustion occurs.

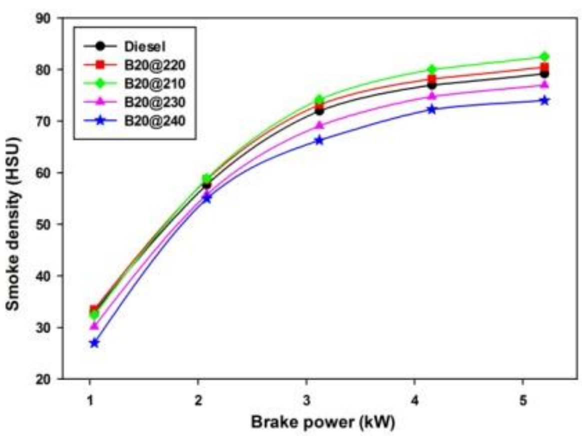

Figure-7 *Brake power vs Smoke density*

4.3. Combustion Characteristics

4.3.1. Heat Release Rate

The heat release rate with respect to crank angle at various fuel injection pressure for 100 cycles as shown in fig 8.The heat release rate of LGME B20 at 240bar fuel injection pressure shows maximum compare to diesel and other retarded fuel injection pressures. This may due to complete combustion occurs in the cylinder causes NOx is increased. In the advanced fuel injection pressures of LGME B20 are lower heat release rate leads to lower combustion temperature due to poor atomization of fuel.

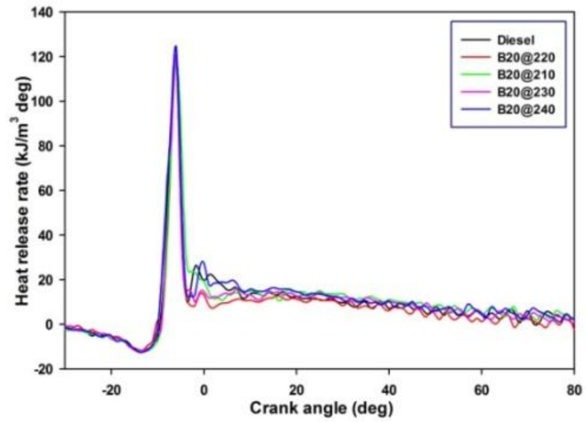

Figure-8 *Crank Angle Vs. Heat Release Rate*

4.3.2. Cylinder Pressure

Figure-9 shows cylinder pressure with respect to crank angle at various fuel injection pressure of engine for the LGME and diesel. The cylinder pressure of diesel is 62.4bar and LGME B20 at 240 bar is 66.2bar.The LGME B20at 240 bar is higher than that of diesel and other advanced fuel injection pressures due to better atomization of fuel. The higher viscosity of LGME B20 in advanced fuel injection pressures leads lower cylinder pressure.

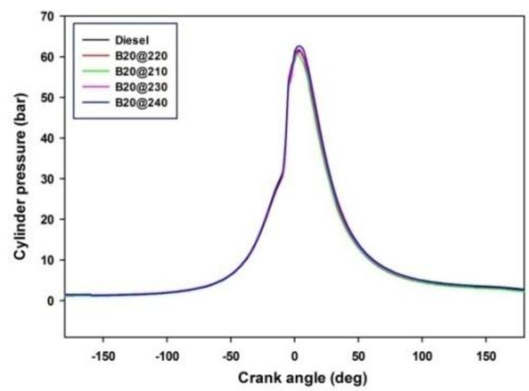

Figure-9 *Crank angle Vs. cylinder pressure*

5. CONCLUSION

The following results were observed from the experimental investigation of LGME B20 in the single cylinder diesel engine. The break thermal efficiency of LGME B20 at 240bar fuel injection pressure is higher and the specific fuel consumption of LGME B20 at 240bar fuel injection pressure is decreases than that of diesel. The advanced fuel injection pressure of LGME B20 is lower break thermal efficiency and higher specific fuel consumption of fuel. The combustion wise UBHC, CO and smoke density of LGME B20 at 240 bar fuel injection pressure were maximum reduction than that of diesel and other fuel injection pressures. The NOx emission of LGME B20 at 210bar fuel injection pressure is reduced compare to diesel and other injection pressures. The combustion wise heat release rate and maximum pressure in cylinder of LGME B20 at 240bar fuel injection pressure is higher combustion temperature and higher heat release rate compared to diesel and other fuel injection pressures. On whole the optimum fuel injection pressure is 240 bars in the lemon grass methyl ester of B20 blend.

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