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Performance and emission characteristics of a constant speed diesel engine fueled with Rubber seed oil and Jatropha oil (Dual fuel) blended with pure diesel fuel

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Abstract: *The continuous increasing price of petroleum fuels and demands enforces the researchers to concentrate on the different biodiesel fuels collected from non edible oil, have the physical and chemical properties which are closer to the diesel fuel. But, the high viscosity and density are the major problems for all the biodiesels. If those bio fuels were directly used in the engine, the fuel injection capacity will be reduced and the complete combustion will not take place inside the engine. By increasing the use of fossil fuels and burning of petroleum fuels, the emissions such as Carbon dioxide (CO_2), Carbon monoxide (CO), Unburned Hydro Carbons (UHC), Nitric Oxides (NOx) will be increased which affects the environment. In this experimental study, it was investigated the effects of injection pressures on the performance and emission characteristics of a constant speed (1500 rev/min) diesel engine at constant injection timing. In the diesel engine a dual fuel such as Rubber seed oil and Jatropha oil 20%, blended with diesel fuel was used. The test was concentrated on maximum injection pressure of 240 bar and 24^0 of injection timing which were maintained while running the diesel engine. The test results of the 20% of biodiesel were presented such as the specific fuel consumption (SFC) and Brake thermal efficiency (BTE) were reduced. Also the emission characteristics namely CO_2, CO, NOx were less compared to the other biodiesel blends.*

Key Words: **Rubber seed oil, Jetropha oil, performance analysis, emissions.**

1. INTRODUCTION

The renewable source of biodiesel can be used to reduce green house gas emission and minimize the carbon footprint of agriculture. It also maintains less to global warming because the carbon emission in the fuel was reduced from the air. The pure biodiesel used in the engines frequently reduction of life cycle emission characteristics of total particulate matter, carbon monoxide and sulfur oxides, carbon dioxide (32%, 35%, 8%and 28%) reductions, respectively, relative to petroleum fuel. From the vegetable oil animal fat which is used or not used to produce the clean burn of biodiesel was produced.int is replacement of petroleum fuels. The biodiesel have high viscosity and density compared to the conventional petroleum fuels. The esterification process was introduced to reduce the viscosity and density and increased the combustion efficiency of the biofuel. The biodiesel produces considerably less harmful emissions than regular petroleum diesel when burned in a internal combustion engine but, using biodiesel emits higher levels of nitrogen oxides (NOx), pure biodiesel emits up to 13% more than the NOx of pure diesel.

The different injection pressures of 170, 190,210 and 230 bars were used in constant speed, DI diesel engine. The biodiesel of Sea lemon oil blended with the diesel fuel and studied the performance and emission characteristics of modified engine. The smoke emissions and unburned hydrocarbon were reduced, creasing of injection pressures the brake thermal efficiency also increased Hariharan.v.s[1]. the effect of advancing the injection timing and increasing the injector opening pressure (IOP) maximum 220 bar used in tested engine the brake specific energy consumption was reduced and increased the peak pressure. It also studied the combustion performance and P-θ characteristics of a CI engine operating on 20% biodiesel fuel like Jatropha oil blended with diesel. Barboza A.B [2]

The constant speed dual fuel direct injection diesel engine was used to analysis the performance such as brake thermal efficiency, brake specific fuel consumption, power output. For combustion studylike peak pressure, rate of pressure rise and heat release rates were evaluated. In addition that emission parameters such as carbon monoxide, carbon dioxide, un-burnt hydrocarbon, nitric oxide and smoke opacity of biodiesel blended with the diesel also studied, it was concluded that the brake thermal efficiency, brake specific energy consumption increased using Jatropha methyl ester. The emission

characteristics of CO2, CO and HC slightly lower that the diesel fuel and the NOx emissions were increased compared to the diesel fuel. Bhupendra Singh Chauhan [3].

To improve the Brake thermal efficiency and reducing the specific fuel consumption of jetropha methyl ester blended with the diesel in direct injection constant speed at rated power 3.5kw diesel engine was used. In this study was changed the standard design parameters of compression ratio and injection pressure. The emission characteristics of CO2, CO, HC, NOx and smoke opacity are lowered compared to the diesel fuel while increasing the compression ratio and injection pressure of the tested engines. Finally it was found that CR of 18 and 250 bar most suitable for agricultural applications. Jindal. S etc [4].

The ethanol mixed isopropanol blended with the diesel fuel at different composition (10% and 15% in volume) in four strokes, four cylinders turbocharged indirect injection Diesel engine. In this study the different injection pressures was followed such as 150, 200 and 250 bar at full load condition and analysis the CO, soot and SO_2 of emission characteristics of the tested engine. It was found that NOx increases from 12.5% to 20% power reductions, and increasing injection pressures between the 1500 to 2500 rpm decreased CO and smoke emissions of blended fuels compared to the diesel fuel Ozer Can [5].

The increasing amount of methanol and different injection pressures , injection timing in diesel blend, and the brake specific fuel consumption (BSFC), brake specific energy consumption (BSEC), and nitrogen oxides (NOx) emissions increased as brake thermal efficiency (BTE), smoke opacity, carbon monoxide (CO) and total unburned hydrocarbon (THC) decreased using at 20 Nm engine load and 2200 rpm. Cenk Sayin[6].

The present invigilated was the rapeseed oil methyl ester and the soybean oil methyl ester blended with the diesel fuel in four-cylinder diesel engine for tree different injection pressures such as 250, 300 and 350 bar with each of biodiesel fuels. Evaluation of three different fuels showed that, rapeseed and soybean biodiesels have lesser CO and smoke level than diesel fuel but have higher NOx emission for all injection pressures. It concluded that using 300 bar injection pressure of biodiesel given performance and emission valves are same for the diesel fuel Ismet Çelikten [7]. Three different fuels cetane numbers and injection pressures used and analysis the performance and emission characteristics of the engine. In this experimental work 46, 51, 54.5 and 61.5 of cetane numbers (CNs) and 100, 150, 200 and 250 bar of injection pressures were used. It was found 15% to 5% of NOx, SO2 and CO emissions reduced .when the fuel CN is increased for the standard injection pressure, but the injection pressure and cetane number was reduced, the smoke opacity value is increased. With the lower injection pressure, NOx was increased and smoke opacity decreased when the injection pressure is increased to at the maximum pressure of 250 bar the emissions was reduced. When the CN is increased from 46 to 54.5. However, when increasing CN above 54.5, no major increases in engine performance.YakupIcıngur [8].

In this study, the esterified rubber seed oil and jetropha oil blended with the pure diesel fuel was used to determine the performance such as Brake thermal energy consumption and emissions characteristics of CO, HC, NO_x of single cylinder constant speed diesel engine running at 1500 rpm in different injection pressures (200,220 and 240 bar) at also maintained constant injection timing of 24^0.The diesel engine was performed change of ratted power to measure the performance and emissions characteristics with some engine modification. The following properties fuel in table1.

Table1 Properties of Fuels

Property	Diesel	Rubber seed oil	Jetropha oil	Biodiesel (Rubber seed and Jetropha)
Sp. Gravity	0.74	0.82	0.96	0.90
Viscosity at 40^0C(mm^2/s)	4.15	70.2	4.4	4.2
Calorific Value (KJ/kg)	42000	37000	38500	39500
Carbon residues%	0.12	0.19	0.61	0.26
Iodine value	0.067	133.46	120.5	133.32

2. EXPERIMENTAL SETUP AND TEST PROCEDURE

The single cylinder constant speed DI engine was used to evaluate the engine performance and emission characteristics biodiesel. The diesel runs under different load condition at a constant speed of 1500 rpm with the different biodiesel proportions. The diesel engine (Kirloskar made) was directly attached with an eddy current dynamometer for changing the different loads. The different type of measuring device was attached in the test engine such as orifice meter with U tube manometer for measuring air consumption, the one liter burette for fuel consumption and the Separate biofuel fuel tank An

AVL415 smoke meter was provided for measuring the smoke opacity and exhaust temperatures. The test rig was installed with AVL software for obtain various curves and results during testing operation. A five gas analyzer was used measured the emission characteristics such as CO_2, CO, HC, NO_x, and O_2 values from the exhaust gas. The performance and emission test was conducted in 17.5 compression ratio at different injection pressures like 200, 220, and 240 bar at ratted power 4.4 Kw.The test was carried out at different proportions such as biodiesel 20%, blended with the diesel fuel.The performance analysis of the engine at different ratted power was evaluated in terms of brake specific fuel consumption (BSFC), brake thermal efficiency (BTHE) and emissions characteristics of carbon monoxide (CO), carbon dioxide (CO_2), un-burnt hydrocarbon(UHC) and Nitric oxide(NOx). The following specification of the test engine is described in table 2.

Table 2 The test engine specifications

Bore	95.5 mm
Stroke	130 mm
Speed	1500 (constant speed)
Compression ratio	16:1
Rated power	4 HP
Number of cylinders	One
Type of cooling	water cooled - eddy current dynamometer
Injector opening pressure	220 bar
No. of stroke	4 stroke

3. RESULTS AND DISCUSSIONS

3. 1. Specific fuel Consumption (SFC)

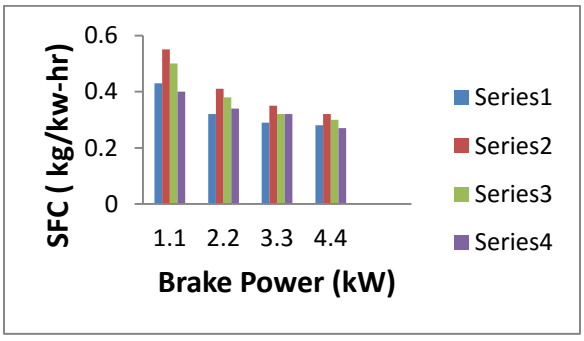

Fig.1 variation of brake power with specific fuel consumption

The comparison of brake power and specific fuel consumption (SFC) as shown in Fig 1.The different pressures such as 200 bar, 220 bar and 240 bar of BSFC were increased at no load condition. The ratted power increased from 1.1 kW to 4.4 kW at 200 bar pressure always increased at zero ratted power then in was deceased from 0.55 kg/kW-h to 0.33 kg/kW-h.The next stage of injection pressure 220 bar was maintained to test the BSFC gradually decreased at minimum ratted power to the maximum ratted power 4.4 kW. The 240 bar used in the test engine the BSFC were reduced from 0.40 kg/kW-h to 0.24 kg/kW-h. The result was the 240 bar full ratted power of BFC always reduced compare to the other biofuel blends. With increasing injection pressures in the C.I engine, ignition delay was reduced and the fuel may be completely burnt.

3.2 .Brake Thermal Efficiency (BTE)

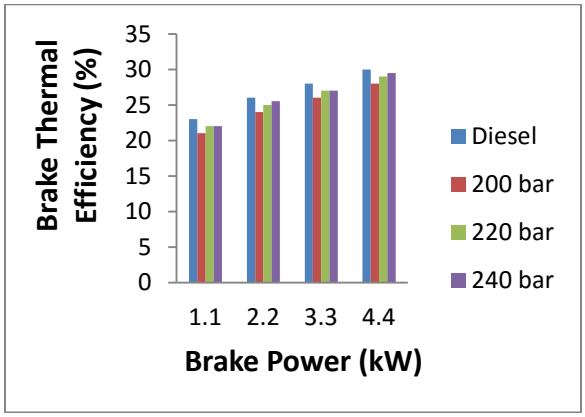

Fig.2 variation of brake power with brake thermal efficiency

Fig 2. Show that the variation of Brake thermal efficiency it rated power. The BTE was increased when the engine load increased. The no load conditions the various from 24% to 30% of diesel fuel. When the injection pressures increased BTE also increased. For 200 bar the BTE increased from 22% to 27% at no load to full load condition. In further increased the injection pressures from 220 bar to 240 bar the BTE were increased from 23% to 29%. The 240 bar at full load condition BTE was slightly equal to the diesel fuel. Thus, the main reason for the increasing in the BTE of biodiesels is the increased the Large amount of heat energy released during the combustion.

4. EMISSION ANALYSIS

4.1 Carbon Monoxide emission (CO)

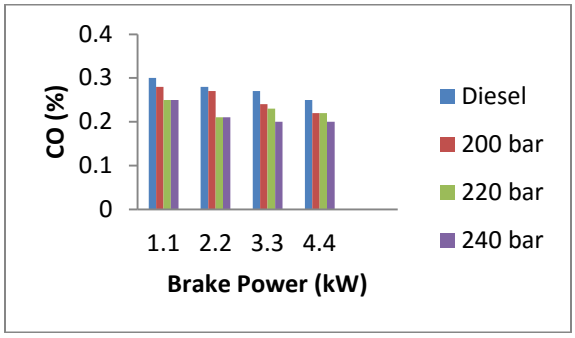

Fig.3 Variation of brake power with carbon monoxide

Fig. 3 shown that the variation of carbon monoxide to brake power. CO was increased the product of incomplete combustion, which is that decreasing of air fuel ratio. The increasing of exhaust temperature the CO emission also increased. The four type of rated power were considered and increasing the load to analysis the CO emission. In single cylinder constant speed engine with the modification of inlet spring at the different pressures like 200 bar, 220 bar, and 240 bar the CO was analyzed using the exhaust gas analyzer and smoke meter. While CO emission of diesel engine decreases from zero load to the full load. Using dual fuel of rubber seed and jetropha oil the CO decreased in different proportions with compared to the other biodiesel. It was concluded that increasing the injection pressure of 240 bar given that the best proportion for reduction of Carbon monoxide.

4.2Carbon Dioxide emission (CO_2)

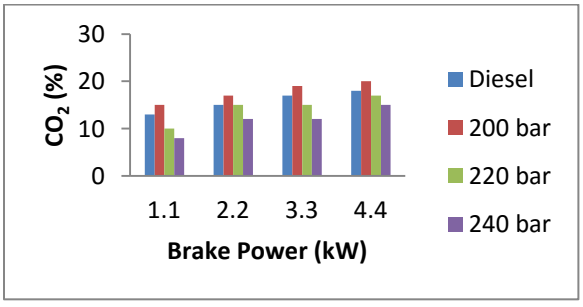

Fig.4 Variation of brake power with specific fuel consumption

The variation of CO_2 emissions characteristics of B20 biofuels with pure diesel are shown in Fig. 4. In the diesel fuel CO_2 emission was high compared to the 220,240 bar from the low load to full load condition, because This is biofuel take the continues esterification process and removing of ester deducing the viscosity and increasing the oxygen element from the vegetable oil; the carbon content was lower in the same volume of fuel consumed at the tested engine load, therefore CO2 emissions from vegetable oil and its blends are lower but during the combustion period the exhaust temperature blended fuel was increased. In this result 200 bar of injection pressure the emission increased compared to the diesel fuel up to 5% from the 25% load to full conditions. In addition that 220 bar injection pressure 5% different in 25% load to 75% load conditions. In 240 bar injection pressure CO_2 was very low at compare to the diesel fuel. After that load increased in 100% CO_2 increased but it compare to the diesel considerable lower at the rate of 3%.it concluded that the injection pressure was increased the CO_2 emission decreased and this experimental result using 240 bar injection pressure in single cylinder constant speed engine at B20 of rubber seed and jetropha oil given that the best result compare to the other injection pressures.

5. CONCLUSIONS

The present investigation was using single cylinder constant speed diesel engine fueled such as rubber seed and jetropha oil blended with the diesel fuel. The 20% of esterified biodiesel blended with the diesel fuel to analysis the performance emission characteristics of the engine. The engine was modified with the different injection pressures like 200 bar, 220 bar, and 240 bar at 240 BTDC. As fuel injection pressures of biodiesel increased, the engine performance improved. The Brake Thermal efficiency (BTE) of the engine was higher and Brake Specific Fuel Consumption (BSFC) of the engine was lower compared to diesel fuel.

From the emission analysis the CO emissions for biodiesel at B20, increase at low engine loads at the ratted power of 1.1 kW, and remain decrease at high engine loads of 4.4 kW.in all injection pressures low engine load the CO were increased and Other loads CO was decreased.

It was accomplished that increasing the injection pressure of 240 bar given that the best proportion for reduction of Carbon monoxide. The second stage emission of Carbon dioxide (CO2) when the load increased from 1.1kW to 4.4 kW in diesel engine was increased. The different types of injection pressures used in tested engine 200 bar of low injection pressure the CO2 was increased upto5% compared to the diesel engine. For 220 bar CO2 decreased compared to the 200 bar. In increasing of injection pressure at 240 bar was very efficient, in that injection

pressure the fuel is completely burnt inside the engine so the CO2 was reduced up to 3% for full load condition. Finally it were concluded that 240 bar gives better efficiency and considerably less emissions.

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