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Performance Testing On IC Engine Using Diesel MixedWith Neem Castor Oil

*1 Naseeb Khan, [2]Mohammed Sohail, [3]N Raja Srikanth, [4]Syed Azam Pasha Quadri

[1]*Head of the Department, Department of Mechanical Engineering, Shadan College of Engineering & Technology, 500086.*

[2]*Assistant Professor in Department of Mechanical Engineering, Shadan College of Engineering & Technology, 500086.*

[3]*Associate Professor in Department of Mechanical Engineering, Shadan College of Engineering & Technology, 500086.*

[4]*Vice Principal, Head of the Department, Department of Mechanical Engineering, Lords Institute of Engineering & Technology,500091.*

ABSTRACT
The aim of the present investigation is to study the performance characteristics of single cylinder four stroke direct injection diesel engine using Neem castor oil as an alternate fuel. Here castor seed oil is used in the form of blends at various proportions with diesel. High viscosity is one important difference between Neem castor oil and commercial diesel fuel. A single cylinder, fourstroke, constant speed, water cooled, direct injection diesel engine is going to be used for the experiment. The performance characteristics of engine are determined using Neem Castor oil blends with diesel. These results are compared to those of pure diesel.

The performance of the engine will be measured using Lab view software. After acquiring the experimental data they will be analyzed for various parameters such as brake thermal efficiency, brake specific fuel consumptions (BSFC). The engine is expected to run with reduced emission levels with acceptable engine performance. It is concluded that Neem castor non-edible oil can beused as an alternate to diesel. This usage of Neem castor oil has a great impact in reducing the dependency of India on oil imports.

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I. INTRODUCTION

A number of researchers and scientists conducted performance tests on compression ignition engines using different vegetable oils and biodiesel derived from different feedstocks. The performance parameters such as power output, specific fuel consumption, exhaust gas temperature and brake thermal efficiency of different vegetable oils and biodiesel have been reviewed in a detailed manner in the subsequent paragraphs. Dharmadhikari et al. (2012) studied and experimented on fuelled single cylinder compression ignition DI engine with the blends of mineral diesel and biodiesel at different injection pressures. He observed that the optimal value of injection pressure is 200 bar in range of 180-200 bar. Investigator evaluated parameters are brake thermal efficiency, brake specific fuel consumption and emissions. He used biodiesel chemically known as mono alkyl esters of FAME type derived from renewable lipid sources obtained from Tran's esterification to avoid few problems. Although, he conducted experiments on esterified palm oil and observed that torque, brake power, SFC and brake thermal efficiency were found comparable to that of diesel fuelled engine. He used Neem oil biodiesel (neem oil methyl ester NOME) or karanja oil biodiesel (karanja oil methyl ester KOME) blended with mineral diesel in diesel engine. However, the experiments revealed that there are certain differences in physical and chemical characteristics of NOME/KOME and diesel oil. He proved that biodiesel can be directly mixed with diesel fuel and is used for running the engine. He observed that biodiesel and diesel has density close to that of mineral diesel. Results of the experimental investigation done on engine with blends of diesel and methyl ester of karanja and neem oil in various proportions, showed that brake thermal efficiency increased with an increase in injection pressure and brake thermal efficiency of B10, B20 and B60 are better than B100.He lastly concluded that the emissions of CO and HC are reduced while NO_X emissions are increased when compared to diesel. Amba Prasad Rao et al. (2012) studied on the injection parameters and its influence on engine performance andemissions. The experimentation was carried out on various injector nozzle hole sizes. It was observed that spray tip penetration is reduced due to the low spray momentum. His experiments revealed that the diesel engine has high injection pressures with small nozzles, which reduces injection duration and improves combustion efficiency. From his experimentations on different oils, he observed that the vegetable oil has thermo-physical properties close to petro-diesel. And use of biodiesel in engines will reduce the emissions of CO, HC and PM exhaust compared to petro-diesel fuel. But with the use of neat biodiesel, the emission of NO_X increases and can be reduced by retarding of injection timing or employing exhaust gas recirculation (EGR).He stated that the injection timing and fuel nozzle hole size have got strong influence on the performance and emissions of engines with biodiesel and diesel blends, as he noticed that diesel sprayatomization and combustion can be controlled by the geometry of nozzle. And rather than biodiesel fuel, the biodiesel blends have better performance with optimized values of fuel injection pressureand nozzle hole size. He concluded that the NO_X levels are lower for retarded injection timing andHC emissions would be obtained with advanced injection timings.

Lakshmanan et al. (2010) have carried out the experimental investigation of timed manifold injection (TMI) of acetylene in direct injection diesel engine in dual fuel mode. To carry out the experiment an air cooled stationary diesel engine with rated power output of 4.4 kW at 1500 rpm was used. Acetylene was introduced into the engine intake manifold through an electronic gas injector from a high pressure cylinder. The optimized start of injection and duration were fixed at 10^0 ATDC and 90^0 crank angles and the experiments were carried out at 110 g/h, 180g/h and 240 g/h of gas flow rates. From the cylinder pressure and crank angle data over the compression and expansion strokes the progress of combustion can be analysed. From the observations it was found that for acetylene TMI operation the peak pressure was 73 bar at 240 g/h whereas for baseline diesel operation the peak pressure was 72 bar at same 240 g/h. Heat release rate was calculated byanalysing the average pressure versus crank angle variations for 100 cycles. A higher heat release rate was observed for acetylene than the normal diesel operation. The highest heat release rate wasnoticed at 240 g/h of gas flow rate i.e. 68 $J/^0$ CA but for diesel it was 66 $J/^0$ CA. Gerhard Vellguth studied the performance of a direct injection single cylinder diesel engine with different vegetable oils. He reported that vegetable oils could be directly used as fuels in diesel engines on a short- term basis with little loss in efficiency. In long-term operation of engine with vegetable oils, he observed operational difficulties like carbon deposits, changes in the lubricating oil properties and ring sticking problems. Rao and Gopalkrishna studied the vegetable oils and their methyl esters as fuel for diesel engines and found that the pure vegetable oils could be used in diesel engines without any major problems. The direct injection diesel engine given almost similar output for allthe vegetable oils tested.

Altin et al. indicated that the vegetable oils produced from numerous oil seed crops have high energy content, most of them require some processing to assure safe use in internal combustion engines. They also conducted experiments on a single cylinder DI diesel engine to evaluate the performance and exhaust emissions using sunflower oil, cottonseed oil, soya bean oil and their methyl esters. They found little power loss, higher particulate emissions and less NOX emissions with neat vegetable oils. They concluded that raw vegetable oils can be used as fuel in diesel engines with some modifications. They also indicated that the methyl ester of vegetable oils is more acceptable substitutes for diesel fuel. Nwafor et al. performed tests on an indirect injection diesel engine with rapeseed oil with an injection advance of 3.5 and 5^0 CA BTDC. It was reported that the delay period was noted to be influenced by the engine load, speed and system temperature.

At 2400 rev/min, there was a significant increase in brake specific fuel consumption with standardfuel injection timing. There was a significant reduction in carbon monoxide and carbon dioxide emissions with advanced timing for the speeds tested. A moderate injection advance was recommended for operations at low engine speeds. Further, he reported that the fuel consumption of heated and unheated oil operations at high loads was slightly higher than the diesel fuel operation. The heated fuel showed a comparative reduction in delay period over the unheated oil. The overall test results showed that fuel heating was beneficial at low speed and part-load operations.

Varaprasad et al. Investigated the effect of using jatropha oil and esterified jatropha oil on a single cylinder diesel engine. They found that the brake thermal efficiency was higher with esterified jatropha oil as compared to raw jatropha oil but inferior to diesel. They also reported low NOX emission and high smoke levels with neat jatropha oil as compared to esterified jatropha oil and diesel.

Parmanik studied the properties and use of jatropha curcas oil and diesel fuel blends in compression ignition engine. The exhaust gas temperature was observed to be reduced due to reduced viscosity of the vegetable oil diesel blends. It was found that the fuel consumption was increased with a higher proportion of the jatropha curcas oil in the blends. Acceptable thermal efficiencies of the engine were obtained with blends containing up to 50% (by volume) of jatrophaoil. The tests were also conducted by Forson et al. On a single-cylinder direct injection engine operated on diesel fuel, jatropha oil and blends of diesel and jatropha oil in proportions of 97.4%

/ 2.6%; 80% / 20%; and 50% / 50% by volume. The test results showed that jatropha oil can be conveniently used as a diesel substitute in a diesel engine. Jajoo and Keoti Carried out experimentson a single cylinder diesel engine using rapeseed oil, soybean oil and their methyl esters as fuel. They revealed that the engine performance with esters and diesel-vegetable oil blends were comparable to that of diesel operation. For longer use methyl esters are preferable because of their lower viscosity and low smoke formation tendency. Ramadhas, Jayeraj and Muraledharan Studiedthe characterization and effect of using rubber seed oil in a compression ignition engine and found that the rubber seed oil can be directly used instead of diesel and does not need any modifications in the design of the engine. Further, they observed that up to 50% of rubber seed oil can be substituted for diesel easily in the compression ignition engines without any major modification and operational difficulties. Agarwal et al evaluated the performance and emission characteristics of linseed oil, mahua oil and rice bran oil blends. It was reported that linseed oil blends showed comparable thermal efficiency at lower loads; 50% linseed oil blends were found to be more efficient than other blends. Smoke density was higher for 50% blends compared to all other linseed oil blends. Smoke density was found to be higher for mahua blends as compared to mineral diesel at lower engine loads. Rice bran oil blends showed comparable thermal efficiency to that of diesel fuel peration. 20% rice bran oil blend showed minimum brake specific energy consumption and improved performance. Herchel et al found that operation of the test engine with pure coconut oil and coconut oil diesel blends for a wide range of engine load conditions was satisfactory even without engine modifications. Increase of coconut oil in the coconut oil-diesel blends resulted in lower smoke and NOx emissions with an increase in the brake specific fuel consumption.

Rice et al presented the results of an engine test with different blends, neat rapeseed oil and diesel fuel. There were no significant problems with engine operation using these alternative fuels. The test results showed a reduction in brake thermal efficiency as the amount ofrapeseed oil in the blend increases. Reduction of power-output was also noted with the increased amount of emissions. Mustafa and Jacobus et al made an extensive study on a single cylinder diesel engine operated on a number of vegetable oils like sunflower oil, cottonseed oil, soya bean oil and peanut oil to provide a detailed comparison of performance and emissions. They observed that theengine operation with vegetable oils showed slightly inferior performance. They also observed higher gas phase emissions with vegetable oils as compared to diesel. Korete performed the comparative study using 100% rapeseed oil and commercially available diesel fuel. They observedthat the torque and power output with rapeseed oil were only 2% lower as compared to diesel operation. This was because of the high viscosity of the rapeseed oil. They found the lower heat release rate with rapeseed oil than diesel. During the whole operating range they found that the hydrocarbon and carbon monoxide emissions were higher with rapeseed oil as compared to neat diesel operation. They also observed slower combustion and lower maximum gas temperatures in the combustion chamber. A number of researchers also assessed the performance of a compression ignition engine with different vegetable oils and found that the vegetable oil can be used as blending component to diesel fuel. Prasad et al used non-edible oilssuch as pongamia and jatropha in low heat rejection diesel engine. Esterification, preheating and increase in injection pressure have been tried for utilization of the vegetable oils in diesel engine. Performance parameters such as the brake specific energy consumption and exhaust gas temperature have been reported for varying load for different non-edible oils. The emission of smoke and NOx has been found to increase. Sahoo and Das with other scientists investigated diesel engine performance with biodiesel derived from jatropha oil, Karanja oil and honge oil. Kumar et al found longer ignition delay for jatropha oil methyl ester as compared to diesel fuel on a constant speed diesel engine. Bhatt, Murthy and Dutta carried out performance evaluation tests on a diesel engine with karanjaoil and its blends with diesel. It was observed that karanja oil could be easily blended up to 40% (by volume) in diesel without any significant difference in power output, brake specific fuel consumption and brake thermal efficiency. The performance of engine with karanja oil blends improved with the increase in compression ratio from 16:1 to 20:1.

Merve et al indicated that the torque and brake power output obtained with the used cooking oil derived biodiesel were 3-5% less than diesel fuel. The engine exhaust temperature at each engine speed with biodiesel was less than diesel fuel. Scholl and Sorenson studied the combustion of soya bean oil methyl ester in a direct injection diesel engine. They found that most of the relevant combustion parameters for soya bean oil methyl ester such as ignition delay, peakpressure, and rate of pressure rise were close to those observed for diesel combustion at the same engine load, speed, timing and nozzle diameter. It was found that ignition delay for the two fuels were comparable in magnitude and the ignition delay of soya bean oil methyl ester was found to be more sensitive to nozzle diameter than diesel. Carbon monoxide emissions from soya bean oil methyl ester was slightly lower, hydrocarbon emissions reduced drastically, NOx for two fuels were comparable and smoke numbers for the soya bean oil methyl ester were lower than that of diesel. They also observed that the premixed portion of the combustion process had a lower rate of combustion with the ester as compared to neat diesel. Clark et al studied the effects of methyl and ethyl esters of soybean oil on a 4-cylinder diesel engine. They observed that the engine fuelled with soybean esters resulted in a slightly less power combined with an increase in fuel consumption. Agarwal trans esterified the linseed oil to prepared linseed oil methyl ester and performed the engine experiments with different blends of biodiesel (linseed oil methyl ester) with diesel and compared the results with baseline data for diesel using a single cylinder direct ignition diesel engine. Further Agarwal and Das studied the biodiesel development and characterization for use as a fuel in compression ignition engine and observed that almost all the important properties of a biodiesel was in a very close agreement with the diesel oil making it a potential candidate for partial replacement of diesel fuel. The 20% biodiesel blend was found to be optimum, which improved the thermal efficiency of the engine by 2.5%, reduced the exhaust emissions andbrake specific fuel consumption. Al-Widyan et al have carried out variable speed tests on a single cylinder direct injection diesel engine using different blends of biodiesel in diesel, produced from waste vegetable oil. The comparison of the biodiesel blends and the diesel fuel operation was done in terms of engine performance. It was found that with biodiesel blends, the engine operated smoothly without significant problems. The blends burnt more efficiently with better fuel economy and further generated lower emissions.

II. EXPERIMENTAL SETUP

A vertical, 4-stroke cycle, single cylinder, water-cooled, compression ignition engine was used for the experiment. The engine is coupled to an Eddy Current Dynamometer. Air temperature, coolant temperature and throttle position are connected to open ECU which control fuel injector, fuel pump and idle air. The engine was modified and provision were provided to vary the compression ratio from 16.5:1 to 18.5:1,rated Injection opening pressure 200bar and rated crank angle. The line diagram of the engine setup is shown in the fig.1 below and the engine specifications shown in the table.2.Initially the engine was run with pure diesel and after blends of C&N[50:50] biodiesel as B10,B20 and B30 at various compression ratios for different loads varying with help of loading unit. Various engine performance parameters BTE and BSFC were measured with the help of digital lab view software.

Line Diagram

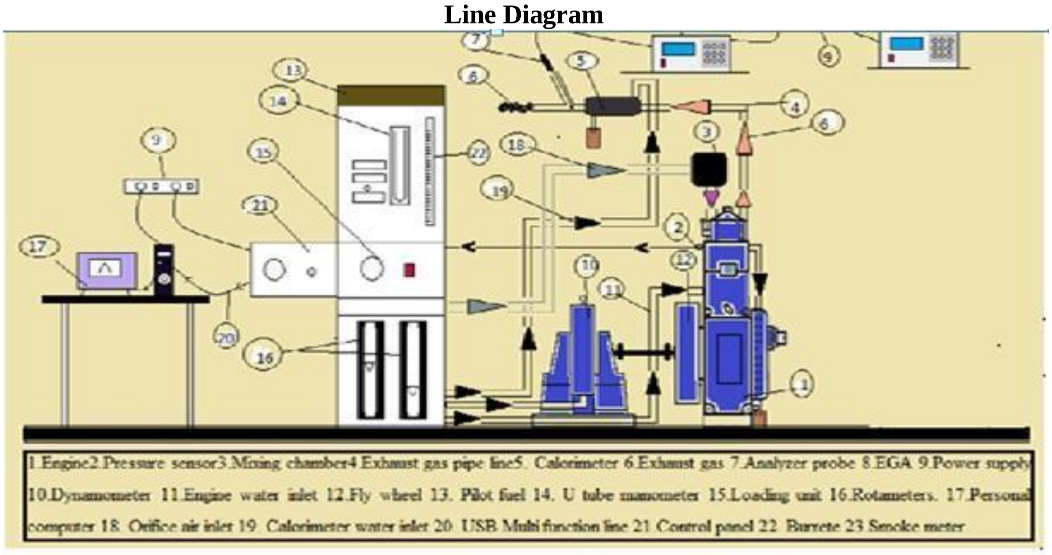

Figure 2.1. Line diagram of Experimental setup

Table 2.1. Specifications of Test Rig.

PARTICULARS	**SPECIFICATIONS**
Type	Vertical, 4S,Water cooled
Type of Ignition	Compression Ignition(CI)
Rated Power(kW)	3.5
Injection opening pressure(bar)	200
Constant Speed(RPM)	1500
Variable compression ratio	16.5:1 to 18.5:1
Fuel Injection	Direct Injection
Injection Timing(bTDC)	23°
Dynamometer	Eddy Current Type

III. RESULT & DISCUSSIONS

The results from the experiments performed on the four stroke engine for maximum load operatingconditions are shown in the graph form and discussed, the graphs of performance BTE & BSFC with BP.

3.1 Brake Thermal Efficiency

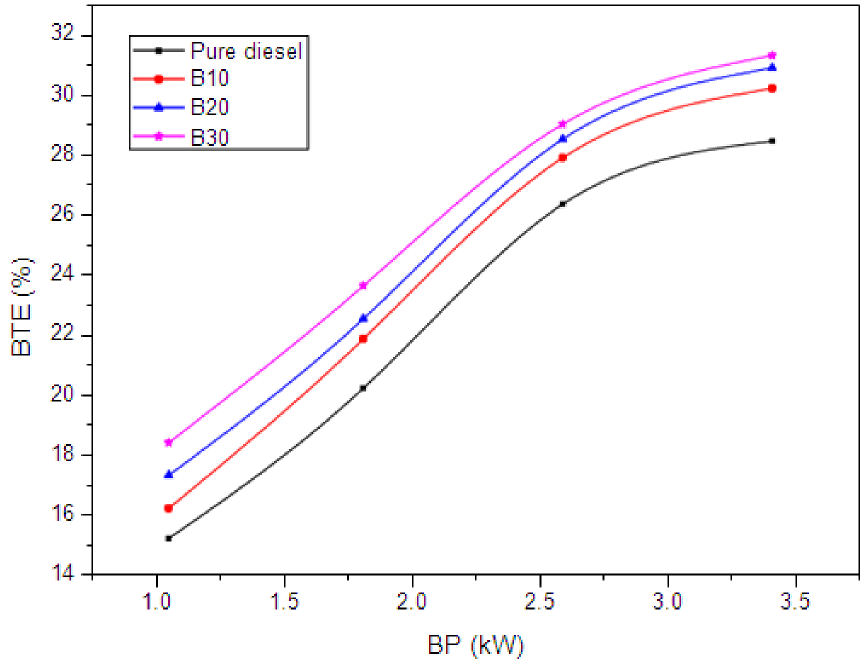

Figure 3.1 Influence of BTE Vs BP for different substitution of Biodiesel.

The above figure shows the effect of Brake Thermal Efficiency with BP. It was noticed that the performance brake thermal efficiency were increases by the increase of blends percentage when compared to pure diesel blends gives an better efficiency. As the load was increased from 25% to 100% the performance of brake thermal efficiency increases. Which shows that the performance of BTE is increases for addition of blends.

3.2 Brake Specific Fuel Consumption

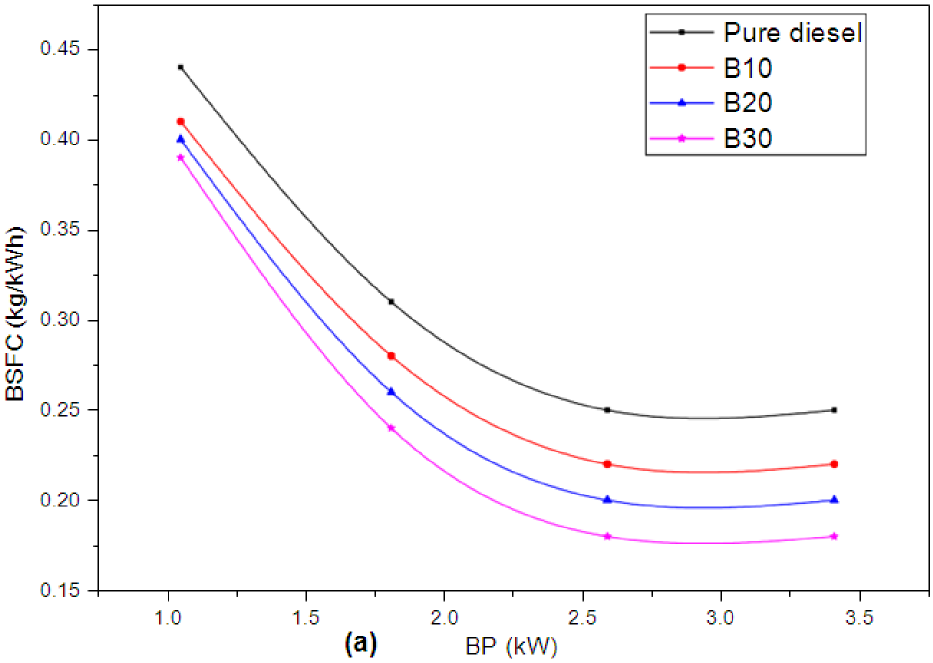

Figure 3.2 Influence of BSFC Vs BP at different mixtures of Biodiesel.

The above figure shows that the decrease of efficiency with increase of load from 25% to 100%. The increase of percentage of blends reduces the performance Brake Specific Fuel Consumption, the BSFC value is lesser than the pure diesel which shows an better performance with lesser consumption of fuel.

IV. CONCLUSION

■ Performance of engine is concluded without modifying.

■ Engine experiment was done in the rated condition of compression ratio of 17.5 and Injectionopening pressure of 200bar.

■ Graphs shows an variation of performance parameters with Brake Power at 25%,50%,75% and 100% of load variance.

■ We can conclude from the graphs that the best blend that can be used for the performance parameter is B-30 Blend.

■ It gives the least amount of BSFC and maximum of Brake thermal efficiency.

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