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Effects on the Performance Characteristics by Altering Different Parameters for Single Cylinder C.I. Engine Blended with Neem Bio-Diesel

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Abstract

This study specially focuses to alter different parameters instead to change design of parts. Experiments carried out on 10 H.P. single cylinder C.I. Engine which normally used by farmers for irrigation purpose. Trial was carried out by altering parameters like no. of nozzle holes and injection pressure with different proportion of Neem Bio-diesel blends. While using such Bio-Fuel blends, lethal emissions were also recorded during each trial to predict emission characteristics and performance. Due to fluid characteristics of bio fuel it needs comparatively different conditions to atomize properly. So as by changing injection pressure and number of hole in nozzle may affect the performance and emission characteristics. Result shows excellent Break Specific Fuel Consumption (BSFC), Break Specific Energy Consumption (BSEC), Break Thermal Efficiency (BTE), and Mechanical Efficiency (ME) at 240 bar injection pressure. While excellent Indicated Thermal Efficiency (ITE) at 220 bar pressure. It was also seen that 3 and 4 hole nozzle pays higher performance at 240 bar pressure. At 220 bar injection pressure, it was clearly seen that 4 and 5 hole nozzle were excellent to atomize the fuel. Reduction of lethal emissions were recorded excellent during 4 hole nozzle with 220 bar pressure and 5 hole nozzle with 240 bar pressure.

Keywords: Bio-Fuel, Blends, Neem Bio-diesel, Lethal Emissions, Injection Pressure, No. of Nozzle Hole

INTRODUCTION

In present era, electricity and transport are one of the primary requirements for any country. For the industrial and economic growth, there should be sufficient supply of power and transport in the country. And to cope up with such requirements we vigorously rely upon the non-renewable energy sources like coal, oil and gaseous petrol. These non-renewable energy sources are depleting day by day and many researchers believe it will exhaust soon. It is also seen by all of us that excessive use of these fossil sources pollutes our environment badly and creates many environmental issues like global warming, green-house effect, air and noise pollution, depleting of Ozon layer and melting of glaciers from north and south poles. Due to lacking of natural resources, Today India is importing larger part of fossil fuels from other country. Hence we are losing maximum foreign exchanges and which directly affects the country economy.

Bio diesel is a replacement agent to ordinary fossil fuel diesel which can be derived continuously from renewable source Biomass. Bio fuels having many properties which are very positive over non renewable fossil fuels like non- toxicity, they are free from sulfur, can be bio logically degradable, oxygen generator and eco-friendly. Basically bio fuel is a long chain of mono-alkyl ester fatty acids which can be available from any non edible sources too. Popularly it can be getting by vegetable oil, edible-non edible oil and animal fat. Bio diesel providing similar power output makes it best replacement compound. Bio diesel can be produce locally with many methods. So it will help Indian farmers and entrepreneur to make more profit by non edible oil feeds. Bio diesel is very much environment friendly and non toxic in behavior so it produce very less carbon monoxide and tends to 0% sulfur dioxide. Bio diesel is biodegradable in nature so no residuals will harm to surface of earth in case of spilling.

Today in India, consumption of diesel than petrol is huge. So country like India seems platform to start up with bio diesel. Bio diesel can be easily produce on small and large scale base. So farmers of ruler area can grow such bio diesel feed stocks on their waste and marginal lands and can use their own oil production for agriculture appliances like tractor, threshers, pitter pumps etc or can gain more profit by selling to others.

Neem (Azadirachta indica) which is the part of Meliaceae family is very precious and most usable tree growing in India. Neem tree and its fruit have many medical and domestic usages. It can be grow on any soils up to pH 10. So it can be grown anywhere in India and so as its versatile tree for Indian land. As it can be use in multiple applications Indian farmers are cultivate Neem since vedic period. Neem tree can be grown in waste land or marginal land without any extra care. Fruits from neem having oil contain and is major source of non edible bio fuel feed stock. A well growth tree can produces 35-50 kg fruit/year. Normally a dry seed of neem has 40-43% oil contain. With the test result it was clearly seen that neem oil's Physico-Chemical Parameters are nearer to pure diesel fuel.

Alteration of fuel in any fossil fuel powered engine needs redesign of engine structure or external conversation kit to run the engine hassle free, efficiently, safely, eco friendly and without losing performance. Research in the era of changing fuel from traditional sources to renewable sources seems difficult because of non availability of raw feed stock, harvesting issues, cost factor and redesigning of traditional engine. There are certain ways to use bio diesel as a raw feed to conventional type diesel engines. Bio diesel can be used

directly to Compression Ignition Engine or can be mixed with ordinary diesel in different proportion. B100 is 100% biodiesel and B20 is 20 % bio diesel and 80% ordinary diesel. Likewise we can use different proportions like B10, B30, B40, B50, B60, B70, B80, B90, and B100. From different studies it is found that B10 & B20 are most likely suitable and desired blend which cannot entertain any design change in conventional engine and power output.

There are many factor which may affects the performance and emission characteristics while using bio-diesel blend in traditional engine like properties of fuel, composition of fuel-blend, nozzle hole size and numbers, injection pressure, compression ratio and injection timing, droplet size spray cone angles and tip angles. In all above factors many factors may require redesign of engine parts or modify the fuel injecting system. The engine performance, power output, pollution free combustion and economy is totally dependent on the effectiveness of the fuel injection system. Effective burning of fuel is depends on proper atomization inside the cylinder and it works by injector, nozzle and injecting pressure.

From all the above parameters Nozzle size and Number of holes plays a dominant role for enhancing performance of diesel engine and slightly affects to emission control too. Performance of the engine, output power and the economy to run the engine is fully dependent on the effective fuel injection system (FIS). Fuel Injection System is very important part of Compression Ignition Engine. It plays main role of igniting and controlling of fuel burning process. Fuel is to be sprayed in very fine droplet to atomize properly towards highly compressive atmospheric air.

For biodiesel fuel the nozzle hole number is increase and decrease size of holes which combination is properly atomized the fuel for strongly effect combustion and emission, high percentage of biodiesel blend with diesel give good performance, decrease brake specific fuel consumption (BSFC) of the engine and good spray characteristics of the fuel but for diesel fuel is increase specific fuel consumption and also effect the thermal efficiency (TE) of the diesel engine.

S. Mahalingam et al. (2013) [1] has studied performance and emission characteristics by varying the injection pressure for dual bio fuel. Experiment was carried out on single cylinder four strokes I.C. Engine. Trial was performed on varying injection pressure of 200, 220, 240 bar pressure with different bio diesel blends of B20 & B60. During trial all the parameters have kept constant and run the engine at 1500 rpm. Reduction of emissions like CO_2, HC and CO was about 5% to 10% on increasing in pressure and NO_x and smoke value gets higher during decreasing of injection pressure. It was also observed that B20 blends has higher Break Thermal Efficiency (BTE) and lower emission to the atmosphere.

Dharmendra Yadav & Nitin Shrivastava [2] has perform the experiment to investigate performance of Neem oil methyl ester on diesel engine of 8 HP. Trial was performed by different Neem Bio-diesel blends of B20, B50 & B100. Result was compared with normal diesel fuel performance. It was observed that break specific fuel consumption and break specific energy consumption was increased up to 8.25% but break thermal efficiency was decrease up to 7.62% compare to the pure diesel fuel trial. It was observed that performance of bio diesel blends are slightly less than pure diesel but B20 blend of Neem oil has very close performance to pure diesel fuel.

Cenk Sayin et al. (2013) [3] has measured the affection of injector hole number on the engine performance and emission characteristics while running on Bio diesel blends. It was mentioned in research that fuel atomization process was greatly affected to combustion and emission. In combustion process injector hole number (INHN) influenced to spray parameters like fine droplet size and penetrating length. To prove such thing experiment was performed in single cylinder C.I. Engine with four different loads of 25%, 50%, 75%, and 100%. Injector hole numbers were vary by 2, 4, 6 & 8. It was clear by result that Break Specific Fuel Consumption (BSFC), Carbon Dioxide (CO_2) and Nitrogen Oxide (NO_x) was increased while Smoke Opacity (SO), Hydro Carbons (HC) and Carbon Monoxide (CO) emissions were reduces due to fuel properties and characteristics. Altering of INHN will increase in BSFC and emissions for low percentage bio diesel blend like B5 to B20.

H. M. DHARMADHIKARI et al. [4] has performed engine run at different injection pressures with blends of bio diesel and noticed performance and emission of C.I. Engine. It was observed that the optimal value of injection pressure is 200 bar and so as trial was performed for the range of 180 bar to 220 bar. The performance value of BSFC and BTE and in emission CO, CO_2, HC and NO_x were measured. It was seen in result that CO and HC emission were recorded less for B10 and B20 blends while NO_x observed very less by 28% to 39% for B10 and B20 blend. BSFC was slightly more for B10 and B20.

K.V.Radha et al. [5] has investigate by experiment that properties of ester found in Neem oil is eco friendly and has closest value of properties and chemical characteristics to the pure diesel. It is found in research for best environment friendly alternative fuel which replace the need of diesel fuel in future.

In this study blends of Neem Bio diesel is blended with pure diesel in two different proportions B10 and B20. Experiment is to be carried out to check different performance parameters and emission characteristics while running at different injection pressure and different numbers of injector nozzle hole. All the other engine parameters are kept unchanged and run the engine at rated speed of 1500 rpm.

TABLE I
NEEM OIL BLEND PHYSICO-CHEMICAL PARAMETERS

Sr. No.	Test Name	Test Method	Test Pure Diesel Fuel	Test Result B10	Test Result B20	Unit
1	Density at 27^0C	ASTM D1298	830	838.3	874.2	kg/m^3
2	Kinematic viscosity at 30^0C	ASTM D445	3	3.18	3.52	cSt
3	Calorific value	ASTM D240	44.8	43.5	41.6	MJ/kg
4	Fire point	ASTM D445	57	78	92	^{0}C

EXPERIMENT SETUP AND TEST PROCEDURE

Experimental setup consists of a 10 HP single cylinder Pitter type C.I. Engine which is connected to rope break dynamometer for variable loading. Engine runs at 1500 rpm rated speed and take the readings of time for consumption of 10 ml of different blends.

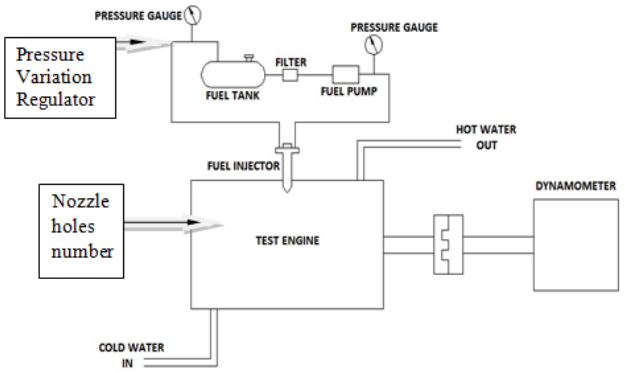

Figure 1. Experiment Set Up Line Diagram

TABLE II
ENGINE SPECIFICATION

Make & Model	PITER Type Engine 54A
General Details	Four stroke single cylinder diesel engine
Bore	102 mm
Stroke	110 mm
Capacity	898 cm^3
Compression Ratio	15:1
Type	Water cooled
Specific fuel consumption	251 g/kWh
Maximum H.P.	10HP

Before we start the engine some preliminaries has to follow as a part of experiment like checking of fuel level, checking of lubricating oil, checking of three way cock for continue flow of water during experiment and at last checking of water level. Soon after this to remove air trapping between cylinder and piston decompression lever is to be pressed. Now to start the engine, hand crank lever is to be attached on crank shaft and rotate it at sufficient speed. As engine takes its rated speed, check by putting tachometer and allow engine to run on 1500 rpm. Record the time taken for 10cc fuel consumption at no load and check the rpm by digital tachometer. Then the engine pulley is loaded by rope wound on pulley attached with different loads and take readings of time taken for 10cc of fuel consumption. Repeat this experiment at different loads of 25%, 50%, 75% and full load 100% at different fuel injection pressures. Original pressure will be around 200 bars but change it to 220 bars and 240 bars. Change the nozzle from the nozzle holder and take reading for different Nozzle holes number three, four, and five.

TABLE III
NOZZLE SPECIFICATIONS

Nozzle Name	Hole size	Angle
3 Holes Nozzle(110S639)	290 µm	120^0
4 Holes Nozzle(150S719)	240 µm	90^0
5 Holes Nozzle(142S1033)	220 µm	60^0

RESULT

A. Break Thermal Efficiency

Brake thermal efficiency is the ratio of brake power to the heat supplied by the engine. For better performance of the engine, Brake thermal efficiency should be higher. From the result it was clearly seen that B20 blend with 3 holes nozzle at 240 bar pressure having excellent efficiency of 43.34 %

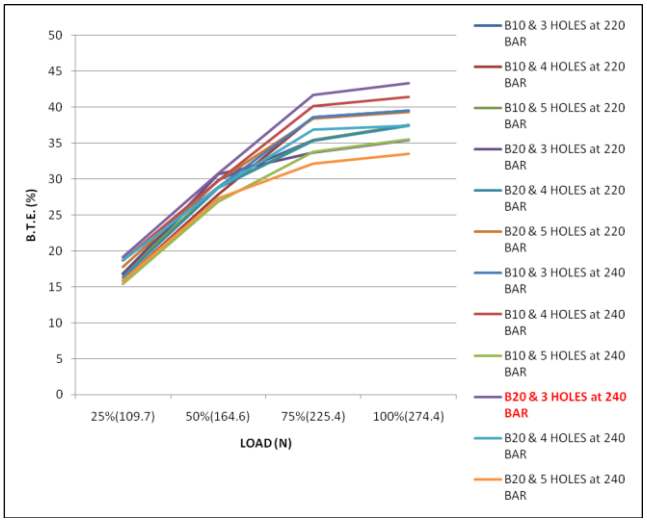

Figure 2. Variation of Load and Break Thermal Efficiency

B. Break Specific Fuel Consumption

Brake specific fuel consumption is the mass of fuel consumed by the engine per unit brake power. For better engine performance, Brake specific fuel consumption should be min. From the result it was clearly seen that at 240 bar injection pressure, B20 blend with 5 holes nozzle has least amount of fuel consumption of 0.21 kg/kW-hr

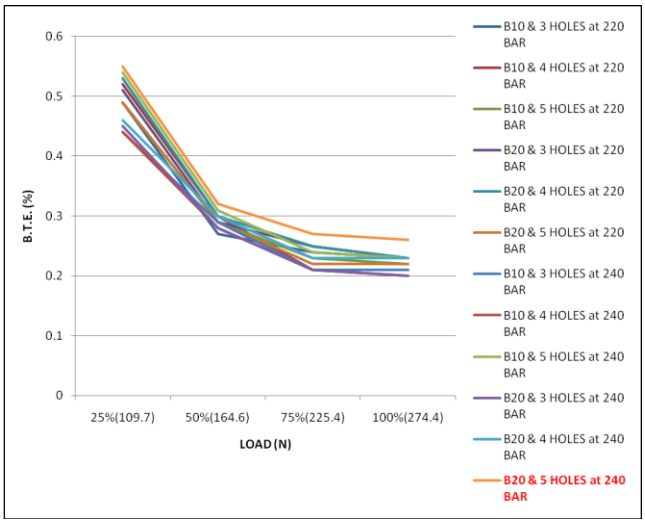

Figure 3. Variation of Load and Break Specific Fuel Consumption

C. Mechanical Efficiency

Mechanical efficiency is the ratio of Brake power produced by engine to Indicated power of the engine. For better performance of the engine, Mechanical efficiency should be higher. From the result it was clearly seen that at 240 bar injection pressure, B20 blend with 4 holes nozzle has excellent Mechanical Efficiency (M.E.) of 68.36 %

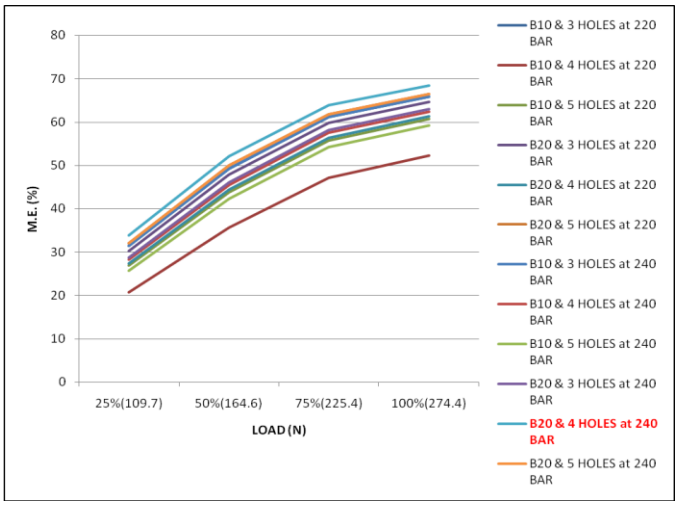

Figure 4. Variation of Load and Mechanical Efficiency

D. Emission of Carbon Monoxide (CO)

Carbon monoxide (CO) is slightly lighter than atmospheric air and which possess characteristics like tasteless, odorless and colorless. It is very toxic to all the animals including human. Carbon Monoxide is dangerous when it inhales in body more than 35 ppm. It is clearly seen from the below Figure that B20 blend with 4 holes nozzle at 220 bar pressure has very low emission of Carbon Monoxide (CO). It is observed only 0.0280 %

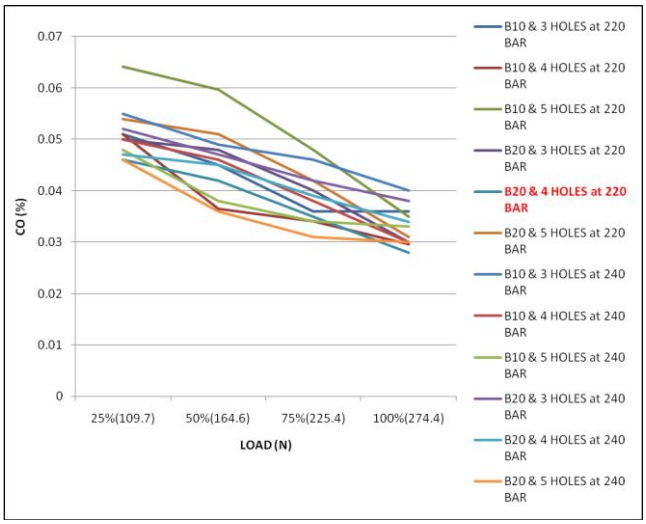

Figure 5. Variation of Load and Emission of Carbon Monoxide (CO)

E. Emission of Hydrocarbons (HC)

Hydrocarbons are basically raw fuel. High emissions of Hydrocarbon (HC) are a sign of poor fuel ignition inside the cylinder. HC greatly affects to the greenhouse effect and global warming, deplete the ozone, and increases the chances of cancer and respiratory disorders. Hydrocarbon contains very less in amount of 4 ppm in B20 blend with 4 holes nozzle at 220 bar pressure, B20 blend with 3 & 5 holes nozzle at 240 bar pressure.

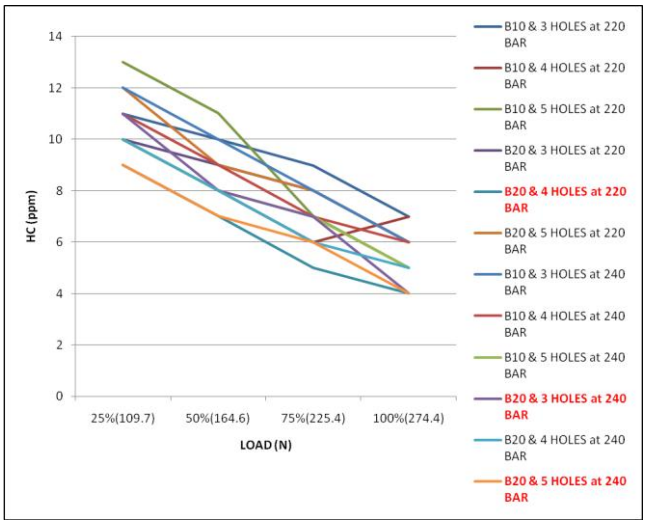

Figure 6. Variation of Load and Emission of Hydrocarbons (HC)

F. Nitrogen Oxides (NO_x)

In large cities where very high motor vehicle traffic is very usual, we can find Nitrogen Oxides in air with large in amount. NO_x gases are formed whenever combustion occurs in the presence of nitrogen. Nitrogen dioxide infects the lining of the lungs and it can reduce immunity system of lung. Many health issues like wheezing, coughing, colds, flu and bronchitis may occur due to inhaling of NO_x.

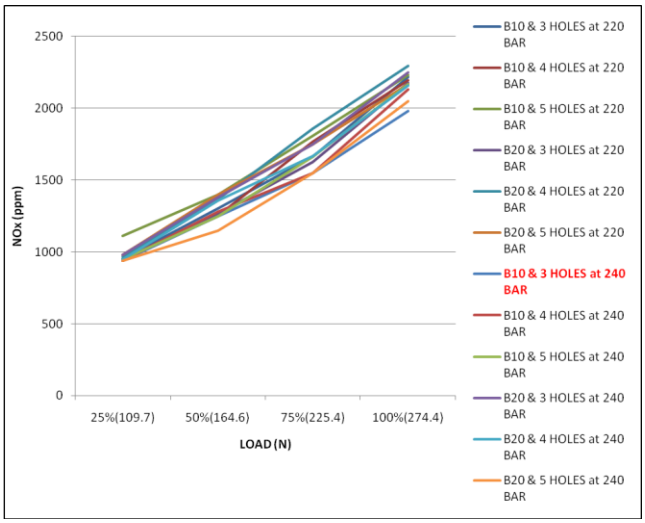

Figure 7. Variation of Load and Emission of Nitrogen Oxide (NOx)

CONCLUSION

It was clearly seen in the result of experimental analysis that B20 blend of Neem Bio diesel is most promising blend where we found all three major performance parameters like Break Thermal Efficiency, Break Specific Fuel Consumption and Mechanical Efficiency were excellent. It was also noted in emission part of performance. B20 blend having low emission record found.

It was also observed that Engine performance parameters are excellent at 240 bar injection pressure. Break Specific Fuel Consumption, Mechanical Efficiency and Break Thermal Efficiency is greatly affected by higher injection pressure where as emission of Hydrocarbon and Nitrogen Oxides found very less for 240 bar injection pressure.

Injector number of holes (INHN) has putted mixed impression on engine performance parameters as well as on exhaust emissive gases. Proper atomization of fuel injected inside cylinder plays major role in performance if engine. It was seen from the results that at lower pressure 4 holes nozzle working fine because of increasing in number of hole decreases the diameter of hole and so as very fine droplet at certain pressure will let atomize properly inside. On higher pressure side there is no particular significant INHN made performance.

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