EXPERIMENTAL INVESTIGATION ON THE COMBUSTION PARAMETERS OF B20 NEEM BLEND IN CI ENGINE BY VARYING INJECTION TIMING AND NOZZLE HOLE DIAMETER

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ABSTRACT

In the present study an experimental work had been carried out to analyze the combustion parameters of B20 neem blend in CI engine by varying injection timing and nozzle hole diameter. The engine tests were conducted on kirloskar 4-stroke single cylinder 1500 rpm water cooled direct injection diesel engine with standard injection pressure of 230 bar was maintained constant throughout the experiment. Three different injection timings such as 20˚bTDC, 23˚bTDC, 26˚bTDC and three different nozzles such as (3×0.28mm), (4×0.23mm), (5×0.20mm) varied to analyze the combustion parameters. From the test results, it could be observed that among three different nozzles (3×0.28mm) nozzle gives higher Peak pressure rise and Indicated mean effective pressure as compared to 4 hole and 5 hole nozzles.

Keywords: *Neem biodiesel, nozzle, injection timing, combustion, B20 blend, CI engine.*

1. INTRODUCTION

The world energy demand has been increased drastically in few decades. Firstly, the price of conventional fossil fuel is rising rapidly and has added burden on the pocket of common man and economy of the nations who imports it. Secondly, combustion of fossil fuels is the main reason behind the increasing the carbon dioxide (CO_2) level, which results in increase of global warming. The depletion of conventional sources are also becomes the main concern for research world-wide into alternative energy sources for internal combustion engines. Bio-fuels have the potential to become alternative "greener" energy substitute for fossil fuels. It is available in plenty in the world and also the renewable source of energy. Neem oil cannot be used directly in diesel engine because of their high viscosity. The viscosity may cause blockage of fuel lines, filters and results in poor atomization of fuel into the combustion chamber. To reduce the high viscosity of neem oil transesterification reaction has to be done. Biodiesel from neem oil had been a promising alternative for diesel for the future.

Fig-1: Neem Seeds

Fig-2: Neem SeedKernels

2. METHODOLOGY

A. TRANSESTERIFICATION PROCESS

It is most commonly used and important method to reduce the viscosity of vegetable oils. In this process triglyceride reacts with three molecules of alcohol in the presence of a catalyst producing a mixture of fatty acids, alkyl ester and glycerol. The process of removal of all the glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is called esterification.

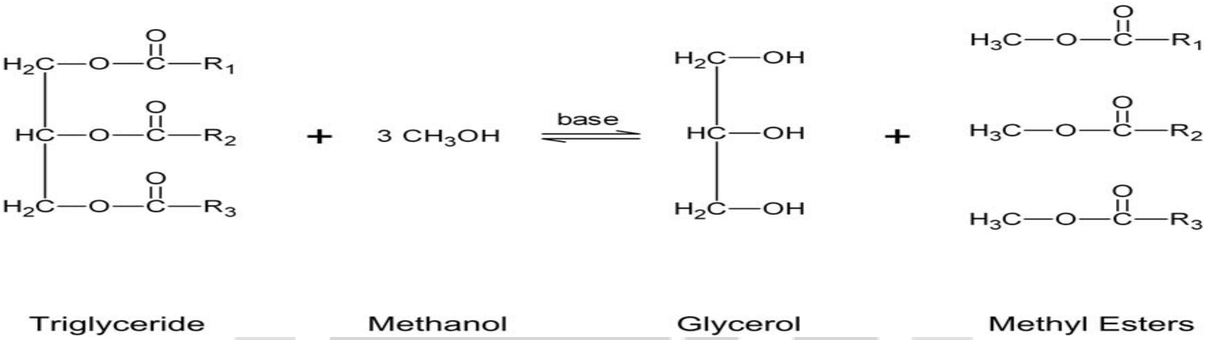

Fig-3:Transesterification reaction

B. PROPERTIES OF FUELS

Properties	Diesel	Neem biodiesel	B20
Density (kg/m³)	827	890	835
Kinematic viscosity at 40˚C (cSt)	3.517	5.648	4.403
Flash point (˚C)	47	174	69
Fire point (˚C)	54	186	83
Calorific value (MJ/kg)	42	39.66	40.87

Table-1: Properties of fuels

C. EXPERIMENTAL SETUP

Fig-4: Computerized engine setup

Fig-5: Pressure transducer

D. ENGINE SPECIFICATIONS

Engine Parameter	Specifications
Engine type	Kirloskar, Four stroke, Single cylinder, Water cooled, Direct injection
Bore x Stroke	87.5 mm x 110 mm
Compression Ratio	17.5:1

Rated speed	1500 rpm
Rated power	5.2 kW
Injection pressure	230 bar
Injection timing	23˚ bTDC

Table-2: Engine specifications

The experiment was carried out to investigate the effect of change in injection timing and nozzle hole diameter on combustion characteristics of B20 neem blend in a stationary single cylinder diesel engine and to compare it with diesel fuel. Technical specifications of the engine are given in above Table-2. The engine was operated on diesel first and then on B20 blend of neem methyl ester. The combustion parameters were analyzed from the graphs regarding Peak pressure rise, Indicated mean effective pressure (IMEP) for the blends of B0 and B20. For determining the effect of injector nozzle diameter on diesel engine combustion, the number of nozzle holes are increased such as 3 hole, 4 hole and 5 hole. All 3 holes have diameter of 0.28 mm. All 4 holes have diameter of 0.23 mm. All 5 holes have diameter of 0.20 mm. Injection timing is varied by adding or removing the shims between the fuel injector pump and the engine body. It is found that by adding or removing each shim of 0.2mm thickness, the static injection timing is varied by 3 degrees. Addition of shims retarded the injection timing, while removing the shims advanced the injection timing.

Fig-6: Shims arrangement in engine **Fig-7: Photographic view of shims**

E. NOZZLE SPRAY PATTERN

Fig-8: 3 hole nozzle spray pattern **Fig-9: 4 hole nozzle spray pattern** **Fig-10: 5 hole nozzle spray pattern**

3. RESULTS AND DISCUSSION

A. PEAK PRESSURE RISE

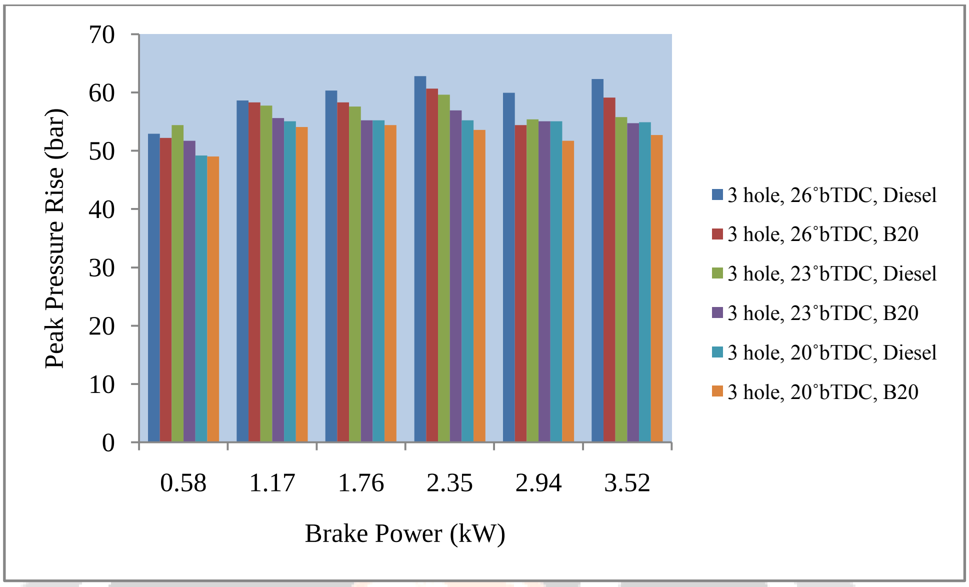

Fig-11: Variation of peak pressure rise with brake power for 3 hole nozzle at different injection timings

Fig-11illustrates the variation of peak pressure rise with brake power for 3 hole nozzle at 230 bar injection pressure and at different injection timings. At all loads, the peak pressure rise of diesel fuel is more than B20 fuel due to lower cetane number and lower heating value of B20 fuel as compared to diesel fuel results in lower cylinder pressure rise for biodiesel.For 3 hole nozzle 26˚bTDC injection timing gives higher peak pressure rise than other injection timings such as 20˚bTDC and 23˚bTDC. This may be due to the fact that at advanced injection timing, large amount of fuel available for premixed combustion. At advanced injection timing, the peak cylinder pressure occurs very close to TDC due to early start of combustion. On retarding the injection timing, the peak pressure lowers and occurrence of peak pressure shifts away from TDC in expansion stroke, less fuel availability for premixed combustion and late start of combustion. For 3 hole nozzle at 26˚bTDC injection timing the highest peak pressure rise was found to be 62.83 bar for diesel fuel and 60.64 bar for B20 fuel. For 3 hole nozzle at 23˚bTDC injection timing the highest peak pressure rise was found to be 59.63 bar for diesel fuel and 56.94 bar for B20 fuel. For 3 hole nozzle at 20˚bTDC injection timing the highest peak pressure rise was found to be 56.22 bar for diesel fuel and 54.41 bar for B20 fuel.

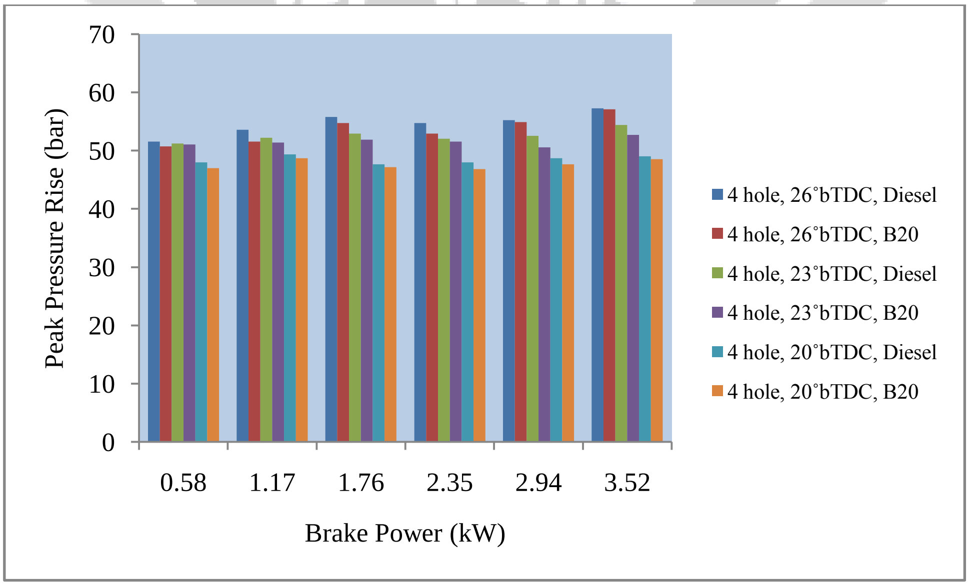

Fig-12: Variation of peak pressure rise with brake power for 4 hole nozzle at different injection timings

Fig-12illustrates the variation of peak pressure rise with brake power for 4 hole nozzle at 230 bar injection pressure and at different injection timings. At all loads, the peak pressure rise of diesel fuel is more than B20 fuel due to lower cetane number and lower heating value of B20 fuel as compared to diesel fuel results in lower cylinder pressure rise for biodiesel. For 4 hole nozzle 26˚bTDC injection timing gives higher peak pressure rise than other injection timings such as 20˚bTDC and 23˚bTDC. This may be due to the fact that at advanced injection timing, large amount of fuel available for premixed combustion. At advanced injection timing, the peak cylinder pressure occurs very close to TDC due to early start of combustion. On retarding the injection timing, the peak pressure lowers and occurrence of peak pressure shifts away from TDC in expansion stroke, less fuel availability for premixed combustion and late start of combustion. For 4 hole nozzle at 26˚bTDC injection timing the highest peak pressure rise was found to be 57.28 bar for diesel fuel and 57.11 bar for B20 fuel. For 4 hole nozzle at 23˚bTDC injection timing the highest peak pressure rise was found to be 54.41 bar for diesel fuel and 52.73 bar for B20 fuel. For 4 hole nozzle at 20˚bTDC injection timing the highest peak pressure rise was found to be 49.36 bar for diesel fuel and 48.68 bar for B20 fuel.

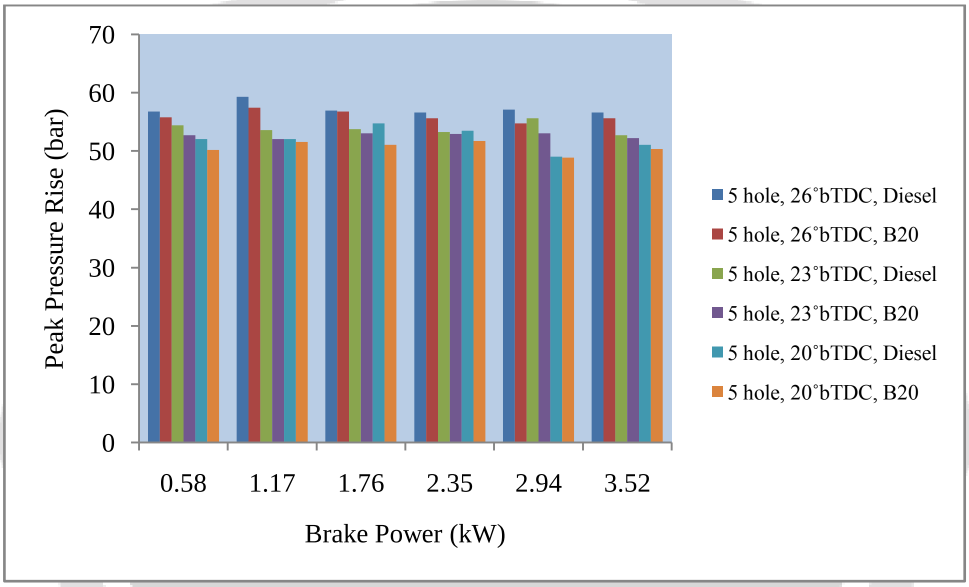

Fig-13: Variation of peak pressure rise with brake power for 5 hole nozzle at different injection timings

Fig-13illustrates the variation of peak pressure rise with brake power for 5 hole nozzle at 230 bar injection pressure and at different injection timings. At all loads, the peak pressure rise of diesel fuel is more than B20 fuel due to lower cetane number and lower heating value of B20 fuel as compared to diesel fuel results in lower cylinder pressure rise for biodiesel.For 5 hole nozzle 26˚bTDC injection timing gives higher peak pressure rise than other injection timings such as 20˚bTDC and 23˚bTDC. This may be due to the fact that at advanced injection timing, large amount of fuel available for premixed combustion. At advanced injection timing, the peak cylinder pressure occurs very close to TDC due to early start of combustion. On retarding the injection timing, the peak pressure lowers and occurrence of peak pressure shifts away from TDC in expansion stroke, less fuel availability for premixed combustion and late start of combustion.For 5 hole nozzle at 26˚bTDC injection timing the highest peak pressure rise was found to be 59.3 bar for diesel fuel and 57.44 bar for B20 fuel. For 5 hole nozzle at 23˚bTDC injection timing the highest peak pressure rise was found to be 55.59 bar for diesel fuel and 53.06 bar for B20 fuel. For 5 hole nozzle at 20˚bTDC injection timing the highest peak pressure rise was found to be 54.75 bar for diesel fuel and 51.72 bar for B20 fuel.

B. INDICATED MEAN EFFECTIVE PRESSURE (IMEP)

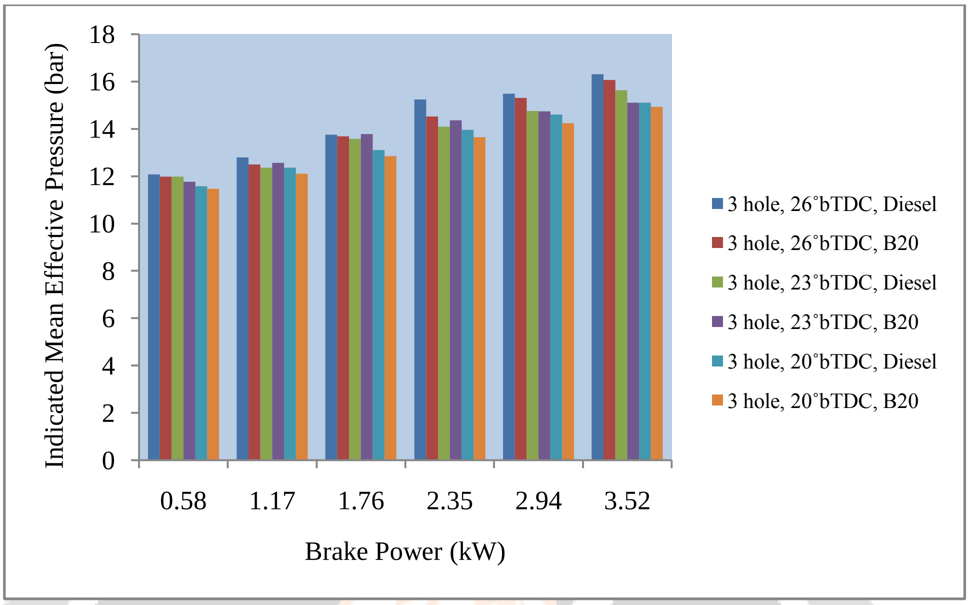

Fig-14: Variation of indicated mean effective pressure with brake power for 3 hole nozzle at different injection timings.

Fig-14 shows the variation of indicated mean effective pressure with brake power for 3 hole nozzle at different injection timings. IMEP increases gradually with increase in BP.For 3 hole nozzle at 26˚bTDC injection timing the maximum IMEP was found to be 16.31 bar for diesel fuel and 16.06 bar for B20 fuel. For 3 hole nozzle at 23˚bTDC injection timing the maximum IMEP was found to be 15.63 bar for diesel fuel and 15.1 bar for B20 fuel. For 3 hole nozzle at 20˚bTDC injection timing the maximum IMEP was found to be 15.11 bar for diesel fuel and 14.93 bar for B20 fuel.

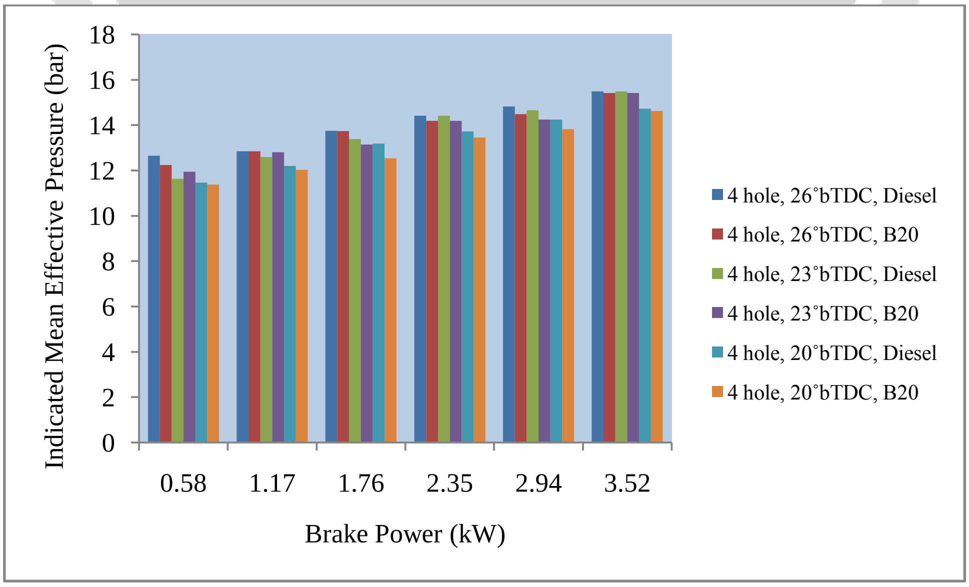

Fig-15: Variation of indicated mean effective pressure with brake power for 4 hole nozzle at different injection timings.

Fig-15 shows the variation of indicated mean effective pressure with brake power for 4 hole nozzle at different injection timings. IMEP increases gradually with increase in BP.For 4 hole nozzle at 26˚bTDC injection timing the maximum IMEP was found to be 15.69 bar for diesel fuel and 15.42 bar for B20 fuel. For 4 hole nozzle at 23˚bTDC injection timing the maximum IMEP was found to be 15.49 bar for diesel fuel and 15.42 bar for B20 fuel. For 4 hole nozzle at 20˚bTDC injection timing the maximum IMEP was found to be 14.72 bar for diesel fuel and 14.62 bar for B20 fuel.

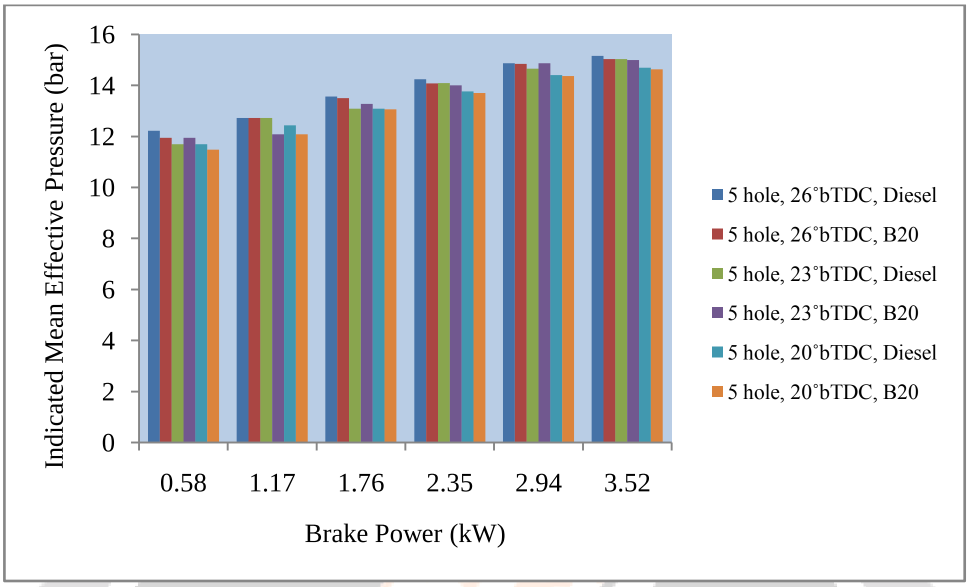

Fig-16: Variation of indicated mean effective pressure with brake power for 5 hole nozzle at different injection timings.

Fig-16 shows the variation of indicated mean effective pressure with brake power for 5 hole nozzle at different injection timings. IMEP increases gradually with increase in BP.For 5 hole nozzle at 26˚bTDC injection timing the maximum IMEP was found to be 15.16 bar for diesel fuel and 15.03 bar for B20 fuel. For 5 hole nozzle at 23˚bTDC injection timing the maximum IMEP was found to be 15.03 bar for diesel fuel and 15.00 bar for B20 fuel. For 5 hole nozzle at 20˚bTDC injection timing the maximum IMEP was found to be 14.70 bar for diesel fuel and 14.63 bar for B20 fuel.

4. CONCLUSION

- For 3 hole nozzle, highest Peak pressure rise was found to be 62.83 bar for diesel fuel, 60.64 bar for B20 fuel and highest IMEP was found to be 16.31 bar for diesel fuel, 16.06 bar for B20 fuel at 26˚bTDC injection timing.
- For 4 hole nozzle, highest Peak pressure rise was found to be 57.28 bar for diesel fuel, 57.11 bar for B20 fuel and highest IMEP was found to be 15.69 bar for diesel fuel, 15.42 bar for B20 fuel at 26˚bTDC injection timing.
- For 5 hole nozzle, highest Peak pressure rise was found to be 59.30 bar for diesel fuel, 57.44 bar for B20 fuel and highest IMEP was found to be 15.16 bar for diesel fuel, 15.03 bar for B20 fuel at 26˚bTDC injection timing.

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