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Comparative Analysis of Performance and Emission Charactristics of Neem Oil Using 3 And 4 Holes Injection Nozzle on DI Diesel Engine

Revansiddappa Byakod[1], Prasanna Phatate[1], Vinodkumar Kamble[1], Sharath Babu[1], M. C Navindgi[2]

[1]*UG Students, Department of Mechanical Engineering, PDA College of Engineering, Gulbarga-585102,*
[2]*Associate Professor, Department of Mechanical Engineering, PDA College of Engineering, Gulbarga-585102,*

ABSTRACT

Bio-diesel is one of the most promising alternatives for diesel needs. Use of edible oil may create shortage of oil seeds for daily food, which necessitates identification of new kinds of non-edible vegetable oil. With this objective, the present work has focused on the performance of neem non-edible vegetable oils and its blend with diesel.

In the present experimental investigation 5.2 kW diesel engine AV1 Single Cylinder water cooled, Kirloskar Make tested for blends of diesel with Castor and Neem Biodiesel. The viscosity of neem oil is reduced first by blending with diesel in 25/75%, 50/50%, 75/25%, and 100% on the volume basis, then analyzed and compared with diesel. The performance and emission characteristics of blends are evaluated at variable loads of 0, 1, 2, 3, 4, 5kw at constant rated speed of 1500rpm and results are compared with diesel. The tests were conducted for injection pressure of 160 bar with fuel injector of 3 holes and 4 holes. In this investigation it is found that the nozzle having 4 holes gives good performance results and lower rate of emissions. Thus the nozzle with 4 holes can be used preferably than the 3 holes nozzle.

Key words: **Performance, emission characteristics, Neem oil, Injectors, diesel Engine**

INTRODUCTION

Petroleum based fuels play a vital role in rapid depletion of conventional energy sources along [1]with increasing demand and also major contributors of air pollutants. Major portion of today's energy demand in India is being met with fossil fuels. Hence it is high time that alternate fuels for engines should be derived from indigenous sources. As India is an agricultural country, there is a wide scope for the production of vegetable oils (both edible and non-edible) from different oil seeds. The present work focused only on non-edible oils as fuel for engines, as the edible oils are in great demand and far too expensive. The past work revealed that uses of vegetable oils for engines in place of diesel were investigated. Though the concerned researchers recommended the use of vegetable oils in diesel engines, there was no evidence of any practical vegetable oil source engines.

The fuel injection performance is important for low emission combustion. During the last 20 years the maximum fuel injection pressure in the available systems has increased rapidly. Today injection pressures of about 250 bar are used and in the near future even higher pressures may be available. The development of electronic injection control has led to an increasing controllability of the injection event. Precise control of the fuel pressure, injection phasing and the use of multiple injections has increased the possibilities to influence the combustion process. This increased controllability together with the injection pressure increase is responsible for a large part of the emission reductions that have occurred in diesel engines during the past 20 years. Current combustion chambers for passenger car and truck diesel engines typically utilize direct injection system with a fairly shallow piston bowl and a central fuel injector with 5 – 8 holes. This paper outlines the main aspects of neem biodiesel as fuel in CI engine operated with fuel injector having 3 and 4 holes and injection pressure of 160 bar.

PROPERTIES OF OILS

In this project, neat vegetable oil such as neem oil is selected for experimentation. The properties of the oil are such as density, viscosity, flash point and fire point are determined using Hydrometer, Redwood Viscometer and Pensky Martin's Apparatus respectively. Table1 shows the properties of vegetable oil and diesel.

Table1: Properties of Neem and Diesel

Properties	Diesel	Neem oil
Calorific Value in kJ/kg	42500	37200
Density of Oil in Kg/m^3	0.8344	0.890
Kinematic Viscosity at 40°C in cSt	4.3	5.7
Flash point in °C	55	152
Fire point in °C	65	158

www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1162-1166 ISSN: 2249-6645

EXPERIMENTAL SETUP

The setup consists of single cylinder, four stroke, diesel engine connected to eddy-current dynamometer for variable loading. It is provided with necessary equipment and instruments for combustion pressure, fuel injection pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ-PV diagrams and fuel injection pressure- crank angle diagram. Windows based Engine Performance Analysis software package is fully configurable. Pθ-PV diagram and performance curves are obtained at various operating points. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurements with computer. The set has stand-alone type independent panel box consisting of air box, fuel tank, manometer, fuel measuring unit, differential pressure transmitters for air and fuel flow measurement, process indicator and engine indicator. The setup enables study of engine for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance.

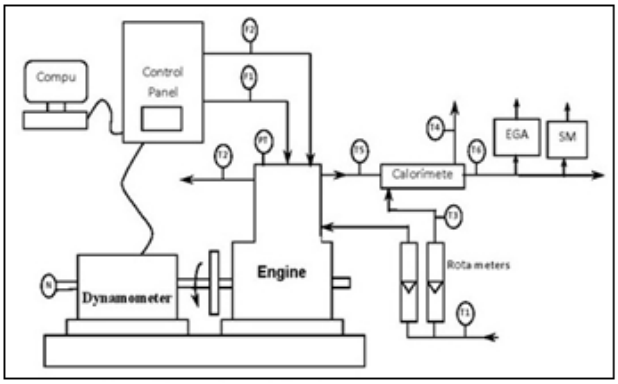

Figure1: Schematic diagram of Experimental Setup

Variable load tests are conducted for 0, 1, 2, 3, 4, and 5 KW at a constant rated speed of 1500 rpm. with fuel injection pressure of 160 bar, and cooling water exit temperature of 60°C. All observations recorded were replicated thrice to get a reasonable value.

The performance characteristics of the engine are evaluated in terms of brake thermal efficiency, brake specific fuel consumption (BSFC), brake specific energy consumption (BSFC), and exhaust temperature. Two gas exhaust gas analyse and smoke opacity meter are used to find the emission characteristics. These performance and emission characteristics are compared with the results of baseline diesel.

ENGINE SPECIFICATIONS:

Manufacturer	Kirloskar oil engines Ltd., India
Model	TV-SR, naturally aspirated
Engine	Single cylinder, DI
Bore/stroke	87.5mm/110mm
C.R.	16.5:1
Speed	1500r/min, constant
Rated power	5.2kw
Working cycle	four stroke
Injection pressure	200bar/23 def TDC
Type of sensor	Piezo electric
Response time	4 micro seconds

RESULT AND DISCUSSION

1. Brake thermal efficiency:

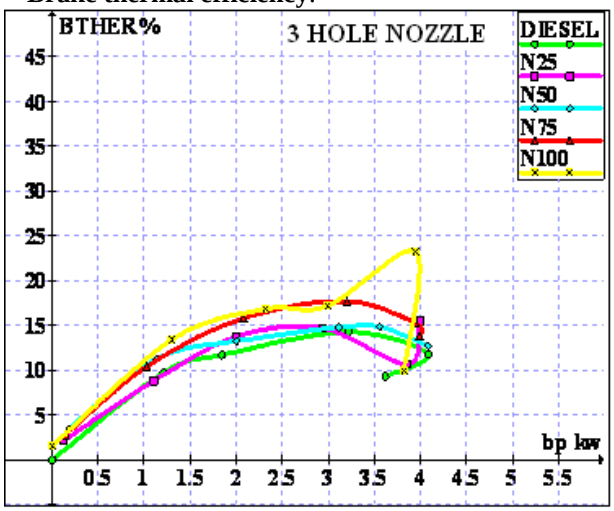

Fig.1(a) Break thermal efficiency vs bp with 3 hole nozzle

PT	Pressure transducer
N	Rotary encoder
Wt	Weight
F1	Fuel flow
F2	Air flow
F3	Jacket water flow
F4	Calorimeter water flow
T1	Jacket water inlet temperature
T2	Jacket water outlet temperature
T3	Calorimeter water inlet temperature = T1
T4	Calorimeter water outlet temperature
T5	Exhaust gas to calorimeter temperature
T6	Exhaust gas from calorimeter temperature

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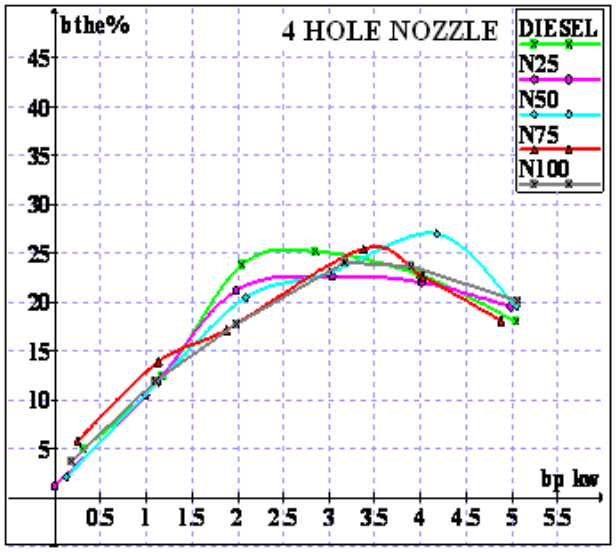

Fig.1(b) Break thermal efficiency vs bp with 4 hole nozzle

Figure 1(a) and (b) shows the comparison of break thermal efficiency with 3 hole nozzle and 4 hole nozzle for neem oil and its blends with respect to brake power. It was noticed that break thermal efficiency of 18.02% for diesel and 20.17% for N100 for 3 hole nozzle, and 14.88% for diesel and 25.08% for N25 was obtained for 4 hole nozzle. The main reason for increase in the brake thermal efficiency is due to more homogeneous mixture formation and spray characteristics.

2. Indicated thermal efficiency:

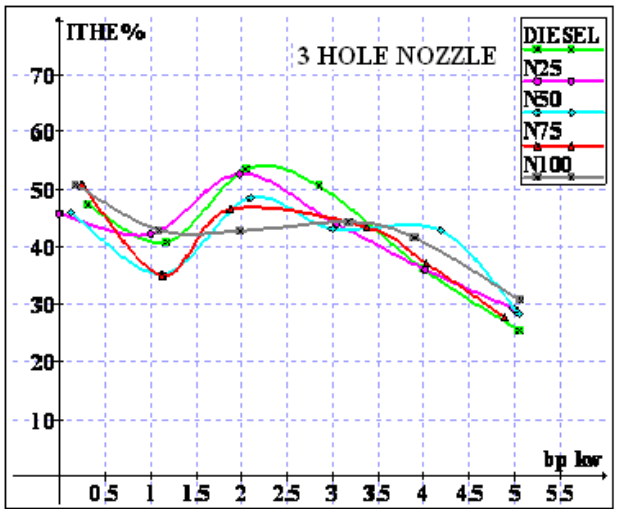

Fig.2(a) Indicated thermal efficiency v/s bp with 3 hole nozzle

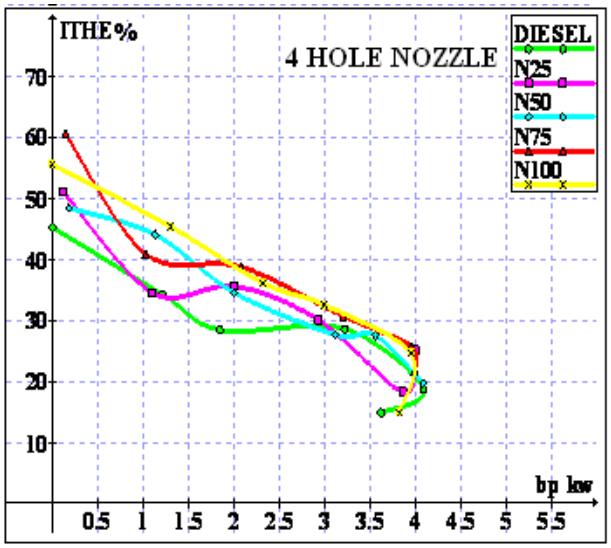

Fig.2(b) Indicated thermal efficiency v/s bp with 4 hole nozzle

Figure 2(a) and (b) shows the comparison of indicated thermal efficiency with 3 hole nozzle and 4 hole nozzle for neem oil and its blends with respect to brake power. It was noticed that indicated thermal efficiency of 25.47% for diesel and 30.62% for N100 for 3 hole nozzle, and 14.88% for diesel and 25.08% for N25 was obtained for 4 hole nozzle.

3. Specific fuel consumption:

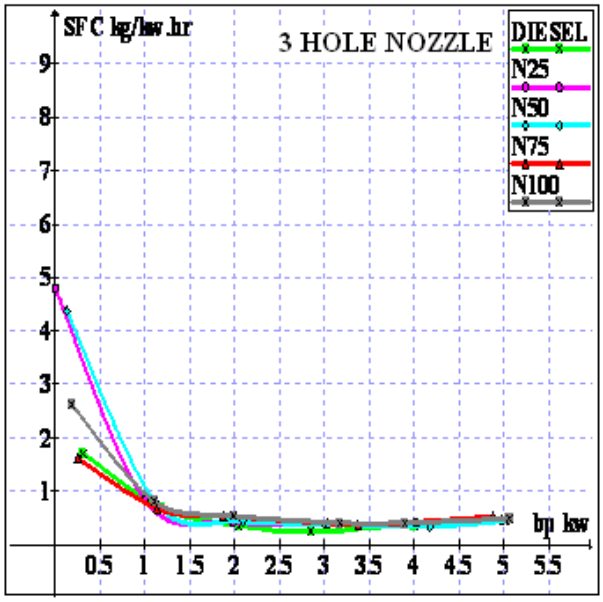

Fig.3(a) Specific fuel consumption v/s bp with 3 hole nozzle

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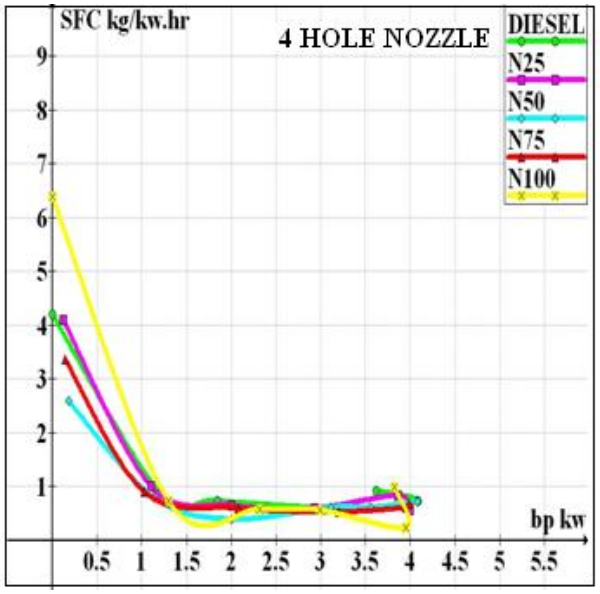

Fig.3 (b) Specific fuel consumption v/s bp with 4 hole nozzle

Figure 3(a) and (b) shows the comparison of specific fuel consumption of 3 hole nozzle and 4 hole nozzle for neem oil and its blends with respect to brake power. It was noticed that SFC of 0.47% for diesel and 0.44% for N25 for 3 hole nozzle, and 0.91% for diesel and 0.56% for N25 was obtained for 4 hole nozzle which is maintained due to presence of oxygen in the bio fuels.

4. Carbonmonoxide emission:

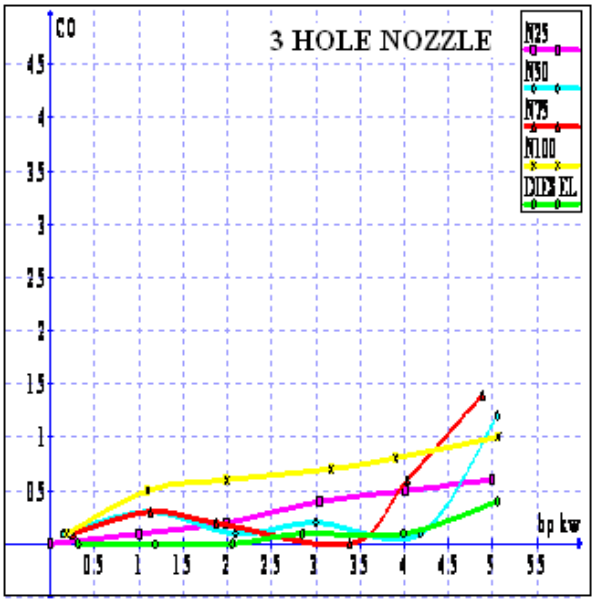

Fig.4(a) Carbon monoxide v/s bp with 3 hole nozzle

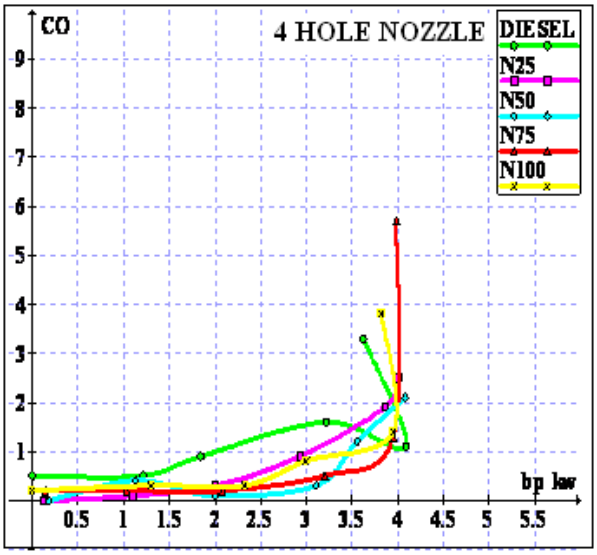

Fig. 4(b) Carbon monoxide v/s bp with 4 hole nozzle

Figure shows the comparison of carbon monoxide for 3 hole and 4 hole nozzle for neem oil and its blends with respect to brake power. It was noticed that Co emission of 0.4% volume for diesel and 0.6%volume for N25 for 3 hole and 3.3% volume for diesel and 2.1% volume for N50 for 4 holes nozzle was obtained which is maintained due to presence of oxygen in the bio fuels.

5. Hydro-carbon emission:

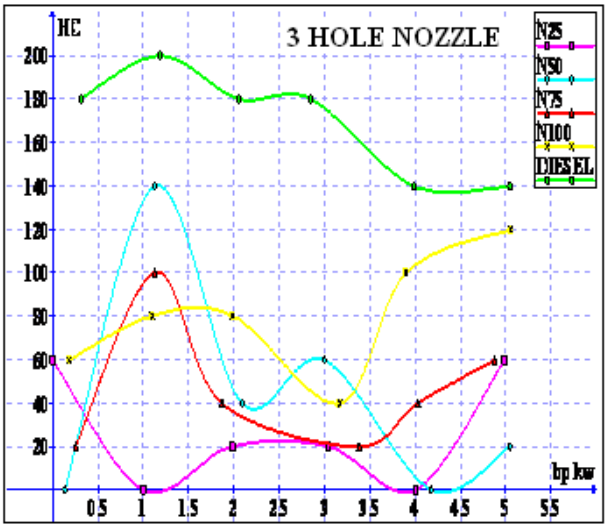

Fig 5(a) HC v/s bp with 3 hole nozzle

www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1162-1166 ISSN: 2249-6645

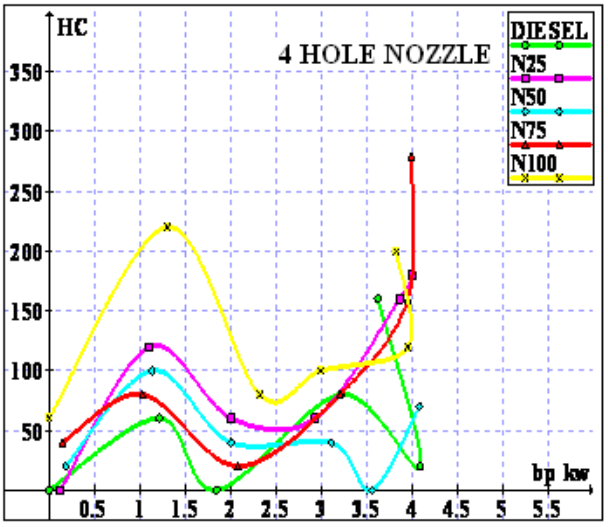

Fig 5(a) HC v/s bp with 4 hole nozzle

Figure shows the comparison of Hydrocarbon for 3 hole and 4 hole nozzle for neem oil and its blends with respect to brake power. It was observed that diesel has the maximum rate of hydrocarbon 140 ppm and hydrocarbon of 20 ppm for N50 for 3 hole nozzle among the tested fuels. It is also found that the hydrocarbon of 160 ppm for diesel and 70 ppm for N50 was obtained for 4 hole nozzle.

CONCLUSION

Experimental investigations are carried out on a single cylinder CI diesel engine to compare the performance and emission characteristics of neem oil using 3 and 4 holes nozzle. The performance characteristics of neem biodiesel and its blends are evaluated with 3 and 4 holes nozzle at 160 bars. From the above investigations, the following conclusions are drawn.

- The brake thermal efficiency for 3 hole nozzle is lower than that of 4 hole nozzle.
- The indicated thermal efficiency for 3 hole nozzle is also lower than that of 4 hole nozzle.
- The specific fuel consumption for 3 hole nozzle is slightly lower than the nozzle of having 4 holes.
- The emission of CO is more in 4 hole nozzle as compared with 3 holes nozzle.
- The amount of un-burnt hydrocarbons is more in 4 holes nozzle as compared with 3 holes nozzle.

Hence, from above investigation it is concluded that the nozzle which is having 4 holes gives good performance results but high rate of emissions. Thus the nozzle with 4 holes can be used preferably for good performance than the 3 holes nozzle.

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