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Experimental Investigation on Performance and Emission Characteristics of Di-Diesel Engine Running On Nelli-Oil

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ABSTRACT: *The increasing demand for fossil fuels and environmental threat, a number of renewable sources of energy have been studied worldwide. An attempt is made to assess the suitability of vegetable oil for diesel engine operation, without any modifications in its existing construction. One of the important factors which influence the performance and emission of diesel engine is fuel injection pressure. In the present investigation, Nelli oil is investigated at a constant speed, DI diesel engine with variable fuel injection pressure from 180bar to 220bar (In steps of 20 bar).The main objective of this study is to investigate the effect of injection pressures on a blend of 50% Nelli oil with 50% diesel fuel and compare with diesel on performance and emissions characteristics of the engine.Two tested fuels were used during experiments including 100 % diesel fuel and a blend of 50% Nelli oil by volume in the diesel. The tests were carried out for the above proportion of Nelli oil and diesel. The performance tests were conducted at 1500 rpm with loading of 20,40,60,80, and 100 percent of maximum load.From experiment results it was found that with Nelli oil - diesel blend the performance of the engine is better compared with diesel. The break thermal efficiency and mechanical efficiencies were found to be maximum at 200 bar injection pressure with both Nelli oil- diesel blend , compared with 180 bar and 220 bar. The brake specific fuel consumption was to be minimum at 220bar compared with 180 bar and 200 bar. Hydro carbon emissions of Nelli oil-diesel operation were less than the diesel fuel mode at all fuel injection pressures.*

Keywords : *fossil fuels , , Nelli oil , thermal efficiency .*

I. INTRODUCTION

Compression ignition engines are employed particularly in the field of heavy transportation and agriculture on account of their higher thermal efficiency and durability. However, diesel engines are the major contributors of oxides of nitrogen and particulate emissions. Hence more stringent norms are imposed on exhaust emissions. Following the global energy crisis in the 1970s and the increasingly stringent emission norms, the search for alternative renewable fuels has intensified. Probably in this century, it is believed that crude oil and petroleum products will become very scarce and costly to find and produce. Although fuel economy of engines is greatly improved from the past and will probably continue to be improved, increases in number of automobiles alone dictate that there will be a great demand for fuel in the near future.Another reason motivating the development of alternate fuels for the internal combustion engine is concern over the emission problems of gasoline engines. Combined with other air-polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. Quite a lot of improvements have been made in reducing emissions given off by an automobile engine. If a 35% improvement made over a period of years, it is to be noted that during the same time the number of automobiles in the world increases by 40% thereby nullifying the improvement. Lot of efforts has gone into achieving the net improvement. In cleaning up automobile exhaust. However, more improvements are needed to bring down the ever increasing air pollution due to automobile population.A third reason for alternative fuel development is the fact that a large percentage of crude oil must be imported from other countries which control the larger oil fields.

II. NELLI OIL

Common names for Nelli oil
English: Aonla,Emnelic myrobahala, Nelli, Indian goosederry.
Sanskrit: Adiphala, Akara,Dhatri,Shriphala,Vayastha,Umrita.
Hindi:Amlaki,Amliki,Aungra,Daula.
Tamil: Amalagam,Andakoram,Indul,Katu Nelli,Nellikai,Tani,Tanttri.
Malayalam: Amalakam,Boa malaca,Laka,Melaka.
Telugu: Amalakamu, Pullayusirika, Usirikaya, Usiriki, Usri.

Fig: 1.1 Nelli Fruit

Fig: 1.2 Seeds of nelli

Description : Nelli tree has been described extensively by many researchers i.e. Jayaweera (1981): Morton (1987); Pathak (2003); Pathak et al. (1993); Pushpakumara (2004); Tewari et al. (2001);Troup (1986); wealth of India (1985); Webster (1980).

Plant : Nelli is a small to medium-sized, much-branched tree, usually grows to 10-20 m in height, but sometimes reaching even up to 30 m. the stem is often crooked, usually buttressed and gnarled and may be thin, smooth, greenish gray-colored, glossy, consists of a distinct chlorophyll layer immediately below the surface, exfoliating, which peels off in thin flakes.

Nelli is a deciduous species, shedding its branchlets as well as its leaves. However, it is seldom entirely bare: hence often cited as an evergreen. The Nelli tree is characterized by its phyllanthoid branching habit with two types of shoots. The indeterminate shoots are longer, shoots do not fall from the tree, irrespective of period of their emergence. The determinant shoots appear on the nodes of indeterminate shoots and their numbers at each node may vary from 3 to 5 in different individuals. These shoots are short (internodes are also short) and bear small sized leaves. They do bear flowers, defoliate amd fall from indeterminate shoots. New determinate shoots emerge a few months after abscission of old shoots on indeterminate shoots. In matures trees, about two weeks after shoot emergence, they produce two rows of leaves, amd at the same tome flowers appear in the axils of the young leaves. The branches and branch lets spread, feathery-like glabrous or finely pubescent.

III. EFFECT ON INJECTION PRESSURE ON CI ENGINE:

The diesel engine is a type of internal combustion engine; more specifically, it is a compression ignition engine, in which the fuel ignited solely by the high temperature created by compression of the air-fuel mixture. The engine operates using the diesel cycle. The diesel engine is more efficient than the petrol engine, since the spark-ignition engine consumes more fuel than the compression-ignition engine. The used of diesel engines have extended in the last years to vehicles area due to their high efficiency also by economic fuel cost. In present diesel engines, fuel injection systems have designed to obtain higher injection pressure. So, it is aimed to decrease the exhaust emissions by increasing efficiency of diesel engines. When fuel injection pressure is low, fuel particle diameters will enlarge and ignition delay period during the combustion will increase. This situation leads to increase pressure. Engine performance will be decrease since combustion process goes to a bad condition. When injection pressure increased of fuel particle diameters will become small. Since formation of mixing of fuel to air becomes better during ignition period, engine performance will be increase. If injection pressure is too higher, ignition delay period becomes shorter. Possibilities of homogeneous mixing decrease and combustion efficiency falls down. The fuel injection system in a direct injection diesel engine is to achieve a high degree of atomization in order to enable sufficient evaporation in a very short time and to achieve sufficient spray penetration in order to utilize the full air charge. The fuel injection system must be able to meter the desired amount of fuel, depending on engine speed and load, and to inject that fuel at the correct time and with the desired rate. Further on, depending on the particular combustion chamber, the appropriate spray shape and structure must be produced. Usually, a supply pump draws the fuel from the fuel tank and carries it’s through a filter to the high-pressure injection pump.

VI.EXPERIMENTAL SETUP & PROCEDURE

4.1 INTRODUCTION:

The details of the experimental set up are presented in this chapter the alternations made to the instrumentation are also described .The experimental setup is fabricated to fulfil the objective of the present work. The various components of the experimental set up including modification are presented in this chapter.

4.2 EXPERIMENTAL SET UP:

The experimental set up consists of engine, an alternator, top load system, fuel tank along with immersion heater, exhaust gas measuring digital device and manometer.

Engine:

The engine which is supplied by M/s. New Kissan Company the engine is single cylinder vertical type four strokes, water-coo1ed, compression ignition engine. The engine is self-governed type whose specifications are given in Appendix 1.is used in the present work.

4.3 REASONS FOR SELECTING THE ENGINE:

The above engine is one of the extensively used engines in industrial sector in India. This engine can with stand the peak pressures encountered because of its original high compression ratio. Further, the necessary modifications on the cylinder head and piston crown can be easily carried out in this type of engine. Hence this engine is selected for the present project work.

Dynamometer:

The engine is coupled to a generated type electrical dynamometer which is provided for loading the engine.

Fuel injection pump:

The pump is driven by consuming some part of the power produced by the engine; it will provide the required pressure to the injector. The pump is BOSCH fuel injection pump.

Fuel injector (BOSCH):

A cross sectional view of a typical BOSCH fuel injector
The injector assembly consists of

i. A needed valve
ii. A compression spring
iii. A nozzle
iv. An injector body

U-tube manometer:

The one of end of the U-tube manometer is connected to the orifice of the air tank and the other end is exposed to the atmosphere, the manometer liquid used is water.

Digital thermometer:

It consists of a temperature sensing element connected to the electronic digital display which is operated by battery

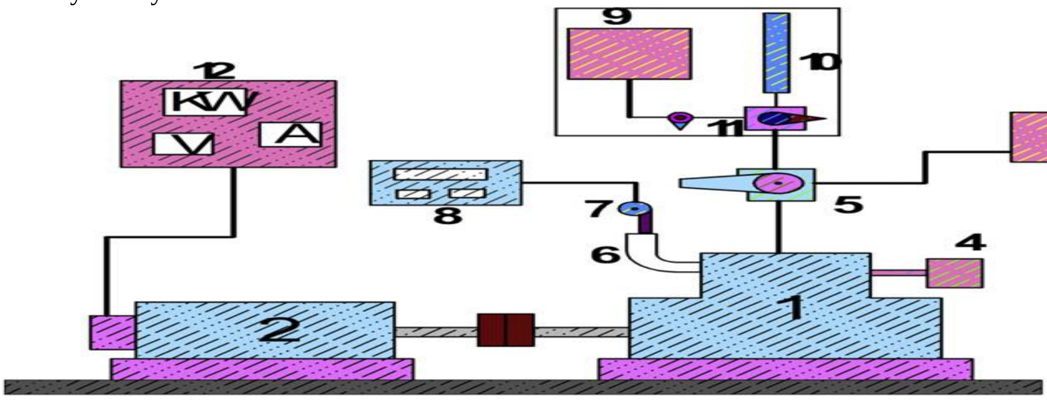

Figure 3.1

V. CALCULATIONS

The parameters that are determined at different loads are as fallows

Sample Calculations for Diesel at 200bar at full load:

1 Brake Power, B.P = $\frac{VIcos\emptyset}{\eta_{tran} \times \eta_{gen} \times 1000}$ kW

Where,

V = voltage, volts

A = current, amperes

Cos $\emptyset$ = Power factor = 1

η_{tran} = Transmission Efficiency = 0.98

η_{gen} = Generator Efficiency = 0.9

Brake Power, B.P = $\frac{230*9.5*1}{0.98 \times 0.9 \times 1000}$ kW

Brake Power, B.P =2.477 kW

2 T.F.C = $\frac{20 \times 0.85 \times 3600}{t \times 1000}$ Kg/hr

Where,

T.F.C = Total Fuel Consumption, Kg/hr

Specific gravity of diesel = 0.85

t = Time taken for 20 c.c fuel, seconds

T.F.C = $\frac{20 \times 0.85 \times 3600}{69 \times 1000}$

T.F.C = 0.886 Kg/hr

3. Brake Specific Fuel Consumption, bsfc = $\frac{T.F.C}{B.P}$ Kg/kwhbsfc = $\frac{0.886}{2.477}$

= 0.357 Kg/kwh

4. Heat Input = T.F.C X C_V kW

Where, C_V = Calorific Value of Fuel, kJ/kg k

= 0.886 X 43000/3600

= 10.582 kW

5. Frictional Power, F.P = kW (from graph by William's line method)

= 1.80kW

6. Indicated Power = B.P + F.P

Indicated Power = 2.477 +1.80 =4.277 kW

7. Mechanical efficiency = $\frac{B.P}{I.P}$ x 100 %

= $\frac{2.477}{4.277}$ x 100 %

η_{mech} = 57.914 %

8. Brake thermal efficiency = $\frac{B.P}{Heat\ Input}$ x 100 %

= $\frac{2.477}{10.582}$ x 100 %

= 23.407 %

9. Indicated thermal efficiency = $\frac{I.P}{Heat\ Input}$ x 100 %

= $\frac{4.277}{10.582}$ x 100 %

= 40.417 %

10. Brake Mean Effective Pressure, bmep = $\frac{B.P \times 60}{L \times A \times n \times k}$ kN/m^2

Where L = length of the stroke, m n = speed of the engine = 1500/2

A = Area of the cylinder, m^2 k = no. of cylinders

$$= \frac{2.477 * 60}{\frac{\pi}{4} \times (0.85)^2 \times 0.110 \times \frac{1500}{2 \times 60}} X100\ \%$$

= 317. 464 kN/m^2

11. Indicated Mean Effective Pressure, Imep = $\frac{I.P \times 60}{L \times A \times n \times k}$ kN/m^2

$$\frac{3.646 \times 60}{0.110 \times \frac{\pi}{4} \times (0.85)^2 \times \frac{1500}{2} \times 1}$$

= 548.161 kN/m^2

12. Volumetric efficiency, η_{vol}= $\frac{actual\ volume\ flow\ rate\ of\ air}{the\ rate\ at\ which\ volume\ is\ displaced}$ x 100 %

$= \frac{area\ of\ inlet\ pipe \times velocity\ of\ air}{\begin{bmatrix} area\ of \\ the\ cylinder \end{bmatrix} \times \begin{bmatrix} length\ of \\ the\ stroke \end{bmatrix} \times \begin{bmatrix} revolutions \\ per\ second \end{bmatrix}}$ x 100%

$$= \frac{\frac{\pi}{4} \times (0.033)^2 \times 5.8}{\frac{\pi}{4} \times (0.85)^2 \times 0.110 \times \frac{1500}{2 \times 60}} X100\ \%$$

= 63.579 %

Table: 4.1 Observations of pure Diesel at 180 pressure bar:

S.N0	Load	Speed	Voltage	Current	Time taken for 20cc of fuel	Air flow velocity	Exhaust gas temperature
	W	rpm	v	amp	sec	m/sec	0_C
1	0	1500	230	0	115	3.5	275
2	500	1500	230	3.0	97	4.0	300
3	1000	1500	230	4.0	89	4.3	345
4	1500	1500	230	5.0	82.5	4.7	367
5	2000	1500	230	5.8	76.2	4.9	386
6	2500	1500	230	7.0	70.5	5.1	406
7	3000	1500	230	8.0	64.5	5.3	440

VII. CONCLUSION

The engine was made to run on diesel fuel mode, and nelli oil- diesel mode. The experiments were conducted at 3 different fuel injection pressures of 180 bar, 200 bar and 220 bar. The performance and emission of the engine at full load were investigated. The following results were obtained.

The engine was able to run on 180 bar, 200 bar and 220 bar fuel injection pressures on diesel fuel mode and nelli oil- diesel mode.

- Brake specific fuel consumption for the nelli oil-diesel blend when compared with diesel is than the BSFC with 0.358 kg/kWhr at 180bar,0.325 kg/kWhr at 200bar and 0.284 kg/kWhr at 220bar.
- The brake thermal efficiency of the engine for nelli oil- diesel blend of operations is high compared to diesel mode at 180,200 and 220bar.
- The exhaust gas temperature of nelli oil-diesel blend mode is less compared to diesel mode at fuel injection pressures of 180,200 and 220 bar.
- HC emissions of nelli oil-diesel blend mode is lower compared to that of diesel fuel mode at all fuel injection pressures.
- CO emissions of nelli oil-diesel blend mode is lower compared to that of diesel fuel mode at all fuel injection pressures.
- NO_X emissions of nelli oil-diesel blend mode is lower compared to that of diesel fuel mode at all fuel injection pressures.

From the above analysis the main conclusion is nelli oil blend are suitable substitute for diesel at high injection pressure, at produce lesser emission and better performance then diesel.

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