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Effect of Fuel Injection Pressures on Performance Characteristics and Emission Analysis of D.I Diesel Engine Running on Honne Oil and Diesel Fuel Blend

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ABSTRACT

In future demand for fossil fuels and environmental effects, a number of renewable sources of energy has been studied in worldwide. An attempt is made to apt of vegetable oil for diesel engine operation, without any change in its old construction. One of the important factors which influence the performance and emission characteristics of D.I diesel engine is fuel injection pressure. In this project honne oil has to be investigated in a constant speed, on D.I diesel engine with different fuel injection pressures.

The scope of the project is to investigate the effect of injection pressures on a blend of 50% honne oil with 50% diesel and compare with pure diesel on performance and emission characteristics of the diesel engine. Two tested fuels were used during experiments like 100 % diesel and a blend of 50% honne oil mixing in the diesel. The performance tests were conducted at constant speed with variable loads.

From experiment results it was found that with honne 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 honne 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 honne oil-diesel operation were less than the diesel fuel mode at all fuel injection pressures.

Keywords—*Direct injection diesel engine;Fuel injection pressure; Honne oil; Gas analyser.*

1 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.

1.1 HISTORY OF HONNE OIL

It is a one type of alternative fuel. It's scientific name is "Calophyllum inophyllum" It is made from the fully mature fruits [Yellow or Red-brown]. In that fruits, seeds can be crush then "crude calophyllum oil [Thick dark Green]"is extracted. After pretreatment [Esterification & Transesterification] the oil is employed. Common names for Honne oil in different languages are 'Indian laurel', Alexandrian Laurel, Beach calophyllum, Beauty leaf, Pannay tree, Sweet Scented Calophyllum (in English), Pong yet, Burmese, Hawaii, Kokani, Nagachampa, (in Marathi), Sultan Champa,Surpan (in Hindi),Nagam, Pinmai, Punnagam, Punnai, Pinnay, Namere (in Tamil), Nagachampa, panchkesara, punnaga(in Sanskrit), hone tree(in Kannada), poona or puna(in Telugu)

Figure-1.1: Prematured fruit bunch

1.2 DESCRIPTION OF HONNE PLANTATION

Calophyllum inophyllum is primarily a tree of the seashore and adjacent lowland forests. It grows in areas with annual ranging from about 1000 to 5000 mm and maximum temperatures ranging from 30 to 35 ^{0}C. Humidity variations recorded in areas of its natural distribution are 60 to 100 percent in July and 60 to 80 percent in January.Trees, up to 20 m tall with spreading crown; bark brown to pale grey; often mottled with wide boat-shaped fissures; exudate milky or yellow; branchlets compressed or slightly flattened. Leaves opposite, broadly elliptic-oblong or obovate, 15-20x5-9 cm, cuneate to rounded at base, rounded or subacute at apex, thinly coriaceous; midrib prominent below, venation distinct, close, raised on both surfaces giving the blade a seriate appearance; petioles stout, flat. Flowers in 5-15-flowered, 5-13 SScm long axillary racemes, polygamous, marble white, fragrant. Sepals . Petals usually . Stamens numerous (175-440), connate into 4-6 bundles; anthers rounded, yellow when young, brownish at maturity. Ovary, globose, depressed, pink or light purple after pollination. Fruit a drupe, globose or spherical to obovoid, 2.5-5x2.5-4 cm, yellowish when ripe. Seed solitary, subspherical, up to 2 cm across. The greenish yellow oil obtained from the calophyllum seeds was used as alternative to candlenut oil in lamps. It may be used for hair oil. It was also used to furnish wooden bowls1 and for cosmetic and topical applications for healing of burns and skin diseases. As calophyllum oil is a significant topical healing agent with skin healing, anti-inflametory, antimicrobial properties. The oil can also used for soap making. Oil contains benzoic and oxi-benzoic acids. Small amount of vitamin F and phosphor aminolipids come along with glycerides and saturated fatty acids. The plant contains free fatty acids, glycerides and steroids (canophyllal, canophyllol. Canoophyllic\acids). Filtered calophyllum oil is applied to wounds possesses the capacity to promote the formation of new tissue, thereby accelerating healing and growth of healthy skin. This process of forming new tissue is known as 'ciatrisation' the oil is a widely used as a traditional topical aid. In coastal area some peoples uses calophyllum oil for applying to cuts, scrapes, soriasis, diabetic sores,anal fissures, sunburn, dry or scaly skin, blisters and to relieves sore throat when it is applied topically to the neck. The oil also demonstrates pain relieving properties and has been used traditionally to relieve neuralgin, rheumatism and sciatica. The calophyllum oil also demonstrates anti-inflamatory activity which has 4-phenyicoumarin calophylloidea and a group of xanthones including dehydrocycloguanandin, calophyllin-B, jacareubin, mesuaxanthone-A, mesuaxanthone-B and euxanthone. These all xanthones explaines reductions of rashes, sores, swelling and abrasions with topical applications. Chemical name is proponone and formula is $C_3H_8O_3$.

1.3 PROPERTIES OF HONNE OIL

Properties of Honne oil is shown in given table

Table.1.1 Properties of Honne oil

Properties	**Diesel**	**Honne oil**
Kinematic viscosity at 40 ^{0}C (cs)	4.59	32.47
Density at 15 ^{0}C (kg/m^{3})	850	910
Flash point (^{0}C)	52	224
Calorific value (kJ/kg)	43000	39100
Specific gravity	0.85	0.91

2. EFFECT ON INJECTION PRESSUR ON C.I 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.

Effects of injection pressure on engine performance have investigated on a unit pump system direct injection diesel engine. The diesel engine performance and fuel consumption have been measured at constant speed with varying loads by changing the fuel injection pressure. In the investigation is the effect of injection pressure are conducted using honne oil diesel blend ratio (50:50) which is called as B-50 is used at the different fuel injection pressures (180 to 220 bar).When fuel injection pressure is low, fuel particle diameters will enlarge and ignition delay period during the combustion will increase. This situation leads to inefficient combustion in the engine and causes the increase in NOx, CO emissions. When the injection pressure is increased fuel particle diameters will become small. The mixing of fuel and air becomes better during ignition delay period which causes low CO emission. But, if the injection pressure is too high ignition delay become shorter. So, possibilities of homogeneous mixing decrease and combustion efficiency falls down.

3. EXPERIMENTALSETUP& PROCEDURE

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

3.1VARIOUS PARTS OF EXPERIMENTAL SETUP

The experimental set up consists of engine, an alternator and top load system, fuel tank along with immersion heater, exhaust gas measuring digital device etc.,. Schematic diagram of the experimental set up as shown below.

1. 4-Stroke Single Cylinder Water Cooled C.I Engine. 2. Dynamometer 3. Diesel Tank 4. Air Filter, 5. Three Way Valve 6. Exhaust Pipe 7. Probe, 8. Exhaust Gas Analyser 9. Alternative Fuel Tank 10. Burette 11. Three Way Valve 12. Control Panel

Figure-3.1: Various Parts of Experimental Setup

3.2 SPECIFICATIONS OF THE ENGINE

Table-3.1. Specifications of the Engine

Engine	4-stroke, 1-cylinder, water cooled, D.I diesel engine
Rated power	5hp
Speed	1500 rpm
Bore	80 mm
Stroke	110 mm
Calorific value(C.V)	43000 kj/kg
Specific Gravity	0.85 kg/m^3
DischargeCo-efficient	0.62
Orifice diameter	0.033m
Torque arm length	0.2m
Densityu of air(ρ_{air})	1.293 m^3/kg

3.3 EXPERIMENTAL PROCEDURE

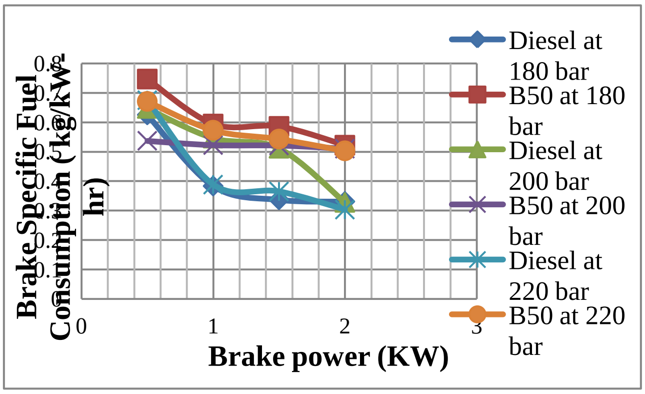
Before starting the engine, the fuel injector is separated from the fuel system. it is clamped on the fuel injection pressure tested and operates the tester pump. Observe the pressure reading from the dial. At which the injector starts spraying. In order to achieve the required pressure by adjusting the screw provided at the top of the injector .This procedure is repeated for obtaining the various required pressures.

- The injection pressure is set at 180 bar for the entire test.
- Always the engine was started with no load condition
- The engine was started at no load condition and allowed to work for at least 10 minutes to stabilize.
- Initially engine was run with the pure diesel with the injection pressure of 180 bar. Engine was run from no load to full load condition with an increment of 20% of load in each run.
- Once the steady state is reached the parameters such as the Manometer reading, Time taken for 20cc fuel consumption, Voltage, Ammeter reading, Velocity of air, exhaust emissions NOx, Co_2, HC, CO and Exhaust gas temperature etc., were taken as per the observation table.
- Engine was then run on blends of Honne oil and diesel mixed in 50% by volume represented by B_{50}, respectively. Performance parameters and the emissions were noted.
- Whole set of experiments were repeated for fuel injection pressure 200 bar and 220 bar.
- After completion of test, the load on the engine was completely relieved and then the engine was stopped.
- The results were calculated as follows.

Finally, the engine is run by honne oil diesel blend at various injection pressures the corresponding observations are noted.

4. RESULTS AND ANALYSIS

4.1BRAKE SPECIFIC FUEL CONSUMPTION

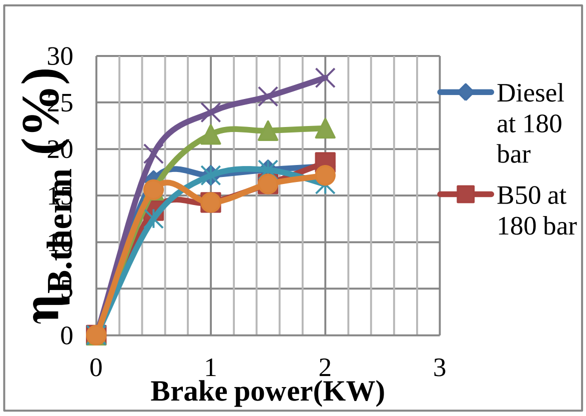


Graph 4.1: Brake power (vs.) B.S.F.C

- It is clearly observed that the fuel injection pressure of 220 bar gives less fuel consumption for pure diesel and blended oil.when compared to 180 & 200 bar.

- Hence it is observed that the BSFC at 220 bar is 0.52 Kg/Kw-hr for 180 & 200 bar it is increased 8.4% and 7.1%respectively compared to 220 bar at rated load.

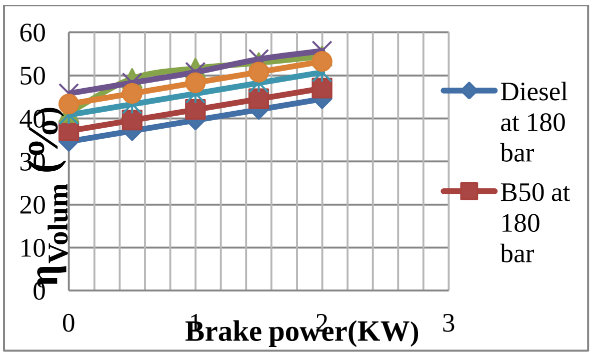
4.2 Brake Thermal Efficiency:



Graph4.2: B.P (vs) Brake thermal efficiency, $\eta_{B.Therm}$

- The above table shows the variation of brake thermal efficiency at rated load. It is clearly observed that the fuel injection pressure of 200 bar gives higher $\eta_{B.Therm}$ for blended oil and pure diesel due to less fuel consumption.
- Hence it is observed that $\eta_{B.Therm}$at 200 bar is 29.81% in favor of 180 and 220 diminish 45.031% and 23.989% in that order appraise to 200 bar.

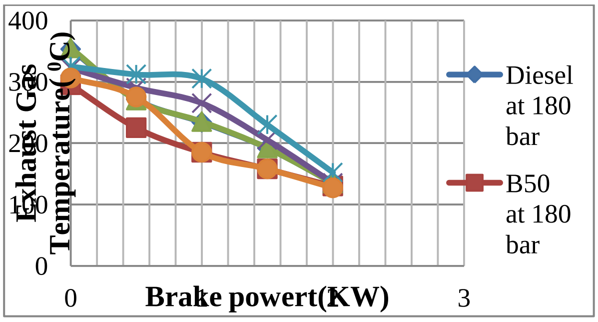
4.4 VOLLLUMATRIKEFFICIENCY:



Graph 4.4: B.P (vs.) volumetric efficiency.

- Volumetric efficiency is higher at 200 bars when compared to 180 bar and 220 bar.
- Hence it is observed that η_{volum} at 200 bar is 55.25% for 180 & 220 bar it is reduces 21.611% and 10.425 %respectively compared to 200 bar at rated load.

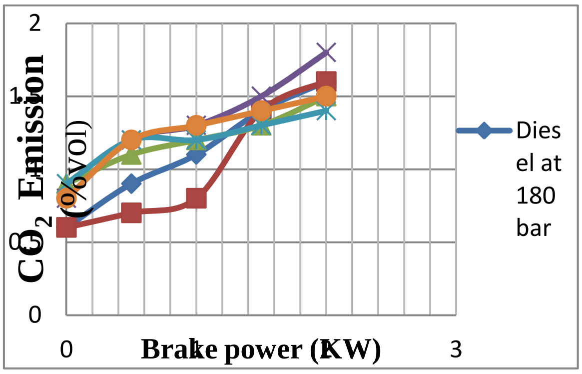
4.5 Exhaust Gas Temperature:



Graph 4.5 : Brake power (vs.) EGT

- EGT is low at 220 bar due to the effective combustion was taking place during the early part of expansion stroke.
- Hence it is observed that EGT at 220 bar is 205 °c for 180 bar and 200 bar it increased 0.3170°c,0.1219 °c respectively compared to 220 bar at rated load.

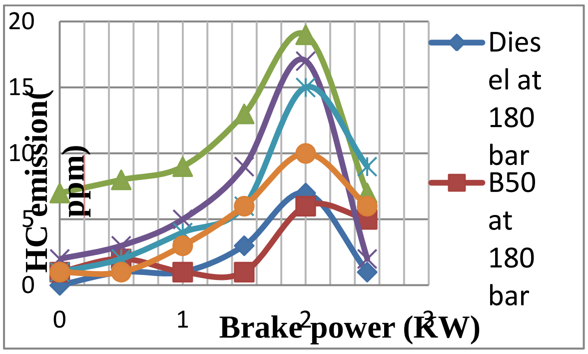
4.6 CARBBON DIOXID EMISSION



Graph4.6: B.P (vs.) Carbon dioxide

- It is clearly observed that the F.I.P of 220 bar gives high CO_2 emission for pure diesel and blended oil when compared to 180 and 200 bar.
- Hence it is observed that the CO_2 emission at 220 bars is 1.54%vol, for 180 bars and 200 bar it is dwindle 0.243 % vol and 0.0344 % vol respectively compared to 220 bar at rated load

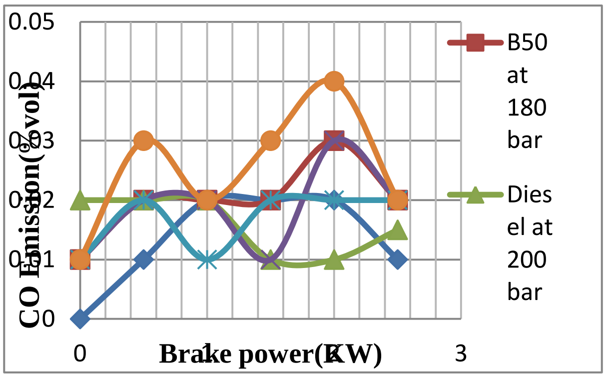
4.7 HC Emission:



Graph 4.7: Brake power (vs.) Hydro carbons

- ➢ It is clearly observed that the fuel injection pressure of 220 bars gives less HC emission for pure diesel and blended oil when compared to 180 and 200 bars.

4.8 CARBEN MANOXYDE EMISSION



Graph4.8: Brake power (vs.) Carbon monoxide

- ➢ It is clearly observed that the fuel injection pressure of 220 bars gives less CO emission for pure diesel and blended oil when compared to 180 bars and 200 bar.
- ➢ Hence it is observed that the CO emission at 220 bars is 0.01 %vol, for 180 bars and 200 bar it is increased 1 %vol and 1.5 %vol respectively compared to 220 bar at rated load.

5. CONCLUSION

- The exhaust gas temperature of honne oil-diesel mode is less compared to diesel mode at fuel injection pressures of 180,200 and 220 bar.
- CO emission of honne oil-diesel mode is higher compared to that of diesel fuel mode at all fuel injection pressures.
- CO_2 emission increased up to the fuel injection pressure of 200 bar for honne oil-diesel mode and then decreased slightly at 220 bar injection pressure.
- CO emission decreased with increase in fuel injection pressure from 180 bar to 220 bar for fossil diesel mode of operation.
- HC emission of honne oil-diesel operation is less than the diesel fuel mode at 180 bar fuel injection pressure.

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

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FEATURE SCOPE

To increase the nozzle hole size and Check the performance

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