R. Bhaskar Reddy Int. Journal of Engineering Research and Applications www.ijera.com
ISSN : 2248-9622, Vol. 4, Issue 8(Version 1), August 2014, pp.10-20

RESEARCH ARTICLE OPEN ACCESS

Performance Characteristics and Analysis of 4-Stroke Single Cylinder Diesel Engine Blend With 50% of Honne Oil at Various Fuel Injection Pressures

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ABSTRACT
In future demand for fossil fuels and environmental effects, a number of renewable sources of energy have 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.

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.

1.1 NEED FOR ALTERNATE FUELS

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

1.2 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)

1.2.1 HONNE PLANTATION

Figure-1.1: Calophyllum seedling

Figure-1.2: Flowers of calophyllum

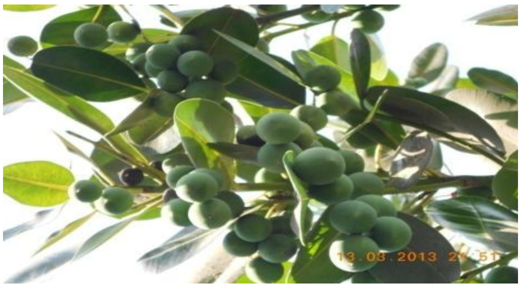

Figure-1.3: Prematured fruit bunch

Figure-1.4: Fresh fruit with shell

1.2.2 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 costal 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 of the oil.

- **Flowering:** Probably flowering throughout the year with several flushes.
- **Fruiting:** December - October.

- **Distribution in India:** Common in coastal regions. Orissa, Maharashtra, Karnataka, Tamil Nadu, Kerala, Lakshadweep and Andaman & Nicobar Islands. Tropical East Africa to Taiwan, New Caledonia.

Uses: Seed oil is used for soap making, burning, for painting work and also as a lubricant; a substitute for castor oil. Wood reddish white or reddish brown. The timber is durable under water and is used for beams, furniture, railway carriages, cooperage, crane shafts and ship building, especially for keels and for pully blocks. It is also used for fishing boats and cabinet work. Bark boiled in water is used for dyeing fishing nets. Cultivated as an ornamental and for shade throughout India. The root is used for treating ulcers; the resin is used as a purgative, emetic, applied to wounds and ulcers; bark astringent, used in internal haemorrhage; decoction of bark applied in indolent ulcers; pounded bark used in orchitis and its juice used as purgative; leaf is used in soar throat, vertigo and migraine; leaf soaked in water and applied to inflated eyes; the decoction of flower is given to cure syphilis, eczema and insanity; seed oil known variously as Wundi; Pinnay; Domba; Dillo; or Poonseed oil applied externally in rheumatism and skin diseases. Refined oil is injected intramuscularly to relieve pain in leprosy. Chemical name is proponone and formula is $C_3H_8O_3$.

1.2.3 PROPERTIES OF HONNE OIL

properties of Honne oil is shown in given table

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

Table.1.1 Properties of Honne oil

II. BASIC PERFORMANCE CHARACTERISTICS

The following are the basic Performance characteristics as shown below.

- ❖ Power, Torque And Mechanical efficiency
- ❖ Mean effective pressure
- ❖ Specific output
- ❖ Volumetric efficiency
- ❖ Fuel-Air ratio (or) Air –Fuel ratio
- ❖ Specific fuel consumption
- ❖ Thermal efficiency and Heat balance
- ❖ Exhaust smoke and Other emissions
- ❖ Specific weight

❖ **Power Torque And Mechanical efficiency:**

Power is the rate of doing work and is equals to the product of torque and angular velacity. It is denoted by 'P'. It is usually expressed in kilowatts (K.W).

P= Torque×Angular velacity=□ × □

P=Force×Speed = F×N

P=2π N T

Torque is measured by Dynamometer and Speed is measured by Tacometer.

Power is classified in to three types. Like

1)Brakepower(B.P) 2)Frictional powewr(F.P) 3) Indicatedf power(I.P)

1) Brake power(B.P): Power developed by an engine at out put shaft is known as brake power. It is obtained by deducting various power losses in the engine from the indicated power it is measured with a dynamometer. It is usually expressed in kilowatts (K.W).

B.P=2π N T/60000 in kw

In other words brake power is defined as BrakePower,B.P=

$$\frac{VIcos\emptyset}{\eta_{tran} \times \eta_{gen} \times 1000} \text{ kw}$$

Where,

V = voltage, volts;

A = current, amperes; Cos Ø= Power factor = 1

η_{tran}= Transmission Efficiency = 0.98; η_{gen} = Generator Efficiency = 0.9

2) Frictional powewr(F.P): It is the power loss to overcome the friction between the piston, piston rings and the cylinder walls. It is usually expressed in kilowatts (K.W).

3) Indicatedf power(I.P): The total power developed by combustion of fuel in the combustion chamber is called indicated power. It is usually expressed in kilowatts (K.W).

I.P=B.P+F.P in kw

❖ **Engine Torque:**

It is the force of rotation acting about the cranks shaft axis at any given instant of time.It is given by

Here, T=F*R

T =Engine torque (vm); F =Force Applied to crank (n); R= Effective crank radius (m).

As the value of 'r' varies during the power-stroke the torque on the power- stroke is continually varying. Moreover there is no torque delivered during the three idle strokes.

Therefore the engine manufactures always quote the average value of torque throughout the engine cycle. Engine torque goes through the vehicle transmission system to the road wheel and is responsible for rotation of the latter and hence for pulling of the vehicle.

- **Mechanical efficiency(η_{mech}):** It is the ratio of brake power to the indicated power. It is expressed by percentage(%).

Mechanical efficiency(η_{mech}) = brake power/indicated power = BP/IP

- **Mean effective pressure(M.E.P):**

The average pressure which is acting on the cylinder, it is a hypothycal pressure which is to be acting on the piston throughout the power stroke is known as mean effective pressure. It is expressed in bars or kilo Pascal's (1 bar=100kps).

I.P = (P_{imep}LAnK)/60000 in kw

Here,

n= No.of power strokes [n=N/2, for 4-strokes and n=N, for 2-strokes]

N = Speed = 1500 rpm; K= No.of cylinders; L= Stroke length =0.110 mm

A= Piston area = $\frac{\pi}{4}x(0.08)^2$= 0.0050mm^2

; P_{imep} = Mean effective pressure

These are divided into three types they are:

1) Indicated mean effective pressure
2) Brake mean effective pressure
3) Frictional mean effective pressure

1) **Indicated mean effective pressure:** If the mean effective pressure is based on indicated power is called as Indicated mean effective pressure(I.M.E.P)

$$\text{Indicated Mean Effective Pressure (I.M.E.P)} = \frac{\text{I.P x 60}}{\text{L x A x n x k}}$$

$$= \frac{\text{I.P x 60}}{0.110 \text{ x } \frac{\pi}{4} x(0.08)^2 \text{ x } \frac{1500}{2} \text{ x 1}}$$

2) **Brake mean effective pressure:** If the mean effective pressure is based on brake power is called as Indicated mean effective pressure (B.M.E.P)

Brake Mean Effective Pressure (B.M.E.P),

$$= \frac{\text{B.P x 60}}{\text{L x A x n x k}}$$

Where L = length of the stroke, mm
n = speed of the engine = 1500/2
A = Area of the cylinder, mm^2
k = no. of cylinders

$$= \frac{\text{B.P x 60}}{0.110 \text{ x } \frac{\pi}{4} x(0.08)^2 \text{ x } \frac{1500}{2} \text{ x 1}}$$

3) **Frictional mean effective pressure:** If the mean effective pressure is based on frictional power is called as Indicated mean effective pressure(F.M.E.P)

I.M.E.P =B.M.E.P+F.M.E.

- **Specific output:**

Brake output per unit of piston displacement is known as specific output.For the same piston displacement and same mean effective pressure of an engine running at high speed will produce more output.

Specific Output =B.P/(A×L)

- **Volumetric efficiency(η_{vol}):**

It is the ratio of mass of the charge actualy induce to mass of the charge corresponding to the cylinder volume at intake pressure and temparature.

(or)

It is the ratio of mass flow rate of air intake to the swept volume.

Volumetric efficiency(η_{vol}) = Mass flow rate of air intake/Swept volume

$$\eta_{vol} = m_a/\rho_{ai}V_s$$

$$\text{Volumetric efficiency, } \eta_{vol} = \frac{\text{actual volume flow rate of air}}{\text{the rate at which volume is displaced}} \text{ x100\%}$$

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

- **Fuel-Air ratio (F/A ratio):**

It is the ratio of mass of the fuel to the mass of the air in the fuel-air mixture.

Fuel-Air ratio = Mass of the fuel/ Mass of the air

F/A ratio = m_f/m_a

- **Air –Fuel ratio(A/F ratio):**

It is the ratio of mass of the air to the mass of the fuel in the air- fuel mixture.

Air -Fuel ratio = Mass of the air/Mass of the fuel

A/F ratio = m_a/m_f

m_a = Mass of the air;
m_f = Mass of the fuel

<u>**Note:**</u> Normal operating ranges for,

S.I engine(Gasoline fuel) is

$12 \le A/F \le 18 [0.056 \le F/A \le 0.083]$

C.Iengine(Dieselfuel) is

$18 \le A/F \le 70 [0.014 \le F/A \le 0.056]$

- **Specific fuel consumption (S.F.C):**

The amount of the fuel consumed per unit power developed per hour and is a criterian of economical power production.

Specific fuel consumption =[fuelconsumed(g/sec)] / [power(Kw)]

S.F.C = m_f / P

$$\text{T.F.C} = \frac{20 \text{ x } 0.85 \text{ x } 3600}{\text{t x 1000}} \text{Kg/h}$$

Where,

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

Specific gravity of diesel = 0.85

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

- **Brake Specific fuel consumption (B.S.F.C):**

It is determined on the brake output of the engine.

B.S.F.C = [fuel consumed in kg/hr] / B.P = m_f / B.P in kg/kwhr

or

Brake Specific Fuel Consumption (B.S.F.C)= $\frac{T.F.C}{B.P}$ Kg/kwh

Note: Brake Specific fuel consumption(B.S.F.C) for,

- S.I engine: 75 mg/j = 270 g/kwhr = 0.47 lbm/hp.hr
- C.I engine : 55 mg/j = 200 g/kwhr = 0.32 lbm/hp.hr

- **Heat Input:**

Heat Input =T.F.C X C.V kW

Where,

C.V = Calorific Value of Fuel, kJ/kg k

- **Thermal efficiency($\eta_{thermal}$):**

It is the ratio of indicated work done to the energy supplied by the fuel. It is denoted by $\eta_{thermal}$.

$\eta_{thermal}$ = I.P/(m_f×C.v)

- **Indicated thermal efficiency($\eta_{ind.thermal}$):**

It is based on the indicated power of the engine.

$\eta_{ind.thermal}$ = I.P/(m_f×C.v)

- **Brake thermal efficiency($\eta_{b.thermal}$):** It is based on the brake power of the engine.

$\eta_{b.thermal}$ = B.P/(m_f×C.v)

2.1 EFFECT ON INJECTION PRESSURE 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.

Dependent on the area of application and engine size, pressures between 100 and 200 MPa generated. The high pressures injection pump carries the fuel through high-pressure pipes to the injection nozzles in the cylinder head. Excess fuel transported back into the fuel tank. The functionality of the so-called unit pump system is practically identical to that of the unit injector system and offers the same advantages and disadvantages. However, the pump and nozzle not combined into one unit. The camshaft driven a high pressure pump and thus directly coupled with the engine speed. The injection nozzle is located inside a so-called nozzle holder in the cylinder head and connected via a high-pressure pipe with the pump. An advantage of this system is that the pump and nozzle not installed at the same place. This reduces the size of the components that have integrated into the cylinder head and simplifies the assembly of the injection system.

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

III. EXPERIMENTALSETUP& PROCE DURE

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

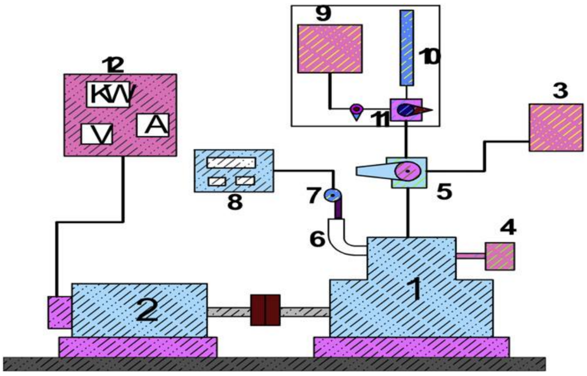

Figure-3.1: Various Parts Of Experimental Setup

3.2 SPECIFICATIONS OF THE ENGINE

Engine	Four stroke, single cylinder, water cooled, Direct injection diesel engine
Rated power	3.7kW
Speed	1500 rpm
Bore	80 mm
Stroke	110 mm
Calorific value(C.V)	43000 kj/kg
Specific Gravity	0.85 kg/m^3
Co-efficient of discharge (C_d)	0.62
Orifice diameter	0.033m
Torque arm length	0.2m
Densityu of air(ρ_{air})	1.293 m^3/kg

Table-3.1. Specifications of the engine.

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. As first said, diesel alone is allowed to run the engine for about 30min, so that it gets warmed up and steady running conditions are attained. Before starting the engine, the lubricating oil level in the engine is checked and it is also ensured that all moving and rotating parts are lubricated.

The performance test was conducted in a single cylinder four stroke diesel engine. Figure-8 Shows the schematic diagram of the complete experimental setup for determining the effects of Honne oil blend on the performance and emission characteristics of compression ignition engine. It consists of a single cylinder four stroke water cooled direct injection diesel engine connected to an eddy current dynamometer. The fuel injection pressure can be varied from 200 bar and 220 bar. It is provided with temperature sensors for the measurement of water jacket, calorimeter water, and calorimeter exhaust gas inlet and outlet temperature. It is also provided with pressure sensors for the measurement of combustion gas pressure and fuel injection pressure. An encoder is fixed for crank angle record. The signals from these sensors are interfaced with a computer to an engine indicator to display and fuel injection pressure. The provision is also made for the measurement of volumetric fuel flow. The built in program in the system calculates indicated power, brake power, thermal efficiency, volumetric efficiency..The procedure followed during the experiments is given below.

- The Experiments were carried out after installation of the engine
- The injection pressure is set at 180 bar for the entire test.
- Precautions were taken, before starting the experiment.
- 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.

The above experiment is repeated for various loads on the engine. The experimental procedure is similar as foresaid. While starting the engine, the fuel tank is filled in required fuel proportions up to its capacity. The engine is allowed to run for 30 min, for steady state conditions, before load is performed.

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

The test is carried out on the Anil Engine for the following fuel blends:

- 100% Pure Diesel
- 50% Honne Oil + 50% Diesel is called as **B_{50}.**

IV. RESULTS AND ANALYSIS

Two test fuels were used during experiments including 100 % diesel fuel and a blend of 50% Honne oil by volume in the diesel. The tests were carried out for the above proportion of Honne oil and diesel. The performance tests are conducted at 1500 rpm with loading of various percentages of maximum loads.

The Performance and Emission characteristics are compared with pure diesel operation. The basic performance parameters such as , specific fuel consumption , brake thermal efficiency and emission are calculated and presented against load for all attempts as shown in below **Figures**

4.1 BRAKE SPECIFIC FUELCONSUMPTION

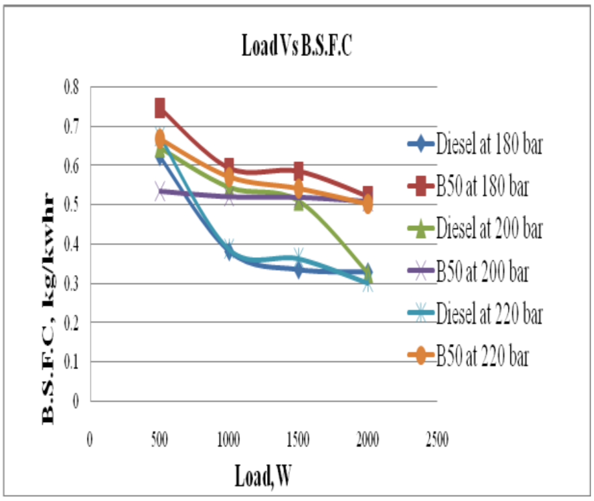

Figure-4.1: Load (vs.) B.S.F.C

From above Figure 4.1, it may be observed that as injection pressure increases brake specific fuel consumption decreases. The injector was set for different opening pressures namely 180 bar, 200 bar and 220 bar and the engine was tested. A quick look on the figure reveals that B.S.F.C decreases with increase in injection pressure and at 180, 200 and 220 bar Honne oil- Diesel blend shows the decrease in BSFC. This may be due to good atomization at higher injection pressure which helps in faster rate of heat release.

4.2 BRAKE THERMAL EFFICIENCY

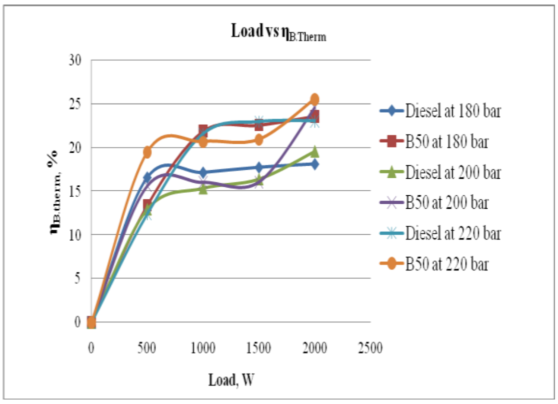

Figure-4.2: Load (vs) Brake thermal efficiency, $\eta_{B.Therm}$

The variation of brake thermal efficiency with respect to load for Honne oil-Diesel blends at various pressures is shown in fig4.2. For all the readings of diesel fuels and blends at various injection pressures the brake thermal efficiency increases with respect to various loads. The brake thermal efficiency values at full load are 23.544% , 24.57% and 25.44% for B50 at 180 , 200 and 220 bar. The brake thermal efficiency values at full load are of 18.13% ,19.53% and 23.02% for Diesel at 180, 200 and 220 bar are decrease to the brake thermal efficiencies of diesel at various loads.

4.3 INDICATED THERMAL EFFICIENCY

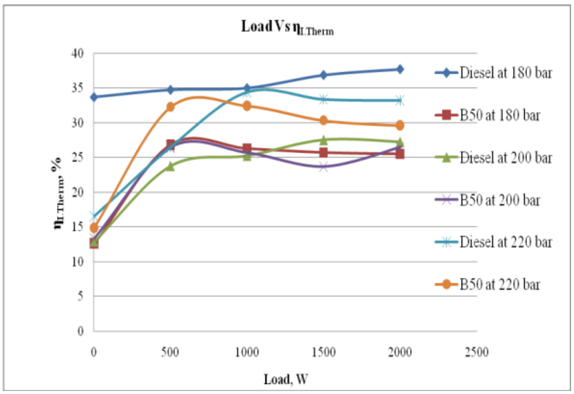

Figure-4.3: Load (vs) Indicated thermal efficiency, $\eta_{I.Therm}$

The variations of indicated thermal efficiency with respect to load for B50 blends and Diesel is shown in Fig.4.3. For all the readings of diesel fuels and blends at various injection pressures the indicated thermal efficiency increases with respect to various full loads. The indicated thermal efficiency values at full load are 25.52%, 26.49% and 29.58% for B50 at 180, 200 and 220 bar. The indicated thermal efficiencies of diesel is 37.723%, 27.23% and 33.25% at 180, 200 and 220 bar are to the indicated thermal efficiencies decreases to the diesel at various loads.

4.4 VOLUMETRIC EFFICIENCY

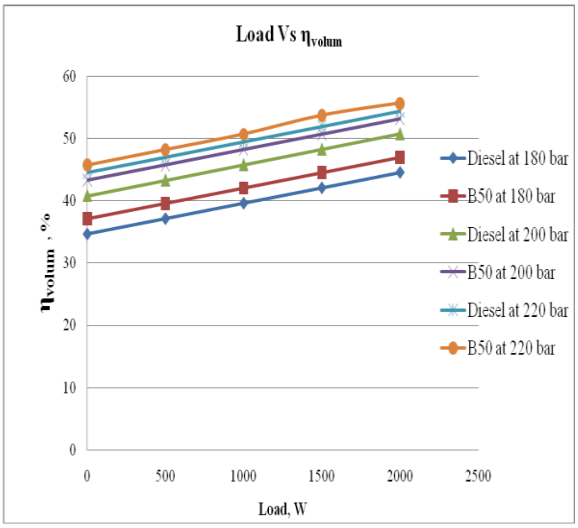

Figure-4.4: Load (vs) volumetric efficiency, η_{volum}

The fig.4.4 shows the variation of volumetric efficiency with respect to load for various injection pressures. Volumetric efficiency is a measure of success with which the air supply, and thus the charge, is inducted in to the engine. It indicates the breathing capacity of the engine. From the figure it is evident that the volumetric efficiency is higher B50 at 180, 200 and 220 bar. Compared to diesel fuel values at various pressures.

4.5 MECHANICAL EFFICIENCY

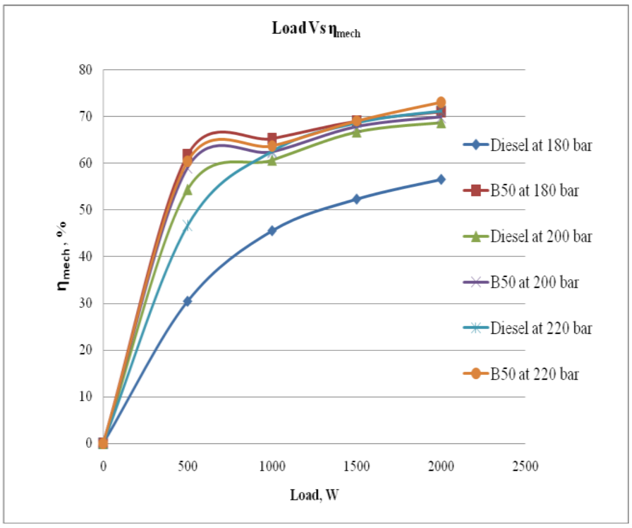

Figure-4.5: Load (vs) Mechanical efficiency, η_{mech}

Mechanical efficiency indicates how good an engine is inverting the indicated power to useful power Fig.4.5, shows that the Mechanical Efficiency increased for all injection pressures are 180, 200, 220 bar honne oil –diesel fuel blends. Compared to diesel fuel has slightly decrease in all injection pressures. Maximum mechanical efficiency is obtained at B50 at 220 bar is 73.05%.

4.6 BRAKE MEAN EFFECTIVE PRESSURE

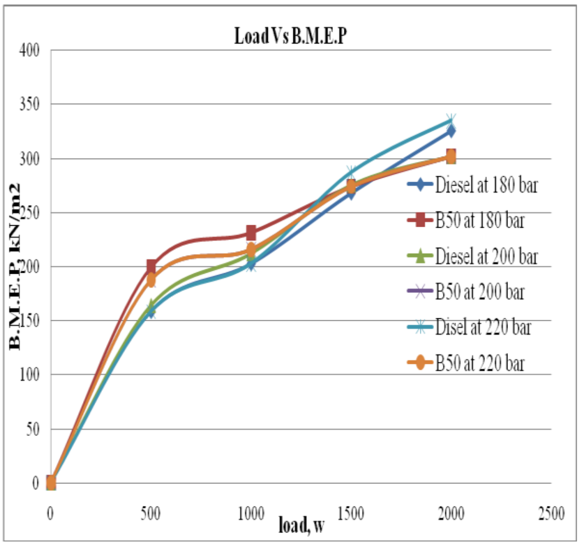

Figure-4.6: Load (vs) B.M.E.P

Fig.4.6,shows the variation of Brake Mean effective pressure with respect to load. Brake Mean effective Pressure is the average Pressure inside the cylinders of an internal combustion engine based on the measured output. From the figure it can be seen that, Brake mean effective pressure is nearer coincides all the values of diesel fuel,B50 at 180,200,220 bar. But the variation in BMEP is siGNificant.

4.7 Indicated Mean Effective Pressure

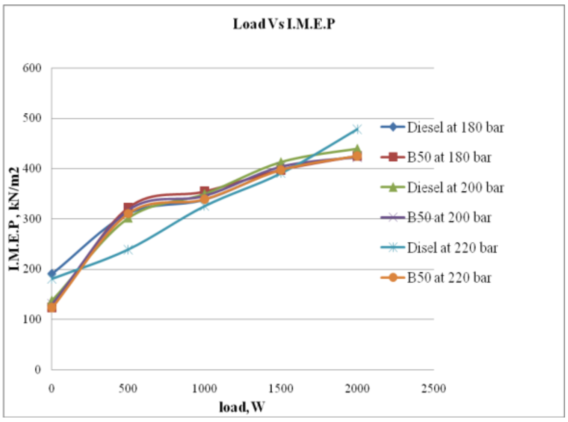

Figure-4.7: Load (vs) I.M.E.P

Fig.4.7, shows the variation of Indicated Mean effective pressure with load. Mean effective Pressure is the average Pressure inside the cylinders of an internal combustion engine based on the measured output. From the figure it can be seen that, Indicated mean effective pressure values are coincide with each other it is slight variation.

4.8 EXHAUST GAS TEMPERATURE

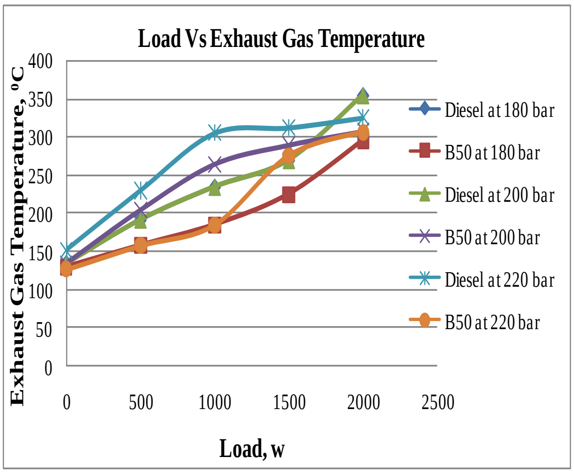

Figure-3.13: Load vs Exhaust Gas Temperature

Figure-4.8: Load (vs) Exhaust Gas Temperature

Fig.4.8, shows the variation of exhaust gas temperature with the fuel injection pressure for diesel mode, and B50 mode at full load condition. It can be seen that the exhaust gas temperature of the engine on diesel mode is higher compared to B50 operation at fuel injection pressures 180,200 and 220 bar because of the higher replacement of diesel with B50 and excess energy supply to the engine.

4.9 CO EMISSION

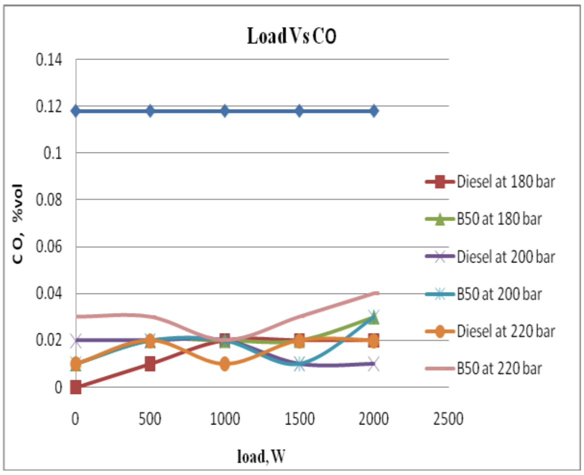

Figure-4.9: Load Vs Carbon monoxide

Fig.4.9, shows the variation of carbon monoxide (CO) emission with fuel injection pressure for diesel mode, and B50 at full load condition. It may be observed from the figure that CO emission for diesel mode of operation is lesser compared to B50 mode at all fuel injection pressure conditions considered because of the Honne oil blend to the engine reduces the amount of oxygen required for complete combustion. This creates incomplete combustion and increase in the CO emissions.

4.10 HC EMISSION

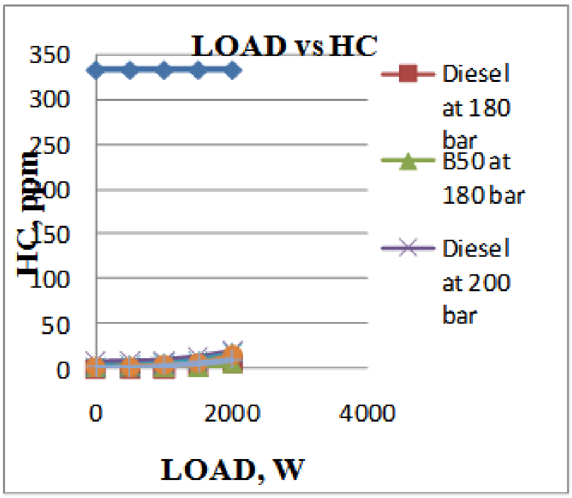

Figure-4.10: Load Vs Hydro carbons

Fig.4.10, shows the variation of hydrocarbon (HC) emission with fuel injection pressure for diesel mode and B50 mode at full load condition. It may be observed from the figure that HC emission for B50 mode of operation is lesser compared to diesel mode of operation at all fuel injection pressure conditions considered. This may be due to the charge in temperature, change in properties of the fuel, air-fuel ratio.

4.11 CO_2 Emission

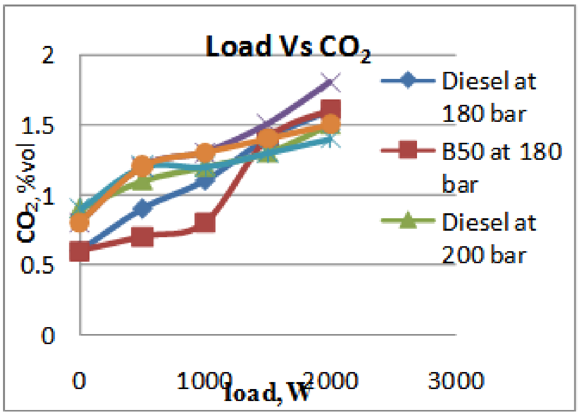

Figure-4.11: Load Vs Carbon dioxide

From fig.4.11, it can be observed sssthat the variation of carbon dioxide emission with load for diesel and B50 operation. From the results, it is observed that the amount of CO_2 produced while using B50 blend is higher than diesel at all load conditions. Carbon dioxide is a desirable byproduct that is produced when the carbon from the fuel is fully oxidized during the combustion process. As a general rule, the higher the carbon dioxide reading, the more efficient the engine is operating.

V. CONCLUSION

The engine was made to run on diesel fuel mode, and honne 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 honne oil- diesel mode.

- Brake specific fuel consumption for the honne oil-diesel blend when lower than the B.S.F.C with 0.522 kg/kwhr at 180 bar, 0.5102 kg/kwhr at 200 bar and 0.503 kg/kwhr at 220 bar .
- The brake thermal efficiency of the engine for honne oil- diesel blend of operations is high compared to diesel mode at 180,200 and 220 bar.
- 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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