JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

JATROPHA BASED BIODIESEL DIESEL ENGINE PERFORMANCE ANALYSIS

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Abstract : As a substitution for diesel motor fuels, a non-edible vegetable oil generated from Jatropha fruits has been created in this research, and its suitability as an essential oil or as a mix with petroleum diesel has been explored. Tests were conducted on a DI-diesel engine that used diesel, Jatropha oil, and various combinations of Jatropha oil and diesel. Different engine loads and Jatropha oil/diesel ratios of 5/95 percent (J5), 10/90 percent (J10), 20/80 percent (J20), 50/50 percent (J50) and 80/20 percent (J80) by volume were taken into consideration. The thermal efficiency of the braking, brake-specific fuel consumption, and CO and CO2 emissions were also evaluated. Up to J20 ratios, there was no discernible difference in brake thermal efficiency or brake-specific fuel consumption. Higher mixes, on the other hand, degraded efficiency and increased fuel consumption by 10% to 25%. Blends had lower CO2 emissions than diesel at low loads, but as the load increased, the amount of Jatropha oil in the blends increased the CO2 emissions. However, blends have greater CO emissions than diesel because of the increased amount of Jatropha oil in the mix.

***Index Terms* - Jatropha fruits, Fish oil ethyl ester, Jatropha Biodiesel, Brake Thermal Efficiency, Fuel Consumption**

I. INTRODUCTION

Bio diesel blends of B20 and B40 at preheating temperatures of 60, 75, and 90°C led to increase of NO x emissions . HC emission for bio diesel blends followed a similar attitude as that of diesel oil but comparatively the values were lower . The higher viscosity of unheated oil compared to diesel fuel resulted in producing higher HC emissions, poor customization, and improper air-fuel mixing. Preheating of bio fuel results in decreased viscosity and hence better combustion. CO2 emissions for bio diesel mixtures were less as compared to petrol-diesel . CO2 emissions of unheated oil were higher than diesel fuel due to the presence of higher oxygen content. Preheated oil showed increase in CO2 emissions over unheated oils . CO2 emission levels are lowered by bio diesel preheating and the reason is attributed to less fuel consumption caused by higher fuel temperature and improved combustion . Smoke emission for jatropha bio diesel blends was less than that of fossil diesel oil. Smoke emission decreased with the increase of bio diesel percentage . Unheated and preheated jatropha oils showed higher smoke emissions. Smoke emission decreases due to lower viscosity and combustion improvement when oil preheating temperature is increased Smoke emission for preheated bio diesel is lower than for unheated bio diesel . Higher viscosity of vegetable oils causes problems in itemization, vaporization and mixing. Oil preheating and conversion of oil to bio diesel are used to overcome oil higher viscosity. Jatropha oil is produced by extraction from Egyptian jatropha seeds by a screw press. Measured properties of the present preheated jatropha oil and bio diesel were near to that of diesel oil. In this research, the exhaust emissions and performance of a diesel engine operating from zero to full load were measured when burning the preheated bio diesel, oil and diesel fuel. Thermal efficiency, exhaust gas temperature, specific fuel consumption and air-fuel ratio were investigated. CO, NO x, HC and smoke emissions were recorded with relative to diesel fuel. Comparisons of engine performance and exhaust emissions were made to obtain higher performance and lower exhaust emissions in comparison to diesel oil.

1.2. Test engine integrated with loading system and exhaust gas emission analyzers

A single cylinder constant speed CI engine (7.4 kW rated power at 1500 rpm) was modified to run under dual-fuel mode. Detailed specifications of the test engine are given in Table 2. The engine was loaded with an eddy current dynamo meter (maximum capacity: 80 kW). Exhaust gas was tapped from tail pipe of the engine for analyzing the NO emission with Bioluminescence Detector (CLD) analyzer under different engine operating conditions.

1.3 . Details of combustion analysis system Combustion analysis system

comprised of an inbuilt charge amplifier, voltage amplifier, and data acquisition system with 14 bit processor. The system was mainly attached with three kinds of sensors; (i) piezoelectric pressure transducer (ii) optical encoder and (iii) piezoelectric strain gauge. The piezoelectric pressure transducer with nominal sensitivity 45 pC/bar was flush mounted on the cylinder head of the engine, for capturing instantaneous in cylinder pressure data during the engine operation. The optical encoder (720 pulses/revolution) was mounted on one end of crankshaft of the engine, for degrees crank angle (CA) measurement with accuracy of 0.1 CA. The piezoelectric strain gauge pressure transducer (pressure measurement range: 0e2000 bar) was fitted on high-pressure diesel pilot fuel line for measuring the pilot fuel injection pressure. know it.

1.4 Jatropha oil extraction process

Jatropha seeds are grown in dry weather and high temperature regions in Upper Egypt. Oil was extracted from jatropha seeds by using mechanical pressing because of its higher yield. The screw press was designed and constructed by the present authors . The press consists of the base, the housing, and the screw . The screw is accommodated inside the housing which is fixed to the base. The base and housing have circular holes to feed the seeds. The oil is collected from the holes of the housing. The press was derived by an electric motor connected with a gearbox to decrease the rotational speed. The direction switch and frequency inverter were fitted to change the motor rotational speed. Jatropha seeds were preheated by using heaters and a digital temperature thermostat was employed for temperature control. Improvement in screw operating conditions was optimized to obtain a better oil yield at a temperature of 100°C and motor speed of 60 rpm. The oil was extracted to obtain a higher oil yield of up to 20% . Figure 1 depicts the schematic diagram of the screw press parts.

1.5 Production Of Jatropha Bio diesel From Jatropha Curcas L.

Jatropha curcas L. is a drought resistant annual shrub belongs to the family of Euphorbiaceae [13]. The oil has golden yellow color and is prepared from the seeds of jatropha curcas. These seeds are black in color and oval in shape [14]. Recently there was a renewed interest on the utilization of this Experimental Investigations on the Influence of Properties of Jatropha seed oil in view of the relatively high oil content about 66% [15], [16]. This shrub is native to tropical America, but is now cultivated widely in tropical countries throughout the world. Jatropha oil is extremely viscous with a kinematic viscosity about 22 times greater than that of diesel fuel. The properties of the Jatropha oil are shown in Table I.

TABLE 1. PROPERTIES OF JATROPHA OIL

Property	**Value**
Cetane Number	45
Density@ 15 oC	0.92 g/cm3
Calorific Value	39.66 MJ/kg
Flash Point	240 oC
Pour Point	8 oC
Viscosity @ 40 oC	49.5 mm2/s
Carbon Residue	0.44%
Iodine Value	93 g of I2 /100g
Water content	822 mg/kg
Acid Value	2.81 mg of KOH/g
Free Fatty Acids	38%

The Jatropha biodiesel (JBD) is produced by chemically reacting jatropha oil with an alcohol (methyl or ethyl), in the presence of a catalyst. The free fatty acid (FFA) content is the key parameter for identifying the process of biodiesel preparation. A two-stage process is used for the esterification of the jatropha oil [17]-[19]. The first stage of the process is called esterification, and this is used to reduce the FFA content in jatropha oil by esterification with methanol (99% pure) and acid catalyst (sulfuric acid-98% pure) in one hour reaction at 60 oC. In the second stage, called transesterification, the triglyceride portion of the jatropha oil reacts with methanol and base catalyst (potassium hydroxide- 99% pure), in one hour reaction at 65 oC, to form an ester and glycerol. In this process, the triglyceride is converted stepwise to diglyceride, monoglyceride, and finally glycerol .

1.6 Characterization Of Diesel And Jbd

The measurements of properties of the fuels were carried out according to ASTM D 6751-02 [20]. The specifications and manufacturers of the instruments were given in the following Table II. The effects of the fuel properties on various operational aspects of the diesel engine were discussed as follows:

TABLE 2 ASTM METHODS AND INSTRUMENTS USED TO MEASURE FUEL PROPERTIES

Property	**ASTM Method**	**Instrument**	**Make**
Density	D 1298	Hydrometer	Petroleum instruments, India
Flash Point	D 92	Cleveland open cup tester	Petroleum instruments, India
Calorific Value	D 240	Bomb calorimeter	Parr, UK
Kinematic Viscosity	D 445	Kinematic viscometer	Setavis, UK

II. PROPOSED BIODIESEL EXPERIMENTAL SETUP

2.1. Production of fish oil ethyl ester

Waste fishes and its by-products were collected from local fish market in Coimbatore on an average of three days. Initially, the collected raw materials were heated in water at ambient temperature. After a period of 1 h in continuous heating process, the oil started to float in the upper layer. The floated oils were collected and stored in a container for the settling of solid impurities. Further, quality improvement in processed oil was performed with water washing technique by using de-ionized water at a temperature range of 65 to 70 ◦C. This process was repeated for thrice to improve the quality. To remove suspended impurities, vacuum filtration procedure was performed. The last acquired oil was termed as crude waste fish oil. Fig. 1 depicts the steps involved in the production of fish oil ethyl ester. The production of ethyl ester was performed by using two-stage transesterification process at controlled operating conditions. The subsequent procedure performed for development of fish oil ethyl ester as follows, • In the beginning, 1 L of crude waste fish oil was taken in three neck round bottom container and maintained the temperature about 55 ◦C and ethanol of 250 ml was allowed to process for few minutes.

2.2 Methods summary

2.2.1 Engine test rig

The current experimentation investigation is conducted on a Kirloskar AV1 engine test rig, specifications of which are detailed in Table 1 and experimental set up is schematically sketched . Inlet air measurement is done with the aid of U-tube manometer and diesel fuel consumption is measured using a burette and stopwatch. Volumetric flow rate of H2 is controlled with the help of a rotameter and pressure with a pressure regulator valve. H2 being highly inflammable, backfire propagation of flame is arrested using flame arrestor and flash arrestor. H2 is premixed with air in an enrichment chamber attached ahead to the inlet port and mixture is inducted through the inlet valve of the engine. Diesel fuel is injected directly into the cylinder with the help of a mechanical injector; details of fuel injection are presented in

2.2.2 Experimentation

Cooling water to the engine is turned ON, and a flow rate of 3 l/ min is maintained using a rotameter. The engine is made to run on standard diesel fuel. Emission analyzer is warmed for 7 min and ensured that a display of 20.9% for oxygen reading Emission Analyser, 13. Crank Angle Sensor, TC. Thermocouple). while other parameters show 0% reading. Load on the engine is applied by switching-ON 0.5 kW heating element. The temperature at the outlet of cooling water is monitored, when the constant temperature is attained i.e. steady state condition of operation, time for 20 ml of diesel consumption, generator voltage & current, emission parameters and EGT are registered. The same procedure is repeated for 1, 2 and 3 kW engine load. The engine is allowed to cool to room temperature; it is ensured that cooling water inlet and outlet temperatures are same. The engine is run on diesel fuel, and H2 (99.9% purity) at a pressure of 1 bar is allowed to flow at 0.5 l/min. Performance and emissions parameters are recorded for all the loads at steady state operating condition. The above process is repeated for 1 and 1.5 l/min H2 flow rate for 1, 2 and 3 kW engine load.

compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for measuring the combustion pressure and crank-angle. These signals are interfaced to computer through engine indicator for Pθ-PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The clearance volume of the combustion chamber is changed by tilting the cylinder block. As the clearance volume is changed and swept volume is constant the CR changes. Using 100 % diesel and B20 (20% of spirulina in 80% of diesel), B40, B60 and B80 blends of biodiesel (spirulina) in the variable compression ratio CI engine at 1500rpm, the performance evaluation of the engine is carried out at various loads (4kg, 8kg, 12kg) and the performance such as mechanical efficiency, brake thermal efficiency, specific fuel consumption, brake power, cylinder pressure are calculated and recorded. The engine specifications and the measurement range and accuracy of delta 1600S gas analyzer used is specified in below table .

Table.No.3

T1	Jacket water inlet temperature,
T2	Jacket water outlet temperature,
T3	Inlet water temperature at calorimeter
T4	Outlet water temperature at calorimeter
T5	Exhaust gas temperature before calorimeter
T6	Exhaust gas temperature after calorimeter

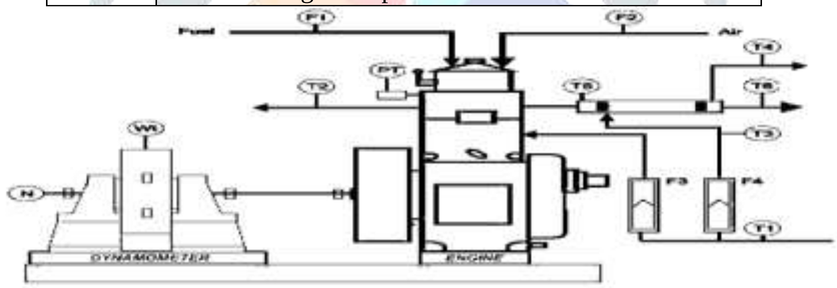

Fig. 1 . Layout of VCR-CI engine coupled with dynamometer

Table 4. Combustion Properties of the sample

Sample	Calorific value (KJ/kg)	Kinematic viscosity (at 40°C)	Cetane Number
DIESEL	45240	1.382	45
B20	43061.6	2.106	47.78
B40	41977.2	2.862	48.63
B60	41169.4	3.374	49.12
B80	40553.8	3.618	50.28

Sample	Flash Point (°C)	Fire Point (°C)	Density (kg/m3)	Specific Gravity
D	68	127	0.864	0.84
B20	85.2	135.2	0.858	0.8488
B40	102.4	143.4	0.866	0.8576
B60	119.6	161.6	0.875	0.8664
B80	136.8	179.8	0.883	0.8752

2.3 Biodiesel production process

Esterification followed by transect certification processes were employed for bio diesel production. In the esterification process, methanol and sulfuric acid catalyst were blended for three hours at a temperature of 80°C. Jatropha oil was preheated up to 70°C to get off moisture. Methanol was mixed with potassium hydroxide catalyst with a molar ratio of 6:1 then the mixture was stirred continuously. Then it is left to settle down for 24 hours. The glycerin was removed, and bio diesel was water washed to remove all the unreacted methoxide. The water traces were removed by bio diesel heating to remove to obtain clear bio diesel.

2.4 Properties of preheated oil and preheated bio diesel

The measured properties of the tested fuels are shown in Table 5. The measured heating values of jatropha oil and bio diesel were 39128 and 387 kJ/kg, respectively. The heating values of biodiesel and jatropha oil are less than diesel oil by about 8 and 7%, respectively. Measured cetane number for jatropha oil and bio diesel are 37.83 and 42.62, respectively. The shorter ignition delay leads to higher cetane number. Flash points for jatropha oil are 142 and 121°C, respectively. Fuel safe handling and storage are related to flash point temperature. Jatropha oil has a higher flash temperature than biodiesel and diesel oils, so, storage and handling of these oils are relatively less hazardous in comparison to petroleum diesel.

Table. 5 Properties of preheated oil and biodiesel compared to diesel fuels

Properties	Method	Diesel	Jatropha Oil	Preheated Oil	Bio diesel	Preheated Bio diesel
Density at 15.56 °C, kg/m3	ASTM D-4052	829	913	875	876	860
Kinematic Viscosity at 40°C, Cp	ASTM D-445	1.2	6.9	2.1	1.8	1.4
Flash Point, °C	ASTM D-93	75	142	142	121	121
Lower Heating Value, kJ / kg	ASTM D-224	42000	39128	39128	38789	38789
Cetane Number	ASTM D-13	45	37.83	37.83	42.62	42.62

The variations in densities for different temperatures of jatropha oil and biodiesel are indicated measured values of densities by test method ASTM D-1298 for jatropha oil and biodiesel at the same temperature of 20°C are 913 and 876 kg/m3 , respectively as compared to only 829 kg/m3 for conventional diesel oil. The densities of International Journal of Mechanical & Mechatronics oils decrease with increase of oil temperature. The variations in viscosities at different temperatures of jatropha oil for the different methods are presented in Jatropha oil viscosity is higher than biodiesel and diesel oils. The measured values of dynamic viscosities by test method ASTM D-445 for jatropha oil and biodiesel at 40°C are 4.1 and 1.4 Cp, respectively as compared to only 1.2 Cp for diesel oil at the same temperature. However, the oil temperature increase led to viscosity decrease. This can be inferred by comparing the values of oil viscosities at 40, 60, 80, 60 and 100°C for jatropha oil and biodiesel. Oil preheating is one of the solutions to overcome higher oil viscosity problems in diesel engines.

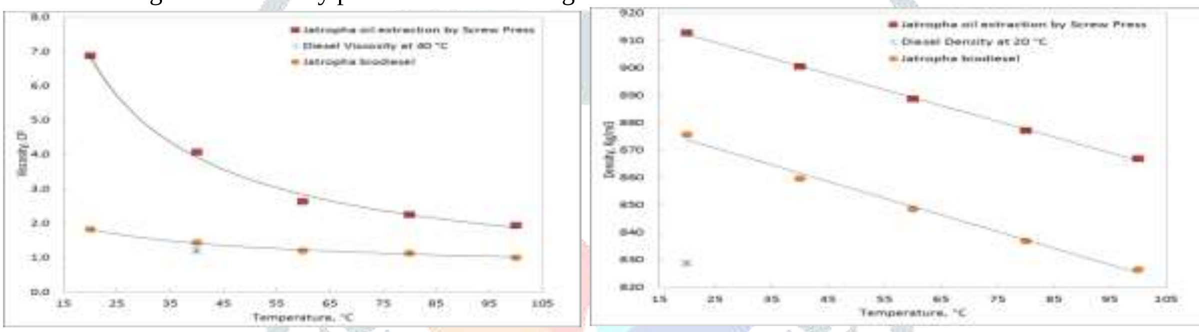

Fig. 2 Density and viscosity of jatropha oil and biodiesel at different temperatures.

2.5 Preheating system of jatropha oil

The water passing inside the shell around the fuel in the inner tube was preheated using exhaust shell and tube heat exchangers. Hot water is used to preheat the injected fuel. A schematic diagram of the present preheating system by exhaust sensible heat is shown in Fig. 3. A coil of copper tube was adopted as a heat exchanger around the exhaust pipe. Hot exhaust gases were utilized to increase the water temperature from room temperature to more than 150°C. A control valve was used to control the flow rate of hot water. A thermocouple of type K measured the preheating temperature. Preheating temperature control was achieved by a digital thermometer. The preheated fuel temperature was measured at the exit point of the heat exchanger.

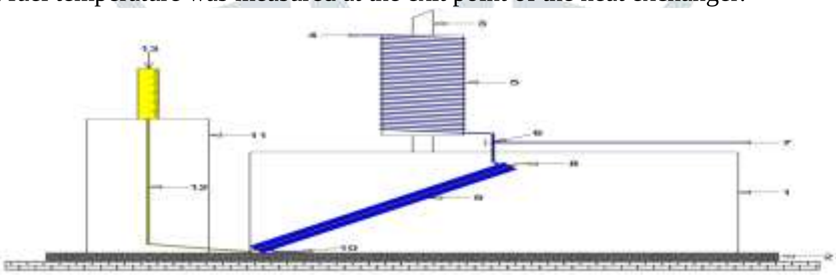

Fig. 3 Schematic diagram of the preheating system.

III. RESULTS AND DISCUSSION

3.1 Engine performance

Brake specific fuel consumptions (BSFC) at different engine loads for jatropha biodiesel, jatropha oil, jatropha biodiesel at 40 oC, and preheated jatropha oil at 90°C are illustrated in Fig.5. BSFC decreased as the engine load increased for all fuels. Higher viscosities and lower calorific values of biodiesel and jatropha oil led to higher specific fuel consumptions of biodiesel and jatropha oil with respect to diesel oil. A reduction in specific fuel consumption was observed for preheated jatropha oil with relative to other fuels. Oil preheating reduces the fuel viscosity and thus resulted in improving combustion characteristics, volatility, and fuel atomization which led to lower specific fuel consumption over unheated fuels. BSFC decrease of up to 2% was achieved for preheated jatropha oil compared to diesel fuel. Brake thermal efficiency (BTE) for jatropha biodiesel, jatropha oil, jatropha biodiesel at 40°C and preheated jatropha oil at 90°C at different brake power are given in Fig.5. BSFC decreased with the engine load increase.

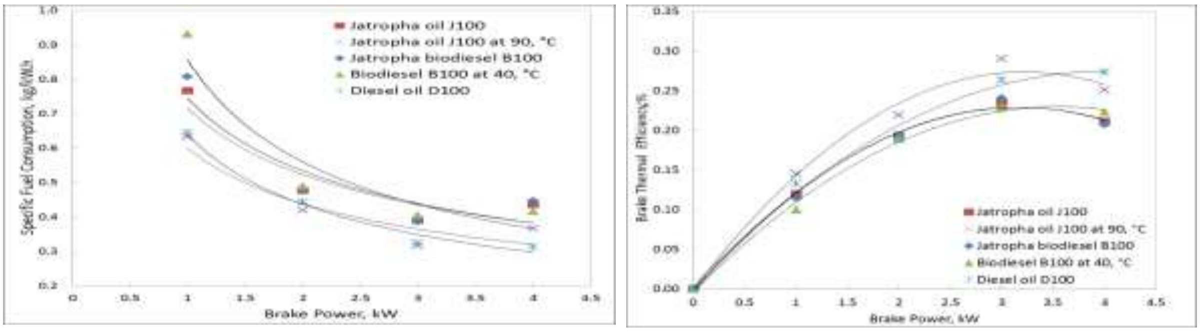

Fig. 4. Specific fuel consumptions and thermal efficiency for all fuels

Jatropha biodiesel, jatropha oil, preheated biodiesel at 40°C and preheated oil at 90°C exhaust temperature values at different brake power are exhibited in Fig. 4. Increase of exhaust gas temperature (Texh). was associated with the increase in load because of thermal efficiency decrease, mass of fuel injected increase, and heat loss increase compared to diesel oil. Jatropha oil and biodiesel preheating led to the decrease of Texh. Oil preheating led to oil viscosity decrease, better combustion, and enthalpy loss reduction in the exhaust. A decrease of up to 41% in exhaust gas temperature for preheated jatropha oil was achieved over that for diesel fuel. Air-fuel ratios (A/F) at different engine loads for jatropha biodiesel, jatropha oil, jatropha biodiesel at 40°C and preheated jatropha oil at 90°C are described in Fig. 6. A/F ratios decreased to the increase of fuel consumption. A/F for preheated oil are greater than all fuels due decrease in fuel density, viscosity, and consumption. Preheated jatropha oil announces air- fuel ratio increase by up to 7% compared to diesel oil.

3.2 ENGINE PERFORMANCE AND EXHAUST EMISSIONS COMPARISON

Comparison of results was made at 75% of engine load as presented in Table 5. Brake thermal efficiency for preheated jatropha oil increased by up to 2% compared to diesel fuel, however for unheated biodiesel, unheated oil, and preheated biodiesel it is decreased by about 9, 11, and 13%, respectively with respect to diesel oil. Exhaust gas temperature decreases were about 41 and 44%, respectively, for preheated jatropha oil, and preheated biodiesel when compared to petroleum diesel and increased by about 9 and 11% for unheated biodiesel and unheated oil, respectively compared to diesel oil. The increases in A/F ratio for preheated jatropha were up to 7% in comparison to hydrocarbon diesel fuel. For unheated biodiesel, unheated oil and preheated biodiesel it decreases by about 16, 17, and 18%, respectively compared to diesel oil. Preheated jatropha oil at 90°C produces improvement in engine performance.

Table 6 Engine performance comparison of diesel engine burning different fuels.

No.	Performance	Unheated Biodiesel	Unheated Oil	Preheated Biodiesel	Preheated Oil
1	Brake thermal efficiency	-9%	-11%	-13%	+2%
2	Exhaust gas temperature	+3%	+5%	-44%	-41%
3	Air-fuel ratio	-16%	-17%	-18%	+7%

At 75% engine load, the effect of unheated and preheated biodiesel and jatropha oil related to diesel oil on exhaust emissions are demonstrated in Fig.4. CO2 emission is lowered down to 45, 13, 7, and 23% for unheated biodiesel, unheated oil, preheated biodiesel, and preheated oil, respectively compared to petroleum diesel. CO emission is reduced by up to 51, 9, 15, and 26% for unheated biodiesel, unheated oil, preheated biodiesel, and preheated oil, respectively compared to petro-diesel. The increases in HC emissions were up to 44, 122, and 11% for unheated biodiesel, unheated oil, and preheated biodiesel, respectively in comparison to diesel oil. Smoke emission for preheated jatropha oil decreased by about 55% compared to fossil diesel fuel. Smoke emission decreased to 51, 47 and 55% for unheated biodiesel, unheated oil and, preheated biodiesel, respectively compared to diesel oil. It is obvious that the engine exhaust emissions were less for jatropha oil preheated to 90°C.

3.3 Combustion Analysis

Load condition at 50%

The crankshaft angle for pure diesel is compared with cylinder pressure figure 5 is given below, biodiesel, biodiesel-ethanol mixture at 50% load condition. It is observed that the neat diesel produced more cylinder pressure compared to B100 and biodiesel-ethanol blends. The lowest cylinder pressure was produced by the B70+E30 blend. As mentioned earlier, the cooling effect of alcohol combined with higher octane number has increased the delay period which led to the attainment of peak pressure after TDC.

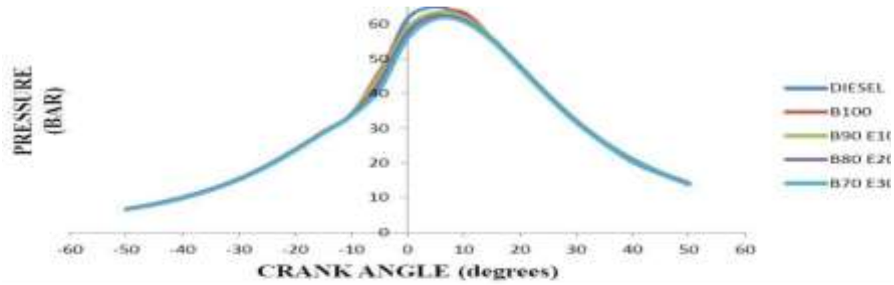

Fig. 5 Crank Angle vs. Cylinder Pressure (50% Load Condition)

Load condition at 100%

In the above graph 6 shows that the crankshaft angle for pure diesel is compared with cylinder pressure, Methyl esters, biodiesel-ethanol mixture at filled load state. This result showing that more cylinder pressure is produced by B70+E30 than pure diesel and other Methyl ester-ethanol mixture. The B100 has lower cylinder pressure. Under full load, higher combustion temperature overtakes the cooling effect of ethanol, and B70+E30 will produce higher combustion pressure thereby leading to better combustion.

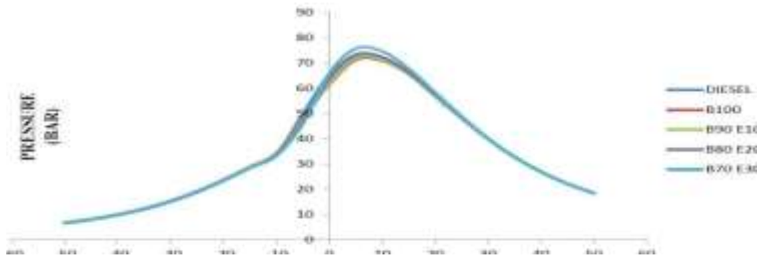

Fig. 6 Crank Angle vs. Cylinder Pressure (100% Load Condition)

3.4 Performance

The performance of DI-CI engine was evaluated in terms of fuel consumption (FC), brake specific energy consumption (BSEC), and brake thermal efficiency (BTE), which were discussed as follows**:**

3.4.1. Fuel Consumption

The variation of fuel consumption (FC) with power output is shown in the **Fig. 7** . For all loads, the FC of JBD is more than that of diesel fuel and at maximum power output the FC for diesel, JBD, and preheated JBD (JBD_PH) are 1.04, 1.23 and 1.19 kg/hr respectively. The JBD contains more percentage of oxygen and consequently less percentage of hydrocarbons and calorific value than that of diesel fuel. Therefore, due to lower value of calorific value of JBD, this behaviour of more fuel consumption was expected for all power outputs. It is also observed that the fuel consumption decreases with preheating of Jatropha biodiesel and the reason is attributed to the improved combustion caused by increased evaporation and spray characteristics**.**

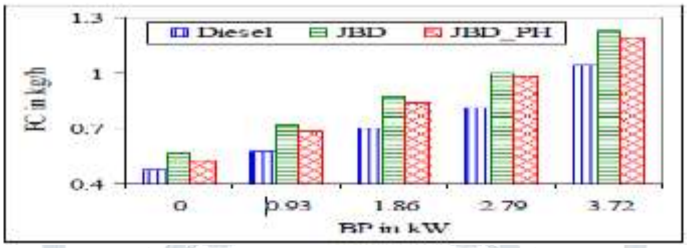

Fig. 7 Fuel consumption

3.4 2. Brake Thermal Efficiency

Fig. 8 shows the variation of brake thermal efficiency (BTE) with power output. The BTE increases as the output power increases for both the fuels. At full load, the BTE for diesel, JBD and preheated JBD is 30.3%, 28% and 29% respectively. The BTE of preheated JBD is closer to diesel fuel, and the reason is attributed to the increased evaporation of tiny fuel droplets with the surrounding air. According to thermodynamic analysis, the degree of constant volume combustion increases the indicated thermal efficiency for JBD . the premixed combustion of JBD is close to top dead center (TDC) and this behaviour is due to early fuel injection caused by the higher bulk modulus of JBD.

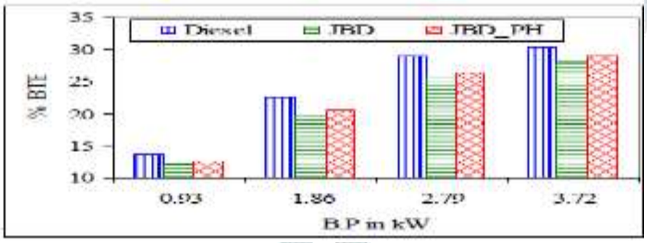

Fig. 8 Brake thermal efficiency

3.4.3. Brake Specific Energy Consumption

Brake specific energy consumption (BSEC) is an ideal variable, because it is independent of the fuel. The BSEC is the input energy required to develop unit power output. Fig. 13 shows that, the BSEC of JBD is higher at all levels of power output compared to corresponding diesel values and the lowest BSEC are 11881, 12414, and 12857 kJ/kW-hr for diesel, preheated JBD and JBD respectively. This is presumably due to lower value of LCV and higher value of kinematic viscosity of JBD. The results also shows that the BSEC decreases with preheating and the reason is attributed to increase in combustion efficiency due to high rate of evaporation of the preheated JBD.

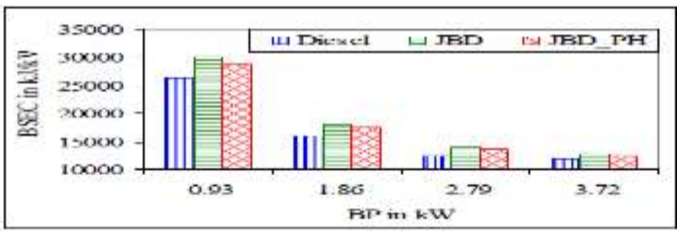

Fig. 9 Brake specific energy consumption

3.5 Combustion Analysis

3.5.1. Peak Pressures

Fig. 11 shows the variation of cylinder pressure with respect to crank angle at maximum power output of 3.72 kW. It is observed that, the jatropha biodiesel (JBD) is burning close to top dead center (TDC) and the peak pressure is higher than that of diesel fuel; even though the jatropha biodiesel is having lower value of LCV. The reason is attributed to the higher bulk modulus of the JBD. When, a fuel with high density (or high bulk modulus) is injected, the pressure wave travels faster from pump end to nozzle end, through an in-line fuel discharge tube. This causes early lift of needle in the nozzle, causing advanced injection . Hence, the combustion takes place very close to TDC and the peak pressure is high due to existence of smaller cylinder volume near TDC. Therefore the reason for peak pressure is attributed to the combined effect of advanced injection and lower value of heat rejection, which occurs due to prevalence of smaller cylinder volume (or surface area) near TDC.

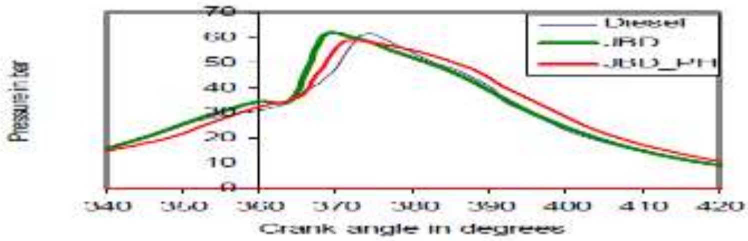

Fig. 10 Cylinder pressure at full load

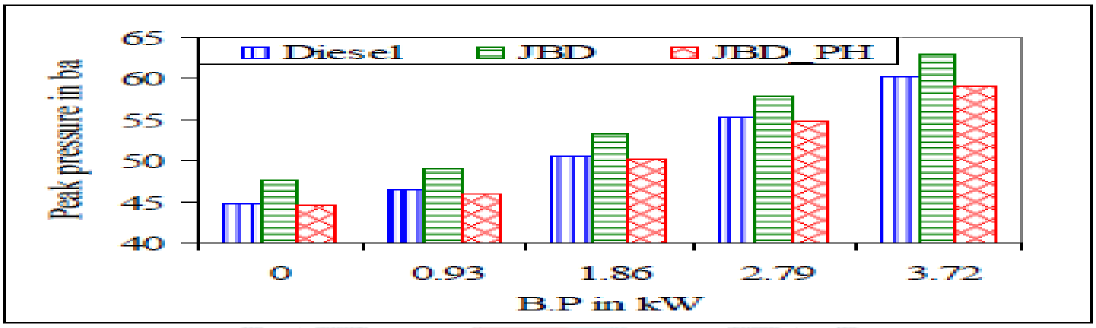

Fig. 11 Peak pressures

IV. CONCLUSION

In this paper discuss on bio diesal. The BTE increases as the output power increases for both the fuels. Diesel, JBD, as well as warmed JBD had BTEs of 30.3%, 28.5%, as well as 29.5%, respectively, at full load. The variation of fuel consumption (FC) with power output is shown better in proposed blande . Even with heavy loads, JBD has a higher flow rate per kilogramme of energy than diesel. When using JBD PH (preheated JBD), the flow rate per kilogramme is 1.19 kg/hr. There are less hydrocarbons as well as calorific values in JBD since it has a higher oxygen content. This increased fuel usage was predicted for all power settings owing to the decreased calorific value of JBD.

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