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A Systematic Study on Influence of Multiple Blends of Kerosene, Cardanol and Jatropha Bio-Diesel on Performance and Emissions of a CI Engine

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ABSTRACT: Due to its high thermal efficiency, good reliability, and sufficient and stable power, the diesel engine has been favored for a long time by the fields of the military, and in power plants, transportation, engineering machinery, and agricultural machinery. Biodiesel as an alternative fuel derived from vegetable (green) oil or animal fats are oxygenated, biodegradable, non-toxic, and environmentally safe. Cardanol is extracted from Cashew Nut Shell Liquid (CNSL), which is a by-product during cashew nut processing. Cashew shell is separated during the process of cashew kernel production. From these shell, Cashew Nut Shell Liquid is separated by different methods. Kerosene is a secondary fuel for blend because of its volatility and its low viscosity nature and as a dry fuel, Kerosene helps primary fuel cardanol to increase its properties when it is miscible completely. In this study, Cardanol and kerosene blend and Jatropha oil bio-diesel blends for an optimized proportion and diesel are to be used as per the literature study and in the view of future scope. Engine performance and exhaust emissions of a naturally aspirated, single cylinder diesel engine have been experimentally investigated. The aim of this present work is to test the performance parameters such as brake power (BP), brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), and emission characteristics such as exhaust gas temperature (EGT), smoke parameters and combustion parameters like ignition delay, combustion duration and start of combustion, end of combustion to be evaluated. The main objective of this investigation is to use raw Cardanol as an alternative biofuel and Jatropha oil bio-diesel as the alternative fuel in addition to diesel by considering its economic sustainability. In this connection, Performance, emission, and combustion characteristics of diesel engine operating with pure diesel D100, CNSLK30 and JOB30 blends at 25 %, 50% and 75%, and 100 % load conditions are to be evaluated and compared for optimum blend selection, at an injection timing of 25°bTDC and at constant injection pressure of 240bar.

KEYWORDS: Bio-fuels, kerosene, Cardanol, Jatropha Curcas oil, diesel, Engine performance, Emissions, etc

I. INTRODUCTION

Diesel fuels have a crucial purpose in the industries for an emerging state and utilized for transporting manufacturing and farming goods, operation of tractor and pump in farming sector. Unlike rest of world, India's claim for diesel is approximately '6' times larger than gasoline henceforth searching for substitute to diesel is an expected choice. Esters from vegetable oils are the best substitutes for diesel because they do not claim any alteration in the engine. When vegetable oils are burned, their chemical composition helps to reduce the emission of unwanted components. According to Murayama et al., vegetable oil fuels produced acceptable engine performance and exhaust gas emission levels for short-term operation only but caused carbon deposit build-up and piston ring sticking after extended operation. They also proposed practical solutions to address these issues, such as raising the fuel temperature to 220 degrees Celsius, blending 25% diesel fuel into vegetable oil, and blending 20% eth oils. The blending method improves the use of vegetable oil fuel while requiring minimal fuel processing and engine modification

Since petroleum fuel sources are finite, the quest for substitute fuel is currently going on the entire world. The mounting cost of gasoline fuels, exhaustion of assets and strict world protocols on exhaust emissions have also

demanding the need for replacement of petroleum fuels with lesser contamination, readily available and renewable non-edible sources of fuels for automobile and industrial engines.

The rapid depletion of petroleum fuels and consequent price hikes have made a serious impact on the power and transport sectors as well as on the international economy. Vegetable oils might provide a viable alternative to diesel since they are renewable in nature and environmentally friendly.

HISTORY OF BIODIESEL

The process of separating the fuel from the fat is not new. Many years before the first diesel engine became completely functional, scientists E. Duffy and J. Patrick conducted the first transesterification of vegetable oil in 1853. Transesterification is the process of chemically breaking the molecule of a raw renewable oil into methyl or ethyl esters of the renewable oil with glycerol in the presence of alcohol, such as ethanol or methanol, in the presence of a catalyst, such as sodium hydroxide or potassium hydroxide.

Less Global Warming:

Bio-diesel is made up of carbon that was removed from the atmosphere when plants and trees developed. Fossil fuels release massive volumes of carbon dioxide (CO₂) into the atmosphere, trapping the Earth's heat like a heavy blanket and causing global warming.

II. RELATED WORK

FUELS

Performance, emission and combustion characteristics of diesel engine operating with pure diesel(D100) and blends of Jatropa oil biodiesel CNSLK30, JOB30 biodiesel at 50% and 100% load conditions are to be evaluated and compared with the results at variable injection pressures of 220bar and 240bar and at an injection timing of 23°bTDC.

DIESEL

Diesel fuel is a mixture of hydrocarbons—with boiling points in the range of 150 to 380°C—which are obtained from petroleum. Petroleum crude oils are composed of hydrocarbons of three major classes: (1) paraffinic, (2) naphthenic (or cycloparaffinic), and (3) aromatic hydrocarbons. Unsaturated hydrocarbons (olefins) rarely occur in the crude. It should be noted that the terms 'paraffinic' and 'naphthenic' sound obsolescent; we use them because they are still common in the petrochemical industry. In modern chemistry, the respective groups of hydrocarbons are called alkanes and cycloalkanes.

JATROPHA OIL BIO-DIESESEL

The calculated density of the jatropa biofuel is 860-900 kg/m³ and the diesel density varies from 836-850 kg/m³. It shows that it approximately reaches the specified limit of ASTM standard. The calculated viscosity of the jatropa biofuel is 4.2cst at 30°C and it is also in the specified range of the ASTM. Also its viscosity is very similar to diesel which varies from 2.2 cst. Flash point of the jatropa biofuel is 168°C and this obeys the ASTM standard of minimum of 93°C and for diesel it is about 80°C. The increase in flash point of the fuel causes start ignition delay of engine which tends to increase NO_x emission. The tested calorific value of the jatropa biofuel is found to be 39,000kJ/kg, which is very much similar to that of diesel which is 42,000kJ/kg. This little decrease in the calorific value of the biofuel tends to increase the specific fuel consumption by a tiny margin. The cetane number of the biofuel is found to be 49 meeting the ASTM standards and also very close to the value of diesel which varies from 51 to 60.

Introduction to Cashew Nut Trees

Cashewnut trees (*Anacardium Occidentale*) belongs to the Anacardiaceae family of plants. Native of the tree is Brazil, but now it has spread to Mexico, south and Central America and West Indies. During 1600s, to prevent soil erosion Portuguese introduced the cashew tree into India and Africa.

Extraction of Cashew Nut Shell Liquid (CNSL):

There are different methods of separating CNSL from cashew shell.

i. Thermal extraction

Cashew nuts are roasted in drums to extract the oil. During roasting the CNSL comes out and the nut becomes brittle that makes cracking easy. The nuts are roasted at 185°C which extracts about 90% of CNSL.

ii. Hot oil bath process

The raw cashew nuts are filled in a cylinder through which steam at 250°C is passed for three minutes. Due to the heat of steam CNSL oozes out from the shells. The process is repeated to extract maximum liquid.

iii. Mechanical pressing process

During this process the cashew nut shells are pressed at high pressure in a screw press or hydraulic press. CNSL comes out of the shell due to high pressure. But complete extraction of oil is not possible in this method.

iv. Solvent extraction

In this method the cashew nut shell is cut to small piece and added to organic solvent. The CNSL comes out of the shell and is added to the solution. The CNSL is separated by boiling the solution. The solvent is condensed and reused.

By the distillation of CNSL at 200°C to 240°C under reduced pressure Cardanol is produced. Double distillation is carried out to improve the purity of Cardanol. Cardanol diesel blends have been tested as fuel in diesel engine and obtained good performance with reduction in exhaust emissions (Velmurugan et al. 2011; Mallikappa et al. 2012; Radhakrishnan et al. 2014; Santhanakrishnan and Ramani 2015). To reduce viscosity, cashew nut shell liquid (CNSL) has been blended with camphor oil and the blend was tested in diesel engine by Kasiraman et al. (2012). The results of this study revealed that 70% CNSL and 30% camphor oil blend shows nearly similar behavior to diesel fuel in terms of emissions and performance. Vedharaj et al. (2015) have explored the performance of compression ignition engine fuelled with pre-heated methyl ester of cashew nut shell liquid. The authors reported that pre heated CNSL methyl ester may be economically used as compression ignition (CI) engine fuel with improved performance and combustion. Jagadish et al. (2012) have mixed 10% methanol with cardanol to reduce the flash point during the test in diesel engine and also resolved that during trans-esterification of Cardanol glycerol was not produced.



Fig:1 Cashew apple with nut



fig:2 Cashew nut



The cashew nuts are split into two halves as shown in Figure and inner cashew kernel is separated. These kernels are rich source of fats and proteins. Raw kernels or the roasted kernels are used as good quality food. From the kernel edible oil can also be extracted. From the remaining outer shell oil is separated which is called as cashew nut shell liquid (CNSL). About 30% to 35% oil is present in the cashew nut shell (Dinesha, P. and Mohanan, P., 2015). This oil is very useful in production of varnishes, brake liners and paints. The CNSL comprises 90% anacardic acid and 10% Cardanol (Jagadish et al., 2012). When CNSL is exposed to distillation at low pressure (265 Pa) and about 235° C temperature anacardic acid is converted to cardanol (Mallikappa et al., 2012). The cardanol so obtained is a phenolic liquid which is used in production of medicines and chemical industries.

TRANSESTERIFICATION PROCESS

Transesterification is an organic reaction in which the R group of an alcohol is exchanged with an R' group of an ester. This is generally done via the introduction of an acid or base catalyst to the reaction mixture. However, it can also be done using certain enzyme catalysts (such as lipases). An illustration detailing the exchange of an R' group belonging to the alcohol with the R'' group of an ester in a transesterification reaction is provided below.

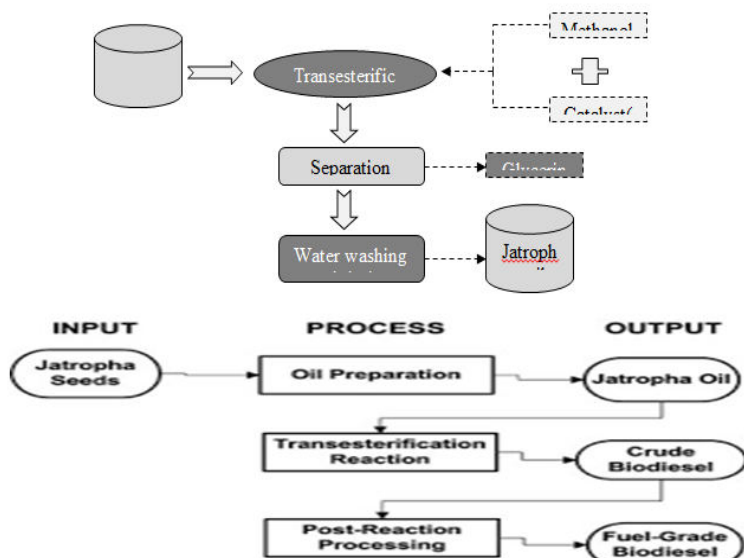


Fig 3: Jatropha oil Biodiesel processing



Fig 4: Diesel and Jatropha oil Biodiesel

Nowadays, in CI (compression ignition) engines, biodiesel is the popular alternative fuel used. It can be used without further variations in the engine’s present design due to its sulfur-free, biodegradable and nontoxic nature. In the current era, diesel engines are more commonly used in the transportation field when compared to gasoline engines due to their advantages like wider torque range, low maintenance cost, and high power. The concerns over global warming are closely tied to the rising need for energy.

III. METHODOLOGY

THEORY

DETERMINATION OF FUEL PROPERTIES

The properties like viscosity, flash point, fire point, calorific value and density of all fuels and fuel blends used in the tests are determined at the laboratory. Initially the purity of Cardanol used for the test is checked at a nearby Cardanol industry. The instrumentations used for testing the properties are discussed in the following section.

Measurement of Viscosity

The resistance offered by any fluid flow to flow is the measure of its viscosity. Viscosity of biofuel plays an important role in fuel atomisation and fuel injection. As per ASTM Standard D6751 the maximum viscosity of biofuel is limited to 6 cSt. Viscosity is determined in a Cannon Fenske viscometer.

Measurement of Flash Point

Flash point of a liquid fuel is the lowest temperature at which it gives sufficient vapours that can burn in contact with a flame. As per ASTM Standard D6751 for biodiesels the minimum flash point is 130°C. The flash point of any fuel must be high in order to reduce the chances of fire hazard. Flash point is determined in Pensky- Marten Closed cup tester.

Measurement of Fire Point

Fire point of a fuel is the lowest temperature at which the fuel starts burning continuously even after the ignition source is removed. Fire point is found using a Cleveland open cup tester.

Measurement of Calorific Value

Calorific value of a fuel is the energy released by complete combustion of unit quantity of fuel in presence of oxygen. The calorific value of solid and liquid fuels are determined in a bomb calorimeter. A bomb calorimeter consists of an inner calorimeter vessel, bomb firing unit, stirrer, timer, pellet press and oxygen cylinder with a pressure gauge. Then unit quantity of the fuel to be tested is filled in the crucible and tested.

Measurement of Density

Densities of liquids are determined by a hydrometer.

ENGINE PERFORMANCE

Engine performance is indicated by the term efficiency.

Various type of efficiencies are

1. Indicated thermal efficiency:- It is a ratio of energy in the indicated horse power to the fuel energy.
2. Mechanical efficiency;- It is ration of brake horse power to the indicated horse power.
3. Brake thermal efficiency :- It is the ration of energy in the brake horse power to the fuel energy.
4. Volumetric efficiency :- Volumetric efficiency is defined as the ration of air actually induced at ambient conditions to the swept volume of the engine.
5. Specific fuel consumption :- It is a ratio of fuel consumption per hour to the horse power.
6. Indicated Horse power :- is the power produced inside the cylinder.
7. Brake Horse Power :- is the power available at the crankshaft. The algorithm automatically generates mask image without user interaction that contains only text regions to be inpainted.

IV. EXPERIMENTAL RESULTS

EXPERIMENTAL SETUP

The setup consists of single cylinder, four stroke, Diesel engine connected to eddy current type dynamometer for loading. It is provided with necessary instruments for combustion pressure and crank angle measurements. These signals are interfaced to computer through engine indicator for Pressure crank angle-PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rota meters are provided for cooling water and calorimeter water flow measurement.

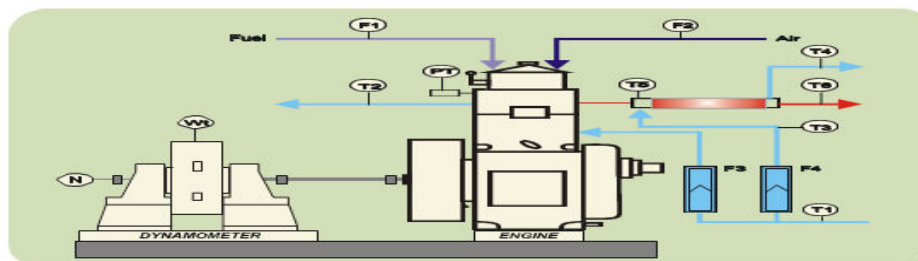
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Fig 6: AVL smoke meter and Experimental setup



Fig 7: Engine Experimental setup and connection to computer



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

Fig 8: Engine Experimental setup Line Diagram



SPECIFICATIONS

Product	Enginetestsetup 1 cylinder, 4stroke, Diesel (Computerized)
Productcode	224
Engine	Make Kirloskar, Model TV1, Type 1 cylinder, 4stroke Diesel, watercooled, power 5.2kW at 1500rpm, stroke 110mm, bore 87.5mm, 661cc, CR17.5
Dynamometer	Type eddy current, watercooled
Propellershaft	With universal joints
Airbox	MS fabricated with orificemeter and manometer
Fuel tank	Capacity 15lit with glass fuel metering column
Calorimeter	Type Pipe in pipe
Piezosensor	Range 5000PSI, with low noise cable
Crank angle sensor	Resolution 1 Deg, Speed 5500RPM with TDC pulse
Data acquisition device	NI USB-6210, 16-bit, 250kS/s.
Piezopowering unit	Model AX-409.
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	Type two wire, Input RTD PT100, Range 0-100 Deg C, I/P Thermocouple, Range 0-1220 Deg C, O/P 4-20Ma
Load indicator	Digital, Range 0-50Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50Kg
Fuel flow transmitter	DP transmitter, Range 0-500mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250mm WC
Software	"Engine soft" Engine performance analysis software
Rotameter	Engine cooling 40-400LPH; Calorimeter 25-250LPH
Pump	Type Monoblock
Overall dimensions	W2200xD2500xH1500mm
Optional	Computerized Diesel injection pressure measurement

In this analysis engine is operating at constant injection pressure of 240bar, at an injection timing of 25°btdc, at half load 25%, 50% and 75%, 100% load conditions.

BLENDS USED

D100- pure diesel

JOBD30- mixture of 30 % Jatropha oil biodiesel and 70% Diesel of total 100% volume

CNSLK30- mixture of 30% Kerosene oil and 70% Diesel of total 100% volume

Brake specific fuel consumption:

The ratio of the mass flow rate of the fuel delivered to the engine to the braking power obtained at a crankshaft is known as brake specific fuel consumption, and it reflects how efficiently the fuel is used to produce brake power.

Table 1: Brake specific fuel consumption Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

BSFC	25	50	75	100
D100	0.6785	0.5856	0.5122	0.4754
JOBD30	0.7256	0.5985	0.5556	0.4987
CNSLK30	0.7876	0.6321	0.5965	0.5014

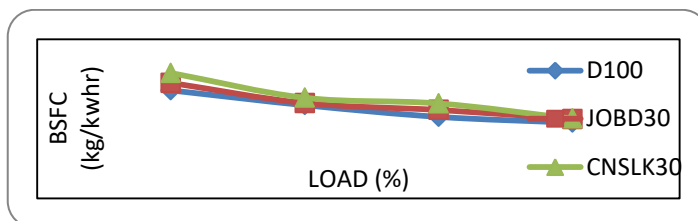


Figure 9: Brake specific fuel consumption Vs Load at 240bar & 25°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Brake thermal efficiency:

The amount of power available at the crankshaft of the engine is referred to as brake power. It's also determined by the product of the available torque at the crankshaft and the crankshaft's angular speed. The brake thermal efficiency is a type of engine thermal efficiency that is defined as the ratio of brake power at the engine crankshaft to power generated by fuel combustion

Table 2: Brake thermal efficiency Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

BTE	25	50	75	100
D100	21.3876	24.5698	27.3214	28.9451
JOBD30	19.3251	23.5412	26.1857	27.1541
CNSLK30	17.0234	21.2151	23.9876	26.7142

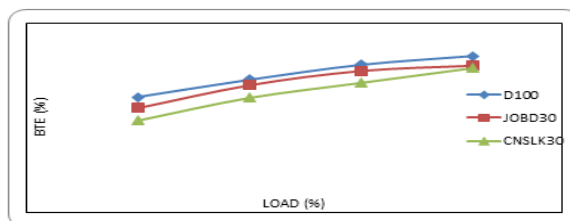


Figure 10: Brake thermal efficiency Vs Load at 240bar & 25°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Exhaust gas temperature:

Through the exhaust system, engine exhaust gases are released into the environment. Mufflers and emission after treatment devices are among the specialized components found in the exhaust system. A number of exhaust gas qualities must be known by the designer of the exhaust system and/or exhaust system components.

Table 3: Exhaust gas temperature Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

EGT	25	50	75	100
D100	151.32	182.36	231.54	261.98
JOBD30	171.04	221.56	242.31	278.52
CNSLK30	159.98	193.55	237.14	266.54

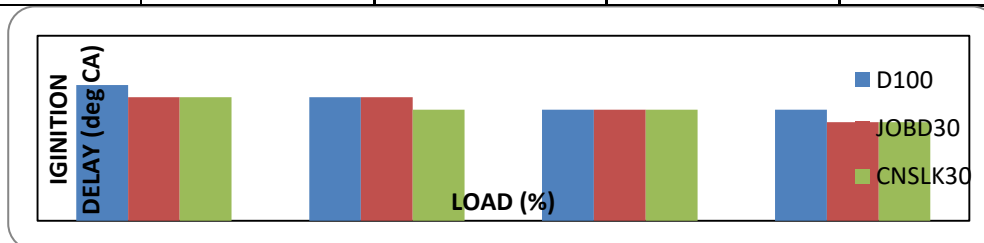


Figure 11: Ignition delay Vs Load at 240bar & 25°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Un-burnt Hydrocarbons HC ppm:

Diesel combustion is heterogeneous in nature, unlike spark-ignited engines, where the combustible mixture is generally homogeneous. A cylinder filled with high-temperature compressed air is injected with diesel fuel. Emissions produced by burning this heterogeneous air/fuel combination are influenced by the conditions present not only during combustion, but also during expansion and, in particular, prior to the exhaust valve opening. Emission formation is influenced by mixture preparation during the ignition delay, fuel ignition quality, residency time at various combustion temperatures, expansion duration, and general engine design aspects. In essence, the formation and decrease of distinct emission species in the exhaust system results in their concentration in the exhaust.

Table 4: Hydrocarbons Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

HC	25	50	75	100
D100	38	45	51	54
JOBD30	40	48	55	59
CNSLK30	35	42	48	51

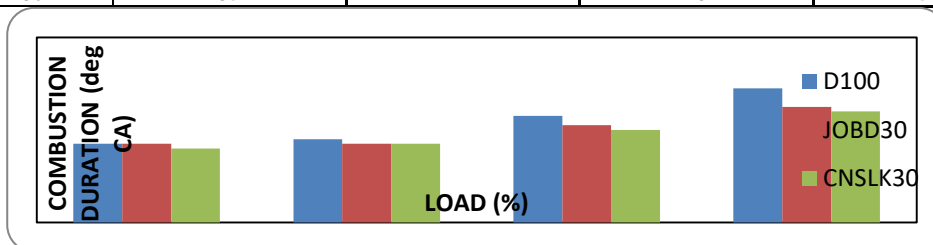


Figure 12: Combustion duration Vs Load at 240bar & 25°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Oxides of nitrogen:

It has to do with nitrogen oxides. Although purists will dispute that it only refers to nitric oxide (NO) and nitrogen dioxide (NO₂), most people will also include nitrous oxide (N₂O). There are other kinds, but their atmospheric concentrations aren't high enough.

When the temperature goes above 1300°C/2370°F, some nitrogen in the air is oxidized to NO_x gases, resulting in high-temperature burning of fuels. Hydrogen is included because it burns at such a high temperature. Here are some thoughts about diesel engines.

Table 5: Oxides of nitrogen Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

Nox	25	50	75	100
D100	226	295	376	422
JOBD30	305	361	478	556
CNSLK30	396	504	578	611

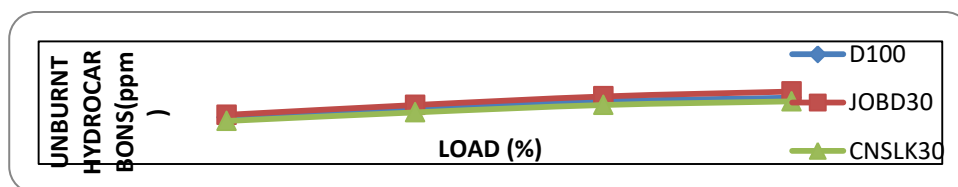


Figure 13: Hydrocarbons Vs Load at 240bar & 25°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Carbon monoxide:

Like other internal combustion engines, a diesel engine turns chemical energy in the fuel into mechanical power. Diesel fuel is a blend of hydrocarbons that, in an ideal combustion process, would create just carbon dioxide (CO₂) and water vapour. (In fact, diesel exhaust gases are mostly CO₂, H₂O, and the unused portion of engine charge air.) Other sources can contribute to pollutant emissions from internal combustion engines, usually in minor amounts but occasionally containing highly dangerous materials.

Table 6: Carbon monoxide Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

CO	25	50	75	100
D100	0.045	0.057	0.061	0.069
JOBD30	0.042	0.052	0.055	0.065
CNSLK30	0.04	0.053	0.058	0.066

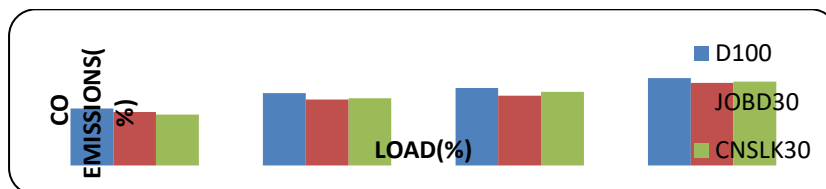


Figure 14: Carbon monoxide Vs Load at 220bar & 23°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Ignition delay:

In a diesel engine, the ignition delay is the period between the start of injection and the start of combustion.

Table 7: Ignition delay Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

ID	25	50	75	100
D100	11	10	9	9
JOBD30	10	10	9	8
CNSLK30	10	9	9	8

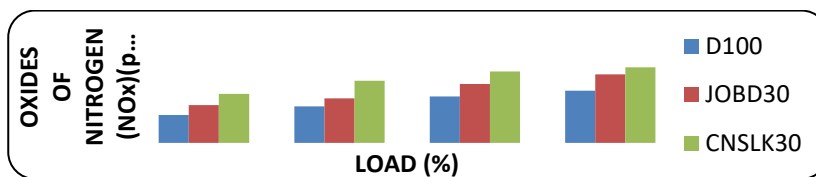


Figure 15: Oxides of nitrogen Vs Load at 240bar & 25°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Combustion duration:

Diesel engine combustion is extremely complex, and its detailed mechanisms were not completely understood until the 1990s. Despite the availability of modern tools such as high-speed photography used in "transparent" engines, computational power of modern computers, and numerous mathematical models designed to mimic combustion in diesel engines, its complexity seemed to defy researchers' attempts to unlock its many secrets for decades. In the 1990s, the use of laser-sheet imaging to the traditional diesel combustion process was critical to considerably improving our understanding of the process.

Table 8: Combustion duration Vs Load at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

CD	25	50	75	100
D100	17	18	23	29
JOBD30	17	17	21	25
CNSLK30	16	17	20	24

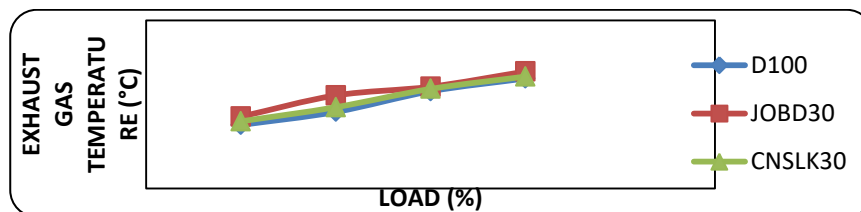


Figure 16: Exhaust gas temperature Vs Load at 240bar & 25°bTDC, 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30 blended fuels

Rate of Pressure rise:

For both the diesel and dual fuel engine cases, the pressure rise rate (dP/dq) reduces as the engine speed rises. the rate of pressure rises with respect to crank angle for various fuels at rated load Among the test fuels, diesel had the fastest rate of pressure rise

Table 9: Rate of pressure rise Vs Crank angle at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

Crank Angle	ROPR AT 100 % LOAD (D100)	ROPR AT 100% LOAD (JOB30)	ROPR AT 100% LOAD (CNSLK30)
-10	1.36	1.01	1.14
-9	1.05	0.98	1.03
-8	0.99	0.85	0.98
-7	0.95	0.82	0.86
-6	0.92	0.71	0.83
-5	0.81	0.69	0.72
-4	0.80	0.65	0.70
-3	0.77	0.71	0.66
-2	1.21	1.08	0.73
-1	1.88	1.74	1.81
0	2.61	2.15	2.31
1	3.32	3.03	3.12
2	3.55	3.16	3.36
3	3.72	3.48	3.49
4	3.83	3.51	3.58
5	3.23	2.97	3.17
6	3.02	2.51	3.05
7	2.26	1.42	2.01
8	1.01	0.92	0.98
9	0.79	0.56	0.75
10	0.34	0.21	0.28

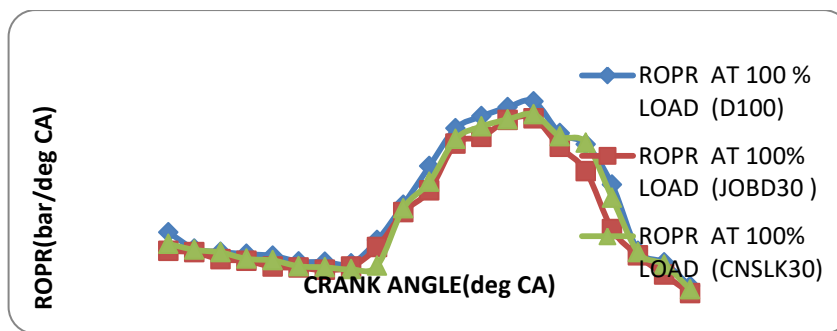


Figure 17: Rate of pressure rise Vs Crank angle at 240bar & 25°bTDC, at 100% load for different fuels D100, JOBD30 and CNSLK30 blended fuels

Heat release rate:

Table 10: Heat release rate Vs Crank angle at 240bar, 25°bTDC at 25%, 50% and 75%, 100% loads for different fuels D100, JOBD30 and CNSLK30

Crank Angle	HRR AT 100 % LOAD (D100)	HRR AT 100% LOAD (JOB30)	HRR AT 100% LOAD (CNSLK30)
-10	-3.02	-4.99	-4.79
-9	-2.79	-4.32	-3.13
-8	-2.15	-3.54	-3.09
-7	-2.02	-2.92	-2.43
-6	-1.29	-2.01	-1.59
-5	1.81	0.97	0.84
-4	6.42	4.56	5.07
-3	11.39	10.95	11.25



-2	18.02	15.03	16.03
-1	22.03	18.71	19.07
0	24.55	20.13	20.50
1	28.16	24.77	26.90
2	31.98	28.01	29.38
3	32.96	29.75	30.21
4	34.07	31.26	33.17
5	38.14	33.18	36.45
6	33.15	29.01	30.16
7	28.42	25.44	25.19
8	21.02	19.78	20.16
9	19.88	18.56	19.01
10	18.51	17.12	18.06

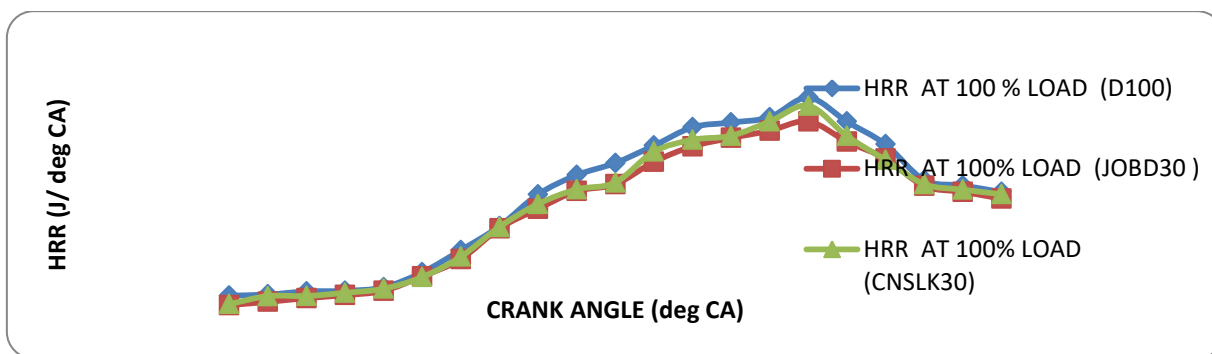


Figure 18: Heat release rate Vs Crank angle at 240bar & 25°bTDC, at 100% load for different fuels D100, JOBD30 and CNSLK30 blended fuels

The net heat release rate (NHRR) was computed using the data obtained for the combustion cycle and the first law of thermodynamics, taking into account the average value of pressure and crank angle data. The in-cylinder pressure is a reflection of the combustion process, which includes piston work on gas, heat transfer to combustion chamber walls, and mass flow in and out of crevice regions between the piston, piston rings, and cylinder liner. Each of these processes must be connected to the cylinder pressure as the combustion process propagates through the combustion chamber.

V. CONCLUSION

The performance, emission, and combustion characteristics of a single cylinder four stroke diesel engine running on diesel D100, Jatropha bio-diesel and cardanol and kerosene blends JOBD30, CNSLK30 at an injection pressure of 240 bar & at constant injection timing of 25°bTDC at engine rated speed of 1500 rpm are investigated. The key results are summarized below:

1. Due to the inherent oxygen content, the ignition delay of Cardanol and its blends JOBD30 and CNSLK30 was found to be less than that of diesel oil D100.
2. By addition of kerosene to Cardanol the viscosity and density of the blend reduces with increase in percentage of kerosene in the blend. The rate of pressure rise is higher for diesel D100 and lower for the blends JOBD30 and CNSLK30. The rate of pressure rise decreases with an increase in the percentage of percentage volume of cardanol in the fuel.
3. Calorific value of the blend increases with increase in the percentage of kerosene. As the percentage volume of biodiesel from jatropha oil in the fuel increases, the rate of pressure rise lowers.
4. Emission of carbon monoxide reduced with increase in kerosene percentage in the blend. The carbon monoxide emissions for blends, which is lower than diesel.
5. The present study showed that the unburned hydrocarbon emission for CNSLK30 blend is lower than the diesel fuel respectively.
6. The emission test was conducted using a 437C smoke metre and an AVL DIGAS 444N, with the findings being recorded. It can readily be observed that blends emit a far lower percentage of CO than diesel.

7. Based on the findings, it is concluded that the CNSLK30 blend consumes about the same amount of fuel, has a greater mechanical efficiency, and has a higher brake thermal efficiency under load fluctuations than the traditional diesel D100. The brake thermal efficiency of the jatropha oil biodiesel and its blends JOB30 and CNSLK30 are slightly lower than that of diesel D100 due to the early start of combustion of jatropha oil biodiesel and its blends, which increases the compression work.

8. A sudden rise in in-cylinder gas pressure is seen after a 75 percent load condition.

9. The exhaust gas temperature of blends is more compared to diesel this is due to the complete combustion which increases the combustion chamber temperature.

10. The CO and HC emission are lower for cardanol and Jatropha oil bio-diesel when compared to diesel this may be due to the fact that biodiesel contains more oxygen.

11. The NO_x emission is seen continuously increasing when load on engine is increased, which may be due to increase in cylinder temperature. Emission of oxides of nitrogen increased for blends when compared to diesel fuel, which is the common characteristic of any biofuel, and also one of its drawback.

12. The developed bio-fuels JOB30 and CNSLK30 blend is showing an inspiring result with minimum emissions and its thermal efficiency is well comparable with that of diesel.

13. Cardanol and kerosene CNSLK30 blend, Jatropha oil bio-diesel blend JOB30 is an innovative biofuel, which can be commercially used without any engine modification.

REFERENCES

- [1] Kasiraman.G, Nagalingam.B and Balakrishnan.N (2012). Performance, emission and combustion improvements in a direct injection diesel engine using cashew nut shell oil as fuel with Camphor oil blending. *Energy* 47,116-124.
- [2] Mallikappa.D, Reddy.R.P and Murthy.C.S (2012). Performance and emission characteristics of double cylinder CI engine with Cardanol biofuel blends. *Renewable energy* 38,150-154.
- [3] G. Lakshmi Narayana Rao., B. Durga Prasad., S. Sampath., K.Rajagopal., Combustion Analysis of Diesel Engine Fueled with Jatropha Oil Methyl Ester-Diesel Blends ,16 October 2014,<http://dx.doi.org/10.1080/15435070701665446>.
- [4] Mathew BC, Thangaraja J, Sivaramakrishna A. Combustion, performance and emission characteristics of blends of methyl esters and modified methyl esters of karanja and waste cooking oil on a turbocharged CRDI engine. *Clean Technol Environ Policy* 2019;21:1791-807. <https://doi.org/10.1007/s10098-019-01750-9>.
- [5] Patel C, Chandra K, Hwang J, Agarwal RA, Gupta N, Bae C, Gupta T, Agarwal AK. Comparative compression ignition engine performance, combustion, and emission characteristics, and trace metals in particulates from Waste cooking oil. Jatropha and Karanja oil derived biodiesels *Fuel* 2019;236:1366-76 . <https://doi.org/10.1016/j.fuel.2018.08.137>.



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