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Performance, emission characteristics of compressed ignition engine with alternative fuel

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ABSTRACT

The primary study is to take the alternative fuel using cashew nut shell liquid as bio-diesel and to moderate the continuous issues posed by the reducing petroleum backup. Cashew nut shell is pulverized and the oil is extracted. The CNSL is then converted in to bio-diesel by transesterification process. The properties of liquid thus accomplished are characterized. The investigational results verified the fact that CNSL consists mostly phenolic compounds. The bio-diesel thus obtained is blended with neat diesel in the ratios 2080 (B20) and 6040 (B60) per litre. The blended mixture is then tested for performance and combustion using Variable Compression Ratio (VCR) Engine set up. The emission characteristics are tested using computerized AVL Smoke Metre.

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1. Introduction

The main inspire is severity in construction, easy in operation as well as maintenance. But due to the demand of fossil fuel, we may not be clever to benefit in this services for long period [1–3]. Therefore works are being made all over the world, to carry out nonconventional fuel for C.I engines. Similarly, how to decreases fuel consumption has put focal point on the automobile and to produce engine with innovative technology. This has lead to improvement of new combustion system [4–5]. Tables 1 and 2.

The performance and emission characteristic of C.I engine depend on various factors like fuel injected, timing of fuel injection, fuel injection pressure, combustion chamber shape, size of nozzle, fuel spray pattern and air swirl. A number of researches are carried out in C.I engines to increase the operating efficiency and also to reduce the pollution out of it [6–9]. In present work injection pressure is varied to study the effect in the direct injection C.I engine. Different ratio of bio diesel blended with diesel was used as fuel. This is an effort to find the optimum working condition injection pressure in the form of output power, SFC and efficiency [10].

2. Extraction of oil from cashew nut shell

Generally there are following methods are used for extracting cashew nut shell liquid from the cashew nuts [8]. These are Mechanical extraction, Thermal extraction and Solvent extraction.

2.1. Blending

Blending is defined as the mixture of different type of the same substance together so as to make a product of the desired quality [11–14]. Bio diesel is blended with neat diesel in different concentrations. B20 %, 40% and 60% of bio diesel as well as 80%, 60% and 40% of neat diesel respectably [15].

It can be represented as follows
For 1 L B20
Diesel 800 ml + Bio diesel (200 ml)
(80%+20%)
For 1 L B40
Diesel 600 ml + Bio diesel (400 ml)
(60%+40%)
For 1 L B60
Diesel 400 ml + Bio diesel (600 ml)
(40%+60%)

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Table 1
Properties of Blends & Diesel.

Property	B20	B40	B60	Diesel
Density in (kg/m^3)	868	875	883	850
C.V in (kJ/kg)	41,891	41,283	40,649	42,500

Table 2
IP, BP & FP of Diesel.

Speed (rpm)	Load (kg)	IP (kW)	BP (kW)	FP (kW)
1532	0.10	1.74	0.02	1.71
1510	3.01	2.60	0.86	1.73
1498	6.01	3.18	1.71	1.47
1483	9.01	3.81	2.54	1.27
1476	12.01	4.49	3.37	1.13

Each type of blends has a different density and calorific value due to variation in their viscosity for each type of blends [16–19]. It shows the blends of B20, B40 and B60 due to the facts that change in the concentration of each type of blends [20–24].

3. Property testing

The blending mixtures of bio diesel and neat diesel have done with various properties testing and they are

Density/ API gravity measurement,
Calorific value testing,
Kinematic viscosity testing,
Flash and fire point testing.

3.1. Density measurement

The density measurement in figure which is used to measure the density of the given samples using the density meter or otherwise known as densometer. The blended mixtures are measured using this densometer. The densometer can measure both the wet portion and the dry portion of a sample.

Fig. 3.1. Density Meter.

3.2. C.V (calorific value) testing

The C.V is the substance in which the amount of energy that is produced when flaming a given amount of the substance. The blended mixture is tested for the calorific value property using the calorimeter. Fig. 3.1. Fig. 3.2.

Fig. 3.2. Calorimeter.

3.3. Kinematic viscosity meter

The fluid viscosity is a measure of resistance to gradual deformation by the shear stress or tensile stress for liquid. The kinematic viscosity is ratio of the dynamic viscosity to density of the fluid. Kinematic viscometer is used to measure the kinematic viscosity. Fig. 3.3.

3.4. Flash point testing

It is the lowest temperature at which vapors will ignite, when ignition given is called as flash point and it is measured by using Pensky Martene Flash Point Apparatus in figure. The apparatus used to measure the blended mixture. The testing has two types one is open cup and other one is closed cup.

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Fig. 3.3. Flash Point Apparatus.

4. Result & discussions

The performance of diesel is tested using C.I engine setup. The engine performance parameters are namely power, specific fuel consumption and torque. The Brake torque is normally calculated by dynamometer which is mounted on a test bed.

4.1. Indicated, brake & friction power

The heat energy which is changed to power is called as I.P, indicated power is always more than the brake power and it is utilized to drive the piston. The B.P is the power output of the engine without the power loss cause by various transitions. The power loss particularly in an I.C engine during friction among parts of the machine is known as frictional power.

It is noted that IP and BP rise with increase in load and FP decrease with increase in applied load. Fig. 4.1.

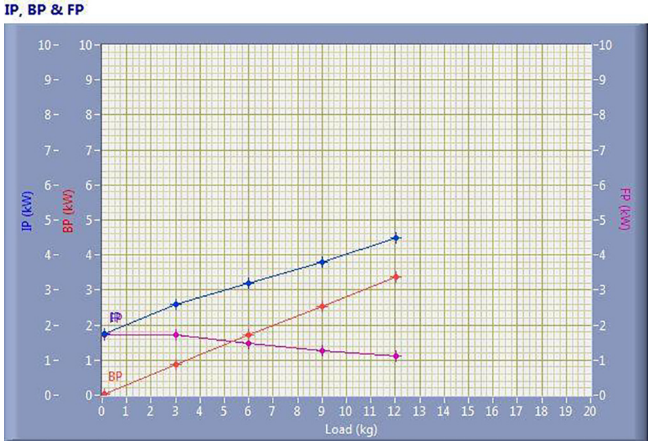

Fig. 4.1. IP, BP & FP of diesel.

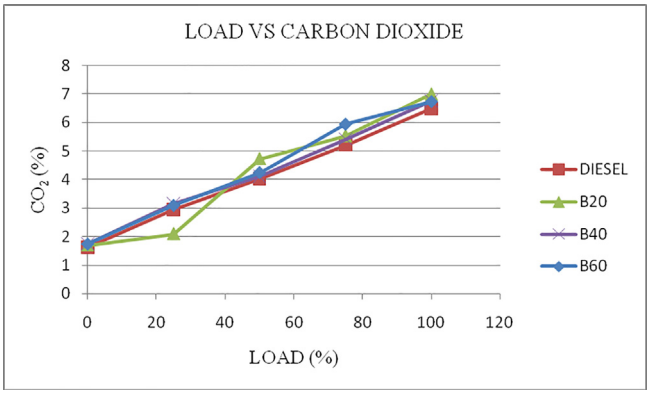

Fig. 4.2. Load VS CO_2 Emission.

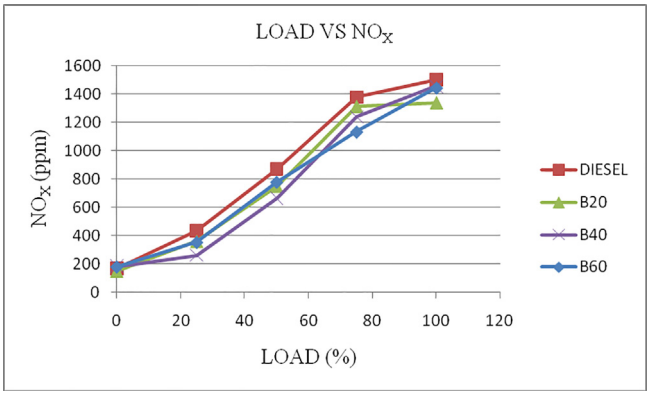

Fig. 4.3. Load VS NO_X Emission.

4.2. Emission characteristic

The biodiesel is well thought-out to be an instant alternative energy which providing a solution to help reduce the effect of injurious global green house gases, as it is derived from the plant oil offering safer, cleaner and renewable alternative to petroleum diesel. The gases emitted in D.I. engine are Fig. 4.2.

1. Carbon dioxide (CO_2),
2. Nitrogen Oxide (NOx).

4.3. Carbon dioxide (CO_2)

It indicates that, for both fuels, the rising trend of CO_2 emission levels which are observed with power output. This rising trend of carbon dioxide emission due to the enhance in volumetric fuel consumptions.

It is noted that carbon dioxide emission of cashew nut shell biodiesel is fewer than that of diesel fuel. This is endorsed to the occurrence of oxygen and more cetane number of cashew nut shell bio diesel. Fig. 4.3.

4.4. Nitrogen oxide (NO_X)

The nitrogen oxide with respect to load for both fuels and blends shown in figure. It clearly indicate, for both fuels, the improved engine load promote NOx emission. Since the formation of NOx is aware to temperature. The high loads endorse cylinder charge temperatures, which is accountable for thermal NOx forma-

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tion. The cashew nut shell biodiesel produces somewhat more NOx than diesel.

5. Conclusion

The performance and emission characteristics of diesel engine with cashew nut shell bio-diesel and its blend has studied and compare with base line of diesel. Thus the result of research work is concluded as:

1. The SFC rises with the augment in the % of the blends due to the less C.V of cashew nut shell bio diesel.
2. Cashew nut shell oil result a little bigger thermal efficiency as compare to the diesel.
3. The exhaust gas temperature increase with % of cashew nut shell bio-diesel in the test fuel for all loads.
4. The B.S.F.C value is more than the engine running with normal diesel by a maximum range of 10%.
5. Emission of CO is less at maximum loads for methyl ester of cashew nut shell oil when compare to diesel. The increase in emission of NOx of cashew nut shell biodiesel is credited to the mono and poly unsaturated fatty acid.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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