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PERFORMANCE, COMBUSTION AND EMISSION CHARACTERISTICS ON SINGLE CYLINDER DIESEL ENGINE USING BALANITES AEGYPTIACA (DESERT DATE)

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1. Abstract

In developing countries like India, it is easily possible to grow these none. Edible vegetable oils but not economically feasible to convert them to methyl esters undergoing different types of chemical process. Therefore, preheated oils blended with diesel are used and tested as alternative fuels in engines. There is no single solution to global warming, which is primarily a problem of too much heat-trapping carbon dioxide (CO_2), methane and nitrous oxide in the atmosphere. The technologies and approaches outlined below are all needed to bring down the emissions of these gases by at least 80 percent by mid-century. Biodiesel is a clean burning alternative fuel produced from domestic, renewable resources such as plant oils, animal fats, used waste cooking oil and even from algae. Biodiesel contains no petroleum, but can be blended at any level with petroleum diesel to create a biodiesel blend. Biodiesel blends can be used in compression ignition engines with little or no modifications. Among the vegetable oils edible and non-edible oils are used to produce biodiesel.

Keywords: Mahua oil, karanja oil, Balanites Aegyptiaca

2. Introduction

Due to excess use of the petroleum based fuels for industry and automobile applications in present time, the world is facing severe problems like energy crisis, environmental pollution and global warming. Therefore global consciousness has started to grow to prevent the fuel crisis by developing alternative fuel sources for engine application. Many research programs are going on to replace diesel fuel with a suitable alternative fuel like biodiesel. Non-edible sources like Mahua oil, karanja oil, Neem oil, Jatropha oil, simarouba oil etc. are being investigated for biodiesel production. Fatty acids like stearic, palmitic, oleic, linoleic and linoleic acid are commonly found in non-edible oils . Vegetable oils-blended with diesel in various proportions have been experimentally tested by a number of researchers in several countries. In developing countries like India, it is easily possible to grow these non. edible vegetable oils but not economically feasible to convert them to methyl esters undergoing different types of chemical process. Therefore, preheated oils blended with diesel are used and tested as alternative fuels in engines. There is no single solution to global warming, which is primarily a problem of too much heat-trapping carbon dioxide (CO_2), methane and nitrous oxide in the atmosphere. The technologies and approaches outlined below are all needed to bring down the emissions of these gases by at least 80 percent by mid-century. Biodiesel is a clean burning alternative fuel produced from domestic, renewable resources such as plant oils, animal fats, used waste cooking oil and even from algae. Biodiesel contains no petroleum, but can be blended at any level with petroleum diesel to create a biodiesel blend. Biodiesel blends can be used in compression ignition engines with little or no modifications. Among the vegetable oils edible and non-edible oils are used to produce biodiesel. The use of edible is a great concern with food materials. So it is justified to use non edible for the production of biodiesel. Non edible trees can grow in inhospitable condition of heat, low water, rocky and sandy soils. So non-edible oil plants like karanja, Jatropha. Mahua, Neem will be the best choice for the source of biodiesel production. This experimental work describes the findings of experiments conducted on a diesel engine to investigate about its performance and emission parameters with a number of test fuels prepared from Balanites aegyptiaca (desert date) Biodiesel.

2. Experimental methods

Transesterification

1 liter of Balanites aegyptiaca(Desert date) seed oil is taken in a three neck flask with reflux condenser, heat the oil up to 60°C add 300ml of methanol and 10gms of potassium hydroxide catalyst. Run the process for about 90minutes. Transfer that oil into separating funnel, allow it to settle for about 7-8 hours then two layers will be formed . Upper layer is biodiesel and lower layer is glycerin. Separate the glycerin and biodiesel. The Yield after this process was found to be 88-90% of biodiesel. (850-900ml). Fig 3.3 to 3.7 Shown the Preparation of biodiesel in different steps by transesterification process.

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Fig 2.1 Oil Filter

Fig 2.2 Transesterification process

Fig 2.3 Separation of biodiesel and glycerin

Fig 2.4 Washing of biodiesel

Fig 2.5 Drying of biodiesel

Fig 2.6 Blended bio diesel

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The Table-2.1 shows Physiochemical properties of Calophyllum Inophyllum biodiesel and its comparison with ASTM biodiesel standards and commercially available diesel.

Table-2.1: The Physiochemical properties of Calophyllum Inophyllum Biodiesel Oil

SL No.	PROPERTIES	UNI TS	EXPERIMENTAL VALUES			
			BIODISEL (Calophyllum Inophyllum Biodiesel Oil)	BIODIESEL STANDARD VALUE (ASTM)	COMMERCIALLY AVAILABLE DIESEL	PROTOCALL
1	Kinematic Viscosity @40^{0}C	Centistokes	6.0	1.9-6.0	2.54	ASTM D445
2	Density	Kg/m^3	880	870-900	840	ASTM D4052
3	Flash Point	^{0}C	152	130	54	ASTM D93
4	Calorific Value	KJ/Kg K	34200	37000 to 42500	43500	ASTM D240

Physiochemical properties of Balanites aegyptiaca (Desert date) biodiesel

Viscosity: Kinematic viscosity is the resistance offered by one layer of fluid over another layer. The viscosity is important in determining optimum handling storage, and operational conditions. Fuel must have suitable flow characteristics to ensure that an adequate supply reaches injectors at different operating temperatures. High viscosity can cause fuel flow problems and lead to stall out. Fill the bio-diesel in the cannon– Penske viscometer [tube no 100, direct type] bulb as shown in figure-5. Kinematic viscosity in Centistokes (cst) = (Number of seconds × standard factor of the bulb viscometer used for testing).

[Note: The standard viscometer factor as specified by manufacturer is 0.0214]

From table 2.1 Shows, Comparison of biodiesel, biodiesel ASTM standards and commercially available diesel.

- The viscosity of diesel is 2.54 Cst
- The viscosity of biodiesel is 6.0 Cst

- The viscosity of biodiesel standard (ASTM) is 1.9-6.0 Cst

Density: A hydrometer is the instrument used to measure the specific gravity (relative density) of biodiesel. That is the ratio of the density of water. The hydrometer is made of glass and consists of a cylindrical stem and bulb weighed with mercury or lead shot to make it float upright. The hydrometer contains a paper scale inside the stem, so that the specific gravity can be read directly. Measure 500 ml of the Bio-Diesel in a clean & dry measuring cylinder. Allow the Bio-Diesel to settle. Gently lower the hydrometer in to the biodiesel in the cylinder until its floats freely. Note the point at which the surface of the Bio-diesel touches the stem of the hydrometer. Reading will be specific gravity multiplied by thousand will give density. From table 3.1 Shows, Comparison of biodiesel, biodiesel ASTM standards and commercially available diesel.

- The density of diesel is 840 kg/m^3 C
- The density of biodiesel is 880 kg/m^3
- The density of biodiesel standard (ASTM) is 870 to 900 kg/m^3

Flash point: The lowest temperature at which the vapor of a combustible liquid can be, made to ignite momentarily in air is identified as the flash point and correlates to ignitibility of fuel. Low flash point can indicate residual methanol remaining from the conversion process. The flash point is often used as a descriptive characteristic of liquid fuel and it is also used to characterize the fire hazards of liquids. "Flash point" refers to both flammable liquids and

- The flash point of diesel is 54^0C
- The flash point of biodiesel is 152^0C
- The flash point of biodiesel standard (ASTM) is 130^0C

Fig 2.7 Instrument of pen sky marten's

Fig 2.8 Instrument of bomb calorimeter

Experimental Set-Up

The experiments of performance and emission characteristics were conducted on a stationary single cylinder four-stroke diesel engine and compare it with baseline data of diesel fuel. The engine is coupled with an eddy current dynamometer as shown in fig: 2.4. The eddy current dynamometer was used for loading the engine. The various components of experimental set up are described below. Shows line diagram & Fig. shows the photograph of the experimental set up. The important components of the system are,

- The engine
- Dynamometer
- Smoke meter
- Exhaust gas analyzer

- **The Engine:**

The Engine chosen to carry out experimentation is a single cylinder, four stroke, vertical, water cooled, direct injection computerized Kirloskar make CI Engine. This engine can withstand higher pressures encountered and also is used extensively in agriculture and industrial sectors. Therefore this engine is selected for carrying experiments.The specifications of the engine given in the actual photos of the C.I. Engine and its attachments. The technical specification of the engine gives the table 3.2 and fig 3.11 shows the photograph of experimental setup in laboratory.

- **Dynamometer:**

The engine has a DC electrical dynamometer to measure its output. The dynamometer is calibrated statistically before use. The dynamometer is reversible i.e., it works as monitoring as well as an absorbing device. Load is controlled by changing the field current. Eddy-Current Dynamometer's theory is based on Eddy-Current (Fleming's right hand law). The construction of eddy-current dynamometer has a notched disc (rotor) which is driven by a prime mover (such as engine, etc.) and magnetic poles (stators) are located outside with a gap.

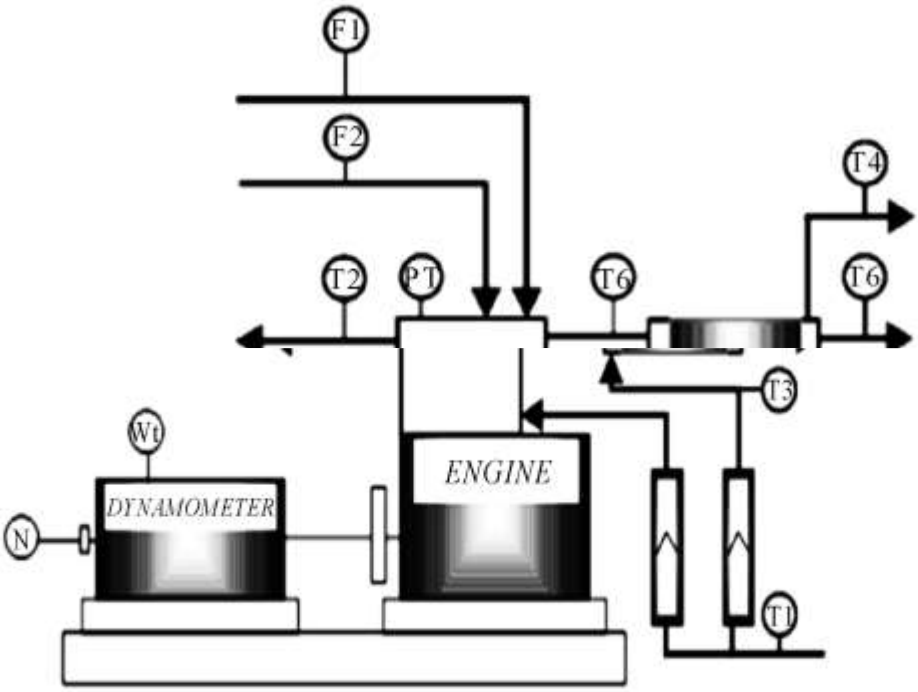

Fig-2.9 Experimental setup

PT-Pressure Transducer. **T1-Jacket water inlet temperature.**

N-Rotary encoder. **T2-Jacket water outlet temperature.**

Wt - Weight. **T3--Calorimeter water inlet temperature.**

F1-Fuel flow. **T4-Calorimeter water outlet temperature.**

F2-Air flow. **T5-Exhaust gas to calorimeter Temperature**

3. RESULTS AND DISCUSSION

Performance charecterstics

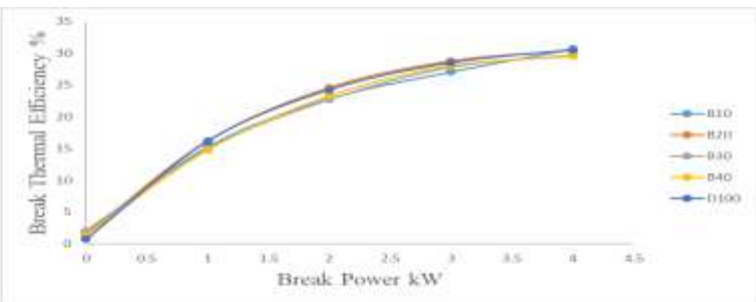

Fig 3.1 Variation of brake thermal efficiency with brake power

The variation of brake thermal efficiency with brake power for diesel, Desert date oil and waste cooking oil and their blends are shown in Fig . Brake thermal efficiency is increasing with increasing brake power for all multi-blends of biodiesel and diesel. It may be due to reduction in heat loss and increase in power with increase in load. The decrase in brake thermal efficiency for higher blends may be due to the combined effect of its lower heating value and increase in fuel consumption. Brake thermal efficiency of 20% biodiesel is very close to diesel for entire range of operation.

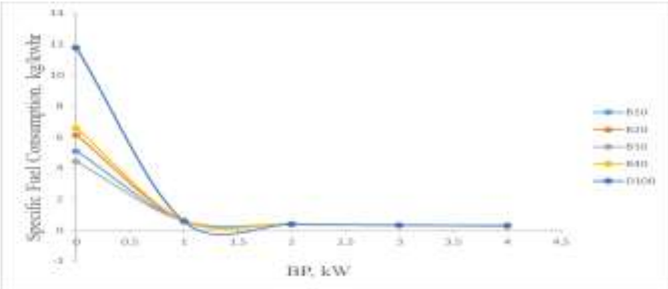

Fig 3.2 Variation of specific fuel consumption with brake power

The variation of specific fuel consumption with brake power shown in fig as the power developed increases the specific fuel consumption decreases for all the tested fuels. The specific fuel consumption of blends is more than that of diesel, this is due to lower calorific value of the fuel, and engine consumes more amount of the fuel in order to produce the same out-put power. Brake thermal efficiency for B30 fuel is very close to that of diesel. At full load, the maximum Brake thermal efficiency for diesel is 0.31 kg/kw-h for B20 the value is 0.3 kg/kw-h, B10 is 0.29 kg/kw-h, and D100 is 0.29 kg/kw-h

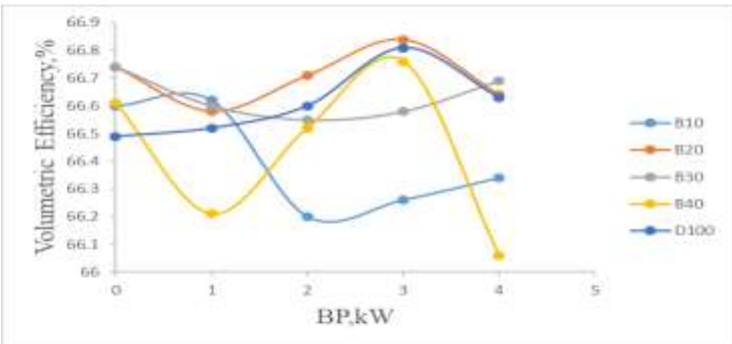

Fig3.3 Variation of volumetric efficiency with brake power

The variation of volumetric efficiency with brake power is shown in fig from graph diesel has higher volumetric efficiency compare to blends .the graph for different blends are in zigzag in nature because of breathing ability of engine for the particular combinations .i.e. ,ratio of the air actually induced at ambient conditions to the swept volume of the engine.

Emission characteristics

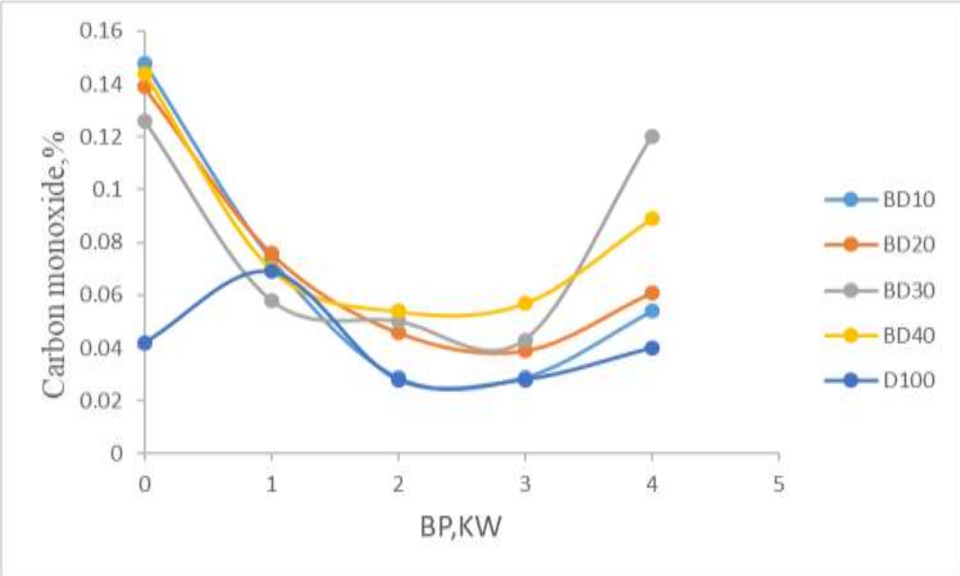

Fig 3.4 Variation of carbon monoxide with brake power

The CO emission depends solely depends upon the strength of the mixture, availability of oxygen and viscosity of fuel. From fig it is observed that the CO emission initially decreases at lower loads sharply increases for all test fuels. This is due to incomplete combustion at very high loads which results in higher CO emissions. CO emission is found highest for B30 if we compare with diesel. Lowest for biodiesel B10 at all loads.

4. CONCLUSIONS

The experimental work carried out on a single cylinder diesel engine using biodiesel derived from Balanites aegyptiaca(Desert date) Biodiesel as an alternate fuel.

The performance, combustion and emission characteristics of blends are evaluated. No difficulty was faced at the time of starting the engine and the engine ran smoothly over the range of engine speed. From the above investigation, the following conclusions are drawn.

- The properties viz; density, viscosity, flash point and fire point of Balanites aegyptiaca (Desert date) biodiesel is higher and calorific value is 42 kg/m^3 higher than that of diesel.

- Performance and emission characteristics of 20% blend are better than other blends, followed by B40. And efficiency of B40 is well compare with the diesel. The maximum brake thermal efficiency of B10, B20, B30 and B40 are respectively 30.7%, 30.44% and 29.74% and 29.54 against, 30.52% of diesel.
- The maximum brake thermal efficiency of blended biodiesel (Desert date, waste cocking oil and diesel) is 30.7% against 30.52% of diesel.
- The minimum SFC of Desert date biodiesel (B40) is 0.27 kg/kW-h higher compared with diesel.
- Unburnt HC, CO and NO_x emissions at maximum load for Balanites aegyptiaca (Desert date) biodiesel compared with diesel are higher by 5ppm, 0.014%, and 20ppm, respectively.

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