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A Review Paper on Thermal Performance Analysis of Single Cylinder CI Engine with Karanja Oil, Blends with Pure Diesel

Swpanil R Patil[1] and Prof. S.U. Patel[2]
[1]P.G Student, M.E (Mechanical), D.N. Patel College of Engineering, Sahada, Maharashtra, INDIA
[2]Professor, Department of Mechanical Engineering, D.N. Patel College of Engineering, Sahada, Maharashtra, INDIA

[1]Corresponding Author: maheshpatil.1646@gmail.com

ABSTRACT

In the present work an experimental research was carried out on a laboratory single cylinder, four-stroke variable compression ratio, direct injection diesel engine converted to Diesel dual fuel mode to analyze the performance and emission characteristics of pure diesel first and then blending of Karnja oil bio-diesel dual fuel mode. The measurements were recorded for the compression ratio of 15,16,and17 at blends % substitution rates of B20,B40 and B60 by varying the load from idle to rated load of 2.5,4.5,and 6.5 kg in steps of 1 up to 2.5kg ,4.5kg and then to 6.5kg. The results reveal that brake thermal efficiency of dual fuel engine is in the range of 15%-30% at the rated load of 6.5kg which is 11%-13% higher than pure diesel engine for B20,B40 and B60 substitution rates. Brake specific fuel consumption of dual fuel engine is found better than pure diesel engine at all engine loads. investigations in this study.

***Keywords*--** VCR, BSFC, BTHE, KARNJA, LOAD

I. INTRODUCTION

This project studies the effect of Karnja oil induction on the performance of biodiesel operated dual fuel engine for both Karnja. The use of Blending of Karnja oil with diesel. Is experimented to improve the performance of a dual fuel compression ignition (CI) engine. Diesel is used as the base fuel for the dual fuel engine results. During experimentation, the engine performance was measured in terms of brake thermal efficiency and brake specific fuel consumption. Results showed that using Blends B20 has improved the CI engine performance with reduction emission of carbon monoxide (CO), hydrocarbon (HC), carbon dioxide (CO2) will be measured. Karnja oil can be the next prime fuel for energy conservation machinery system such as internal combustion (IC) engines.

In India, total consumption of crude oil was 103,44 million tonnnes (MT) in 2000-2001and 160.03MT in 2009-10,whereas production was 32.43MT in 200-01 and 33.69MT in 2009-10.Thus increment in production is only 3.7% as compared to increment in computation of 35.36%1.Transportation and agricultural sectors are major consumers of fossil fuel and biggest contributors to environmental pollution. Current price of vegetable oil worldwide is nearly competitive with petroleum based fuels.

II. BACKGROUND ON BIODIESEL

The idea of using plant-based oils, such as soybean oil or canola oil, to fuel an internal combustion engine is as old as the diesel engine itself. Rudolph Diesel, inventor of the diesel engine, used peanut oil to demonstrate his new invention at the Paris World's Exhibition in 1900. Throughout the 20th century, however, petroleum-based diesel fuel has been relatively cheap and convenient. As a result, diesel engines have been refined through the years to work well with this fuel source. Petroleum diesel flows more easily (i.e. is less viscous) than either plant or animal based fats and oils. As a result, using non-petroleum-based oils in today's diesel engines requires either modifying the vehicle's fuel system to accept these slower flowing oils or modifying the oil or fat itself so that it can be used directly in a diesel engine. The chemical process commonly used make bio-oils less viscous, turning them into "biodiesel" is called "transesterification".

- Biodiesel is made from the combination of a triglyceride with a monohydroxy alcohol (i.e. methanol, ethanol…).
- What is a triglyceride? Made from a combination of glycerol and three fatty acids:

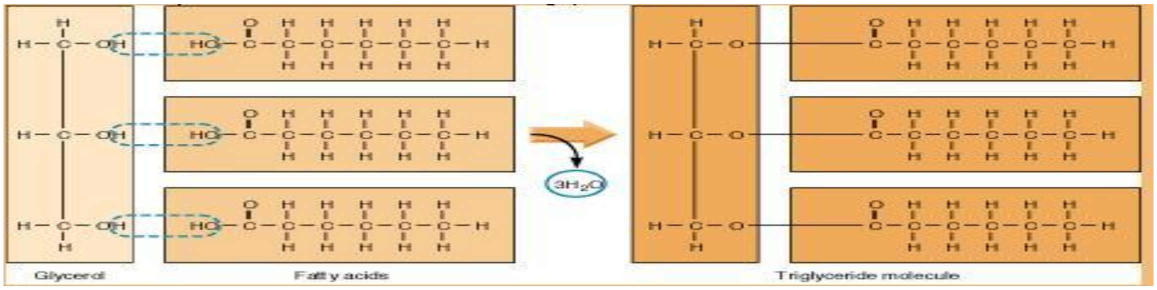
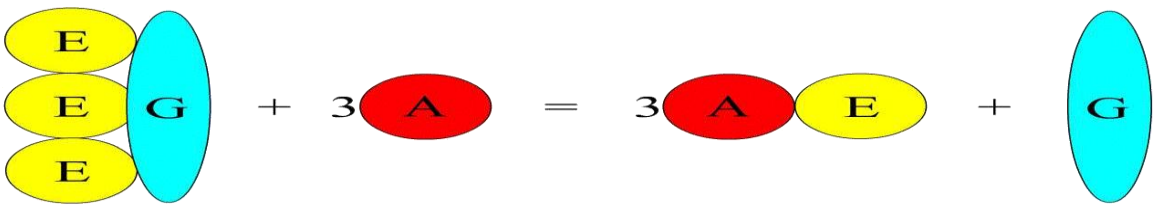


Fig.1 Chemistry of triglycerides

Tran's esterification

While actually a multi-step process, the overall reaction looks like this:



Vegetable Oil Biodiesel

Fig.2 Trans esterification

III. METHODS AND MATERIALS

A. Karnja as an alternate fuel for internal combustion engines

Karnja has emerged as a promising alternative fuel due to its clean burning characteristics and very low amount of exhaust emissions. Major problems encountered with vegetable oil as bio diesel used in CI engine are its low volatility and high viscosity due to long chain structure. The common problems faced are excessive pumping power, improper combustion and poor atomization of fuel particles. The conversion of the vegetable oil as a CI engine fuel can be done any of the four methods; pyrolysis, micro emulsification, dilution/blending and transesterification.

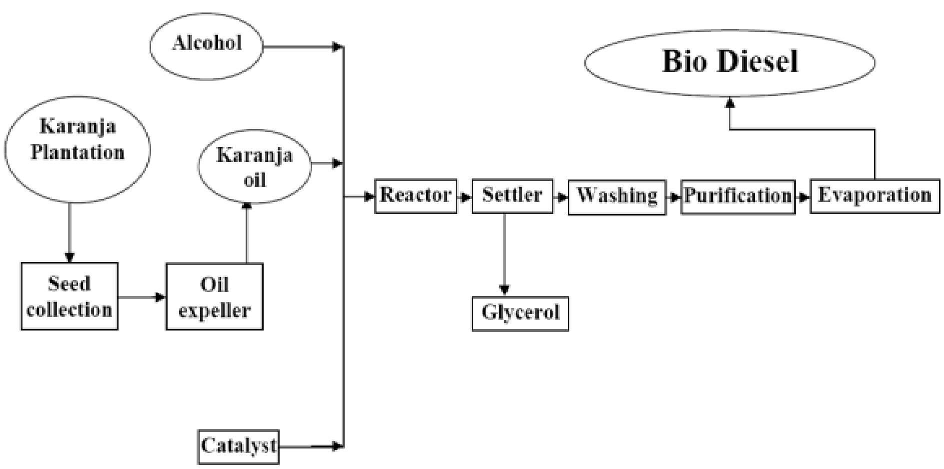


Fig.3 Preparation of laboratory samples of esterified karanja oil (bio diesel)

Flash and Fire point: Flash point is the lowest temperature corrected to a standard atmospheric condition at which application of a test flame causes the vapour of a specimen to ignite under specified conditions of test. Fire point is the lowest temperature at which a specimen will sustain burning for 5 seconds. These two parameters have great importance while determining the fire hazard (temperature at which fuel will give off inflammable vapour). Flash point and fire point of the samples were measured by Cleveland open Cup Tester (followed by the specifications IP 36, ASTM D92, IS: 1448

Viscosity measurements: The resistance to flow exhibited by fuel blends is expressed in various units of viscosity. It is a major factor of consequence in exhibiting their suitability for the mass transfer and metering requirements of engine operation. Higher the viscosity results low volatility and poor atomization of oil during injection in CI engine, that results in incomplete combustion and ultimately carbon deposits on injector nozzle as well as in the combustion chamber. The viscosities of Karanja oil as well as derived bio diesel are measured by Red Wood Viscometer (As per IP70) and a comparative study is made at different temperature. Different temperature dependent viscosities are shown in table 1.

Table 1 Temperature vs. Viscosity

	Karanja oil		Derived bio diesel	
Sl No.	Temp (°C)	Viscosity (cSt)	Temp (°C)	Viscosity (cSt)
01	30	29.65	30	8.73
02	45	17.34	45	7.44
03	60	14.62	60	5.97
04	75	11.74	75	5.34
05	90	10.63	90	4.62

Karanja oil and its properties:Karanja (Pongamia Pinnata) is one of the forest-based tree-borne non-edible oil with a production potential of 135,000 metric tons per year in India. It is one of the few nitrogen fixing trees (NFTs), which produce seeds containing 30–40% oil. The Karanja tree is cultivated for two purposes: (1) as an ornamental tree in gardens and along avenues and roadsides, for its fragrant Wisteria-like flowers and (2) as a host plant for lace insects. This species is commonly called pongam, Karanja, Pongamia, or a derivation of the senames. Karanja is a medium sized fast-growing evergreen tree (Fig. 2), which reaches 40 feet in height and spread, forming a broad, spreading canopy casting moderate shade. Flowers are pink, light purple, or white. Pods are elliptical, 3– 6 cm long and 2–3 cm wide, thick walled, and usually contain a single seed (Fig. 3). Seeds are 10–20 mm long, fig oblong and light-brown in color. Native to humid and subtropical environments, Karanja thrives in areas having an annual rainfall ranging from500 to 2500 mm. In its natural habitat, the maximum temperature ranges of maximum from 27 to 380C and minimum 1–160 C. Mature trees can withstand water logging and slight frost. This species grows up to elevations of 1200 m. It can grow on most soil types ranging from stony to sandy to clayey, including Verticals. It does not do well on dry sands. It is highly tolerant of salinity. It is commonly found along waterways or seashores, with its roots in fresh or salt water. Highest growth rates are observed on well-drained soils with assured moisture. Air-dried Karanja kernels have typically 19.0% moisture, 27.5% fatty oil, 17.4% protein, 6.6% starch, 7.3% crude fiber, and 2.4% ash. Fatty acid composition and structure of Karanja oil is given in Table 2. A single tree is said to yield 9–90 kg seed per year, indicating a yield potential of 900–9000 kg seed/ha. A thick yellow–orange to brown, bitter, non-drying, non-edible oil is extracted from seeds. Yields of 25% (v/v) are possible using a mechanical expeller. It is typically used for tanning leather, soap, and as illuminating oil. The oil has a high content of triglycerides, and its disagreeable taste and odor are due to bitter falconoid constituents such as pongamiin and karanjin. The oil is also used as a lubricant, water-paint binder, and pesticide. The oil has also been tried as fuel in diesel engines, showing a good thermal efficiency. The objective of this paper is to investigate the performance and exhaust emission characteristics of a single cylinder diesel engine fuelled with Karanja oil (K100) and its blends K10, K20, K50 and K75 with and without preheating using a novel exhaust gas heat exchanger specially designed for this purpose.

Table 2 Fatty acid composition of Karanja oil

Fatty acid	Structure	Formula	Percentage (%)
Palmitic acid	16:0	$C_{16}H_{32}O_2$	3.7–7.9

Stearic	18:0	C18H36O2	2.4–8.9
Oleic acid 2	18:1	C18H34O	44.5–71.3
Linoleic acid	18:2	C18H32O2	10.8–18.3
Lignoceric	24:0	C24H48O2	1.1–3.5
Archidic	--	--	2.2–4.7
Behenic	--	--	4.2–5.3
Eicosenoic	--	--	9.5–12.4

B. Development of experimental test set up

The test engine is directly coupled to an electric dynamometer, which permits the engine to operate under partial monitoring conditions representing negative brake output. For any set of operating conditions, the pilot fuel was kept constant while the amount of Blends fuel was B20,B40,B60. The ignition delay period was established from records obtained using a water-cooled piezoelectric transducer. The injection timing was established using an electric inductance transducer. The average values obtained from several consecutive cycles were used. During the tests the injection timing was kept constant and the engine was operated at 1500 RPM, under naturally aspirated conditions. Fig.4 shows a schematic layout of engine test set up and Engine Specification shown in table no.3

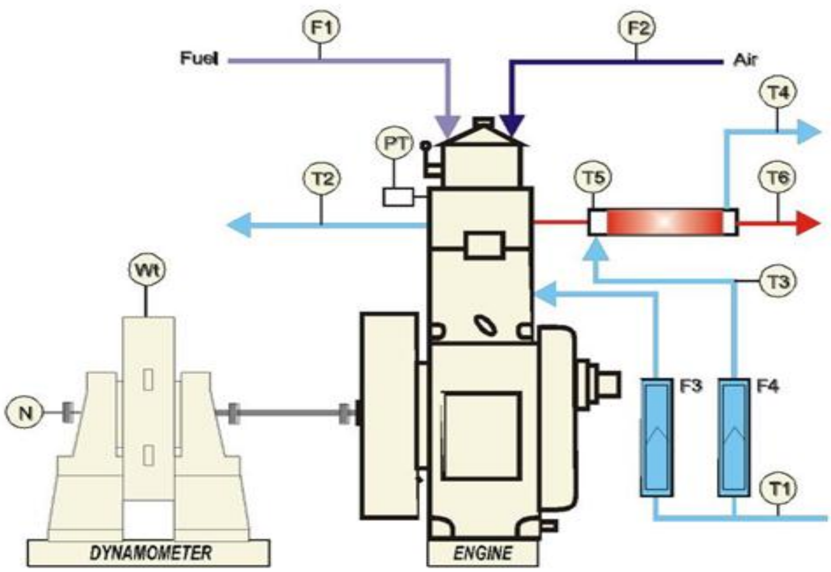


Fig.4 Schematic arraignment

Table 3: Specifications of test engine

Engine type Make	**Kirloskar**
Bore	87.5mm
Stroke length	110mm
No. of cylinders	01
No. of strokes	04
Type of cooling	Water cooled
Rated power	3.5 Kw at 1500 RPM
Engine capacity	661cc
Variable CR range	12 to 18
Fuel used	Diesel, Biodiesel

C. Objectives of Project

Keeping in mind the benefits of biodiesel and so the consequential importance renewable in the near future, the work was undertaken with following specific objectives:

1. To conduct short term field test on C.I. engine.
2. To study performance of C.I. engine with biodiesel produced from Karanja oil.
3. By varying C.R and Load.

In the present work, karanja, biodiesel purchased from Minto-bio fuels ltd., Pirangut Pune. And their physio-chemical combustion properties were provided by same company. And then used for performance analysis in "4-stroke 4-cylinder water cooled diesel engine."

IV. RESULTS AND CONCLUSION

1. Brake thermal efficiency analysis

The variation of thermal performance parameters at different values of CRs at 15, 16 and 17 with a load of 2.5kg, 4.5kg, and 6.5kg and IP of 200 bar it represented in figure 4 to 6. It can be observed that BTHE increases continuously with increase in Load. The increasing trend is due to higher air temperature achieved at diesel due to better combustion of fuel. From above three results clearly indicates at full load condition only Brake thermal efficiency increases continuously in B20 as compare than pure Diesel at C.R 15. The nearest result obtained at B20 at same like as pure Diesel as shown in figures 4 to 6. It depicts the variation of brake thermal efficiency with variation of engine load at CR of 16 for the good one and at C.R 17 B20 gives better BTHE than the diesel in x- axis is the load in kg y-axis is the BTHE

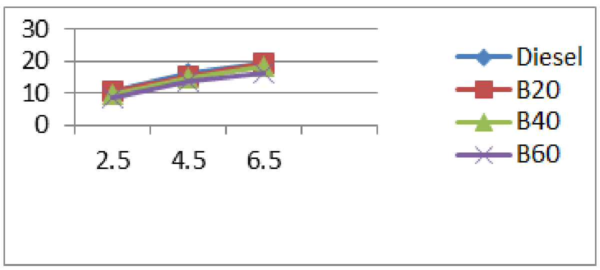


Fig.4 at C.R 15

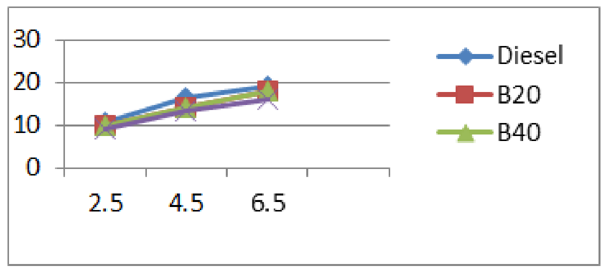


Fig.5 at C.R 16

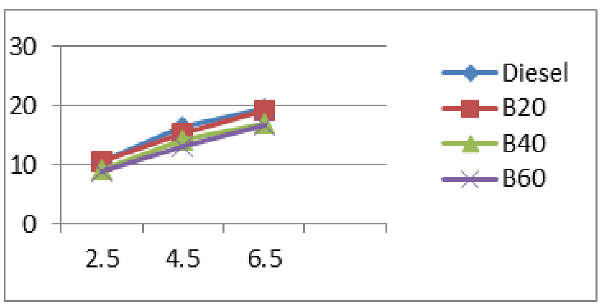


Fig.6 at C.R 17

2. Brake specific fuel consumption analysis

It can be observed that as the CR of the engine increases, then BSFC of decreases when load increases and result will obtained nearly B20 is same BSFC as of pure Diesel but B40 but in almost all CR the B40 gives better performance in increased the combustion efficiency. in x-axis is the load in kg y-axis is the BSFC

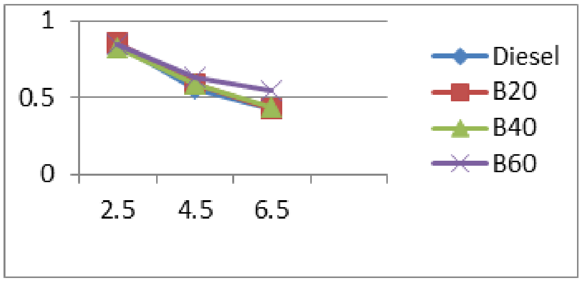


Fig.7 at C.R 15

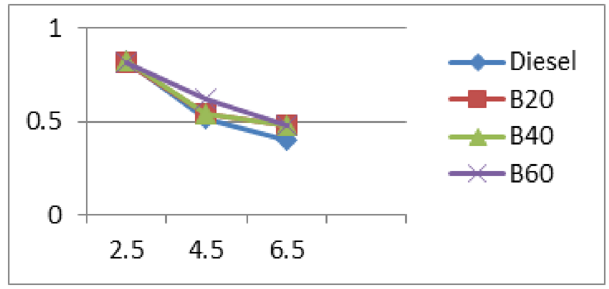


Fig.8 at C.R 16

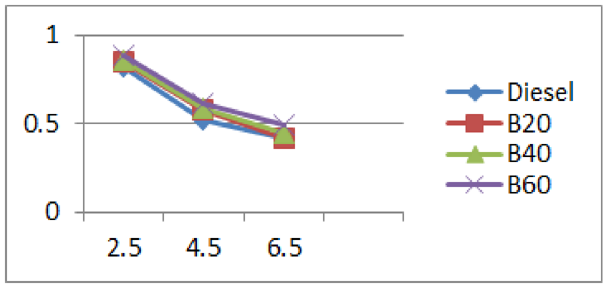


Fig.8 at C.R

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