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Performance and Emission Study of Raw Karanja Oil on a Single Cylinder Diesel Engine

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Abstract:- **The objective of the present work is to evaluate the fuel qualities and check the adaptility of the raw karanja oil on diesel engine. The physico-chemical properties of the karanja oil are characterized and its performance and emission characteristics are studied on diesel engine. The results were analyzed and compared to the reference test fuel diesel. The results showed that the thermal efficiency of raw karanja oil is higher than diesel and the CO emission and exhaust temperature of diesel is found to be lower than karanja oil.**

Keywords**: Diesel; Emission; Engine performance; karanja oil**

I.INTRODUCTION

Energy in one form or another is essential to meet needs like cooking, heating, lighting and similar activities of all sections of society. As in the rest of the world, in India with its predominately rural population, energy is mostly obtained forest and agricultural sources i.e. wood and charcoal, and, where available, coal (non–renewable resources).

The diesel engine is a major contributor to air pollution especially within cities and along urban traffic. Fuel crisis because of dramatic increase in vehicular population and environmental concerns have renewed interest of scientific community to look for alternative fuels of bio-origin such as vegetable oils.

Routes, in addition to air pollution that cause ground level ozone and smog in the atmosphere, diesel exhaust also contain particulate and hydrocarbon toxic air contaminants. Various harmful effect of exhaust emission are already established and known to today's society. Therefore it has become very essential to develop the technology of IC engines, which will reduce the consumption of petroleum fuels and exhaust gas emissions.

The various biomass based resources which can be used as an extender or a complete substitute of diesel fuel may have very significant role in the development of agriculture, industrial and transport sectors in the energy crisis situation. The role of diesel fuel in these sectors cannot be denied because of its ever increasing use. Research in this direction with edible oils yielded encouraging results from the viewpoint of these requirements, triglycerides (vegetable oils and animal fats) and their derivatives may be In fact, agricultural and transport sectors are almost diesel dependent. The various alternative fuel options researched for diesel are mainly biogas, producer gas, ethanol, methanol and vegetable oils [1]-[3]. Out of all these, vegetable oils offer an advantage because of its comparable fuel properties with diesel and can be substituted between 20%-100% depending upon its processing. The various edible vegetable oils like sunflower, soybean, peanut, cotton seed etc have been tested successfully in the diesel engine Vegetable oils can be produced from forests, vegetable oil crops, and oil bearing biomass materials.

Non-edible vegetable oils such as Jatropha oil, Mahua oil, Neem, Kusum oil, rubber seed oil karanj oil, contain 30% or more oil in their seeds, fruit or nut [4]. India has more than 300 species of trees, which produce oil bearing seeds are potentially effective diesel substitute.

Vegetable oils have reasonable energy content; bio diesel has become more attractive because of its environmental benefits and fact that it is made up of renewable resources. In India, non-edible type oil yielding trees such as Mahua, karanj, Jatropha, Kusum, Neem are available in large number. The production and utilization of these oils are low at present, because of their limited end usage. The alternative diesel fuels must be technically and environmentally acceptable, and economically competitive [5]-[6]. Utilization of these oils and biodiesel as fuels in internal combustion engines is

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not only reducing the petroleum usage, but also improves the rural economy. Biodiesel improves lubricity and reduces premature wearing of fuel pump. To find out the best solution the use of karanj oil non–edible oil derived from leguminous tree has been tried [7].

II.MATERIAL AND METHODS

To investigate the fuel qualities results and its performance and emission study on an engine karanja oil and diesel were purchased locally from Ranchi and two fuel samples each of 3.5 liters were used for the study.

Experimental

Determination of Physico-Chemical Properties

Specific gravity of the oil was measured by the standard method IP 59/82. The apparatus used is Westphal balance. The viscosity of the oil was measured by the redwood viscometer as Standard ASTM D2270 method. The flash point and fire point of the oil was determined by the Pensky Martenes apparatus as standard ASTM D93-80 method. Carbon residue was determined by the Conradson carbon residue ASTM 189-81 method. Ash content was determined by standard ASTM-D2270 method. The calorific value of the oil was determined by Bomb calorimeter

Table 1: Comparisons of physico-chemical properties of karanja oil and diesel fuel

Properties	Karai oil	Diesel	ASTM(Diese
Density(Kg/m^3)at 35°C	912	850	860-900
Viscosity(Poise) at 40° C	0.253	0.021	0.013-0.051
Flash point (^{0}C)	205	62	56
Fire point(^{0}C)	209	68	64
Ash content (%)	0.015	0.02	< 0.02
Carbon residue (%)	1.55	0.17	0.15 or less
Calorific value(MJ/kg)	34	45.18	45-47

Experimental Set-up of an Engine

The engine was coupled to an electrical dynamometer to provide the engine load. An air box with U-tube manometer connected to the intake of the engine. The air consumption of the engine was measured with the help of U-tube manometer. Fuel consumption was measured with the help of a burette fitted along the side of especially designed cylindrical tank fixed on a wooden stand of suitable height. When it was required to measure the fuel consumption, the valve was closed

so that the fuel could flow into the engine through filter from the graduated burette. Engine speed was measured using Tachometer and the time for a known volume of fuel (10cc.) consumption was measured using stop watch. The fuel flow rate was measured on volumetric basis using a stopwatch. Automotive emission analyzer (HG-540 mode) was used to measure the exhaust emissions. A probe was used to receive sample of exhaust gas from the engine. All the experiments were conducted at the rated engine speed of 1500 rpm.

Table 2: Specification of CI engine

Engine Parameter	Specification
Make of Model	Kirloskar Diesel Engine AV1
Engine type	Four stroke, CI, single cylinder
Bore(mm)	80
Stroke(mm)	110
Rated power(HP)	5
Speed (rpm)	1500
Cooling	Water
Loading Device	Swinging field type dynamometer

III. RESULTS AND DISCUSSION

3. 1Performance parameter of test engine

Engine performance and exhaust emission tests are very important to observe effects of a fuel on the performance and emission of the engine. Since, these test results indicate an idea whether the fuel is used in an engine efficiently and without any problem or not. For that reason, it is necessary to determine performance parameters of an engine. There are several performance parameters, such as; brake torque (T), brake power (Pb), brake specific fuel consumption (Bsfc) and brake thermal efficiency. It is necessary to find these parameters which can be obtained using measurement values of fuel

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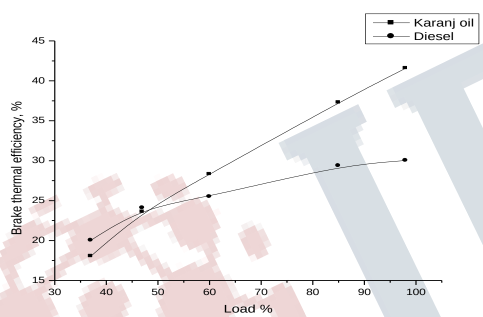
consumptions, heating capacity of the fuel, torque and speed.

3.2 ***Engine performance test***

A four stroke, direct injection, water cooled single cylinder diesel engine was employed for the present experimental study in order to investigate the performance of karanja oil.. The diesel fuel was used in the experimental study as reference fuel.. The tests for both fuels were performed under the same conditions for analyzing the performance and emissions of the fuels in four different levels of engine loads.

The experiment was conducted using two fuel samples of the karanja oil and commercial diesel fuel for evaluating several performance parameters such as torque(T), brake specific fuel consumption (bsfc)



and thermal efficiency((ηbt).

Figure1. Variation of Brake thermal efficiency with load for Karanja oil and diesel

From the fig it is observed that the thermal efficiency of karanja oil is more than diesel for most of the load %.The maximum thermal efficiency found to be 41.57 % and 29.60 % for karanja oil and diesel at maximum load %.

The variation of brake specific fuel consumption (BSFC) with respect to load for different test fuels is shown in Figure 2. The variation of brake thermal efficiency with respect to Brake Power for different test fuels is shown in Figure 3. The bsfc is a comparative parameter that shows how efficiently an engine is converting fuel into work. The BSFC of all the test fuels decrease with increasing engine loads.

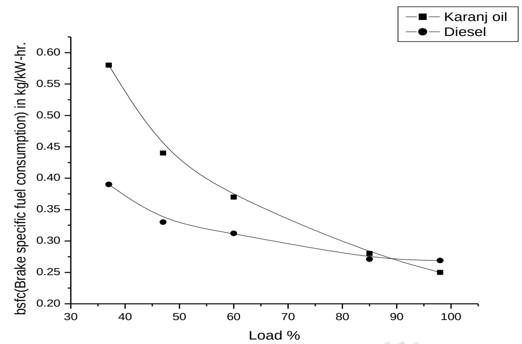


Figure 2. Variation of Brake specific fuel consumption with Load for Karanja oil and diesel

From the fig. 2 it is observed that the bsfc of karanja oil is more for most of the load %, the maximum bsfc for karanja oil is 0.58, and maximum bsfc for diesel is 0.39, at lowest load %. The minimum bsfc for pure karanja oil is 0.25, and minimum bsfc for diesel is 0.26 at highest load %.

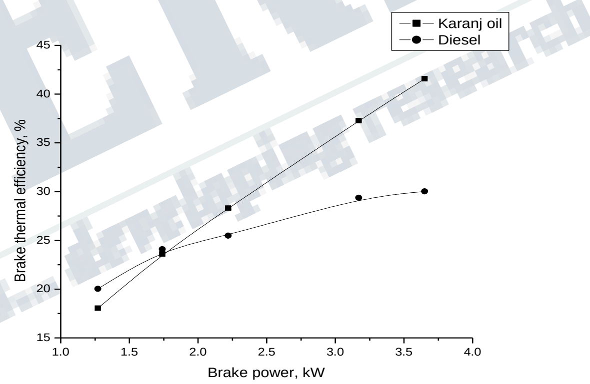


Figure 3. Variation of Brake thermal η with Brake Power for Karanja oil and diesel

3.3 Exhaust test

The emission caused by a fuel is very significant factor for choosing a fuel for the engine. Pollution has reached dangerous levels and curbing it is of utmost importance. The CO_2, CO, O_2 and Exhaust Temperature have been compared for Karanja oil and diesel. The exhaust emission is measured by a flue gas analyzer, for the oils used for testing purpose. The %CO_2, %CO and %O_2 from exhaust emission is compared for both the oils used for testing purpose, and shown in figure 5-7. The %CO_2 is compared in figure 5 with the help of bar chart.

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From the figure it is clear that, as the load was increased on the dynamometer, the value of CO2 % increases. Carbon dioxide or CO_2 is a desirable byproduct that is produced, when the carbon from the fuel is fully oxidized during the combustion process. The increase of % CO_2 with load indicates good combustion. The emission of % CO is compared in figure 6. CO is colorless and odorless but a poisonous gas. Not only the CO considered an undesirable emission, but it also represents lost chemical energy. CO is a fuel that can be combusted to supply additional thermal energy. Emission of CO from diesel engine mainly depends on physical and chemical properties of fuel, A/F ratio and engine temperature. From the figure it is demonstrated that under low load condition, % CO is higher for plastic fuels. But at higher loads due to proper combustion % CO reduced and it is almost equivalent to the diesel fuel. The figure 7 shows the variation of O_2% with load for all the oils used for testing purpose. The low value of O_2 for plastic fuels in the exhaust compared to diesel can be explained with the fact that A/F ratio for the rest is low [8]. Figure 8 shows the variation of exhaust temperature with load for all the oils used for testing purpose. From the fig it is clear that the exhaust temperature increases with the increase in load. This is because more fuel is burnt to meet the power requirements. High temperature in the exhaust is not desirable, for they cause higher energy transfer from the combustion chamber to the surroundings. High heat transfer decreases the thermal efficiency of the engine at finite value [8]. Exhaust gas temperature, shown increased for plastic fuels than diesel, because the carbon content in the exhaust gas is high [9].

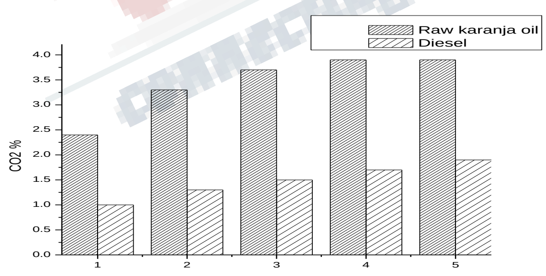

Figure 4 Variation of CO_2 % with load for karanja oil and diesel for load % of 37,47,60,85 and 98 %

The %CO_2 is compared in figure 4 with the help of bar chart. From the figure it is clear that, as the load was increased on the dynamometer, the value of CO_2 % increases. Carbon dioxide or CO_2 is a desirable byproduct that is produced, when the carbon from the fuel is fully oxidized during the combustion process. The increase of % CO_2 with load indicates good combustion.

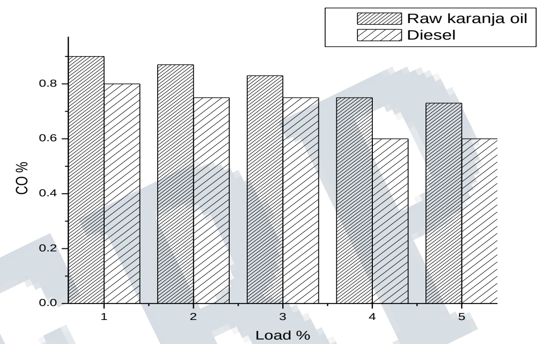

Figure 5 Variation of CO % with load for karanja oil and diesel for load % of 37,47,60,85 and 98 %

The emission of % CO is compared in figure 5. CO is colorless and odorless but a poisonous gas. Not only the CO considered an undesirable emission, but it also represents lost chemical energy. CO is a fuel that can be combusted to supply additional thermal energy. Emission of CO from diesel engine mainly depends on physical and chemical properties of fuel, A/F ratio and engine temperature. From the figure it is demonstrated that CO emission of karanja oil high as compare to diesel.This may be attributed to the high viscosity of karanja oil as compare to diesel.

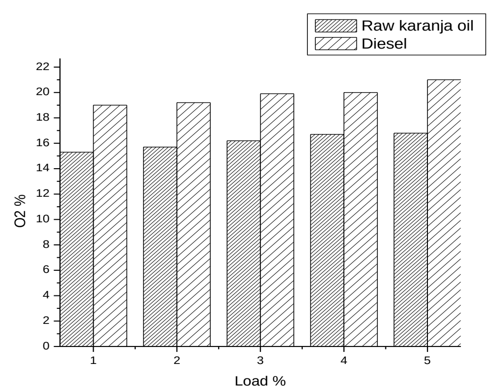

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Figure 6. Variation of O2 % with load for karanja oil and diesel for load % of 37,47,60,85 and 98 %

The figure 6 shows the variation of O_2% with load for all the oils used for testing purpose. The low value of O_2 for karanja oil in the exhaust compared to diesel can be explained with the fact that A/F ratio for the rest is low.

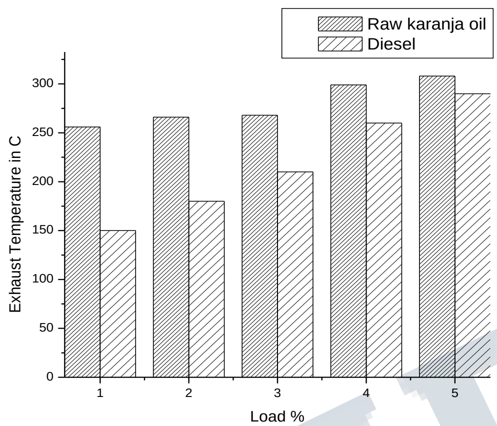

Figure 7. Variation of exhaust temperature with load for karanja oil and diesel

Figure 7 shows the variation of exhaust temperature with load for all the oils used for testing purpose. From the figure it is clear that the exhaust temperature increases with the increase in load. This is because more fuel is burnt to meet the power requirements. High temperature in the exhaust is not desirable, for they cause higher energy transfer from the combustion chamber to the surroundings. High heat transfer decreases the thermal efficiency of the engine at finite value. Exhaust gas temperature, shown increased for karanja oil than diesel, because the carbon content in the exhaust gas is high.

IV.SUMMARY AND CONCLUSION

The following conclusions can be drawn from this study.

The density of pure karanja oil is found to be 912 kg/m^3 ,whereas the density of diesel was found 850 kg/m^3 lower than that of diesel. The viscosity of karanja oil is quite higher than that of diesel. No engine seizing, injector blocking was found during the entire operation of the engine running with different fuels and blends.

The brake thermal efficiency increases with the increase in load. The brake thermal efficiency of karanja oil is found to be higher than diesel. The bsfc for karanja oil is found to be higher than diesel,and it reduces with the increase in load,at higher load it becomes almost equivalent to diesel.

For all the fuels tested, the CO_2 emission was found to be increased with load, which indicates good combustion. The higher CO_2 emissions in the exhaust indicate good combustion for the karanja oil.

The CO emission for karanja oil is found higher than diesel. The exhaust temperature for the karanja oil is found to be higher than that of the diesel. It was also visually observed large amount of smoke from the engine, when it was tested with karanj oil. Vibrations were also observed especially during the change of load, when the karanj oil was used.

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