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Production Of Biodiesel From Oils Of Jatropha, Karanja And Performance Analysis On CI Engine

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Abstract:

The production of biodiesel from two non-edible oils of karanja (Pongamiaglabra) and jatropha (Jatrophacarcus) by base catalyst method and their use in compression diesel engine has been compared to evaluate better one for future purpose. The comparison of performance and emission characteristics of two biodiesels has been carried out in Compression Engine and evaluated for the best one for diesel engine application. Biodiesel of karanja (100% fatty acid methyl ester) gives best efficiency than jatropha but in case of blends of jatropha gives best efficiency than other. Jatropha oil shows maximum reduction in emission and fuel economy than others. Exhaust gas temperature of biodiesel of jatropha is higher than karanja. Considering the results of performance and emissions, jatropha appears to be best as alternative fuel than karanja.

Key words:*Comparison, Jatropha, Karanja, Performance & Emission*

1. Introduction

Increasing the consumption and price hike of petroleum fuel day to day is really problems for developing countries those are dependent on foreign suppliers and pay huge amount of import bill. During the last decade, the use of alternative fuel in diesel engines has received renewed attention. The uncertainty of petroleum-based fuel availability has created a need for alternative fuels [1]. Hence research on biodiesel as an alternative of diesel is in progress. Biodiesel is renewable fuel, it has simple technology of production, low handling hazards, emits low pollutants, and can be used in engine without substantial modifications [2]. The main source of biodiesel i.e. oil producing plant, can grow easily in wide range of geographic locations and flexible climatic conditions. Among the edible and nonedible vegetable oils, the nonedible oils such as jatropha, karanjaetc are economical as biodiesel for its less consumption in domestic purposes. It is widely agreed that biodiesel decreases the emissions of hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM) and sulphur dioxide (SO_2). It is also said to be carbon neutral as it contributes no net carbon dioxide to the atmosphere [3]. Other countries have seriously considered the massive use of bioenergy in the future. China [4], Germany [5], Austria [6] and Sweden [7] have set goals of utilizing 10–15% of their internal primary energy supply through bioenergy up to the year 2020, where Vietnam has set a target of using bioenergy i.e. 37.8% of the total energy consumption [8].

Different researchers have tried to produce biodiesel from vegetable oils either by enzyme, acid or alkali [9]. Knothe et al [10] reported about 97.7% conversion to product in transesterification reaction within 18 minutes by using 1% KOH catalyst at 690^{o}C. Freedman et al [11] studied the transesterification reaction of sunflower and soybean oils at different temperature and different molar ratio. He got the conversion from 90 to 98%. Literature shows already that many researches are done on non-edible vegetable oils such as jatropha, mahua, karanja, neem, etc. and edible vegetable oils separately to study the performance and emission characteristics of these in diesel engine. Jatropha, karanja plants are abundantly available in tropical and subtropical regions such as India, Bangladesh. The seeds from these plants go waste annually which can be utilize for biodiesel production and hence may solve partly fuel crisis problem. The present conventional fuel crisis has inspired the authors to compare the performance and emission characteristics of Ricardo variable compression diesel engine using transesterified oils of karanja and jatropha and select the best one for the use in diesel engine.

2.Material and Methods

2.1.Materials

Oils of karanja and jatropha were obtained by mechanical pressing of seeds that were collected from plantation done at G.B.Pant University of agri. and tech., Pantnagar, Uttarakhand. Methanol and Na_2SO_4 were purchased from Sundar Chemicals (Agra, India). Wood chips were collected from local carpenter shop to prepare charred sawdust for filtration of crude vegetable oils.

2.2.Transesterification Of Two Vegetable Oils

Transesterification of two vegetable oils was done by base catalyst. In transesterification process the oil was taken in a two necked round bottom flask and heated with stirring for 10 minutes continuously by Remi Stirrer at a temperature 100 ^{o}C to remove excess moisture. The weight ratio of oil:methanol was taken as 1:3. Sodium methoxide as base catalyst (1.5% of Oil and Methanol) was mixed well with methanol. The base-methanol mixture was added slowly with oil in the round bottom flask that was fitted with thermometer and condenser. The reaction mixture was stirred vigorously with heating for two hours at 67 ^{o}C. Then the mixture was cooled by ice water. Two layers formed, the upper layer was product layer and the lower layer was glycerol layer. The upper layer was taken in a separating flask and washed three times by distilled water to remove catalyst and methanol. The washed oil was stirred with anhydrous sodium sulphate and kept for three hours at room temperature for dehydration. The dehydrated oil was taken for performance and emission measurement.

2.3.Measurement Of Performance And Emissions

To measure emissions, automotive exhaust monitor of model PEA205 and smoke meter of model OMS103 has been used (Indus Scientific Pvt. Ltd, India). A typical 3.75 KW single cylinder, 4-stroke, constant speed (1500 rpm) diesel engine used for investigation to study the performance and emissions. The engine was coupled to an eddy current dynamometer (Make-BENZ SYSTEMS, PUNE, INDIA).The specifications of the engine are given in Table-1.

Manufacturer	Kirloskar oil Engines Limited, Pune, India
Model	AVL
Engine type	Vertical, single cylinder, water cooled, 4-stroke, constant speed (1500 rpm), Direct injection, compression ignition engine
Power (rated)	67 kW at 1500 rpm
Bore/Stroke	80mm/110mm

Table 1: Specifications of the engine

3. Results And Discussions

3.1. Comparison Of Fuel Properties

The fuel properties of two transesterified vegetable oils and diesel are shown in Table 2.The kinematic viscosities of biodiesel of karanja, jatropha at 40^{o}C are more than diesel fuel. The calorific value and cetane number of the two biodiesel are less than diesel fuel. In comparison of two vegetable oils jatropha shows better results in specific gravity, viscosity, and cetanenumber.The difference in properties for different vegetable oils is due to variation of fatty acid composition and other associated compounds such as colouring matters, odorant compounds, etc.

Properties	**Biodiesel (100%)**		**Diesel**
	Karanja	**Jatropha**	
Viscosity(at 40^{0}C)	5.81	5.42	5.03
Cetane Number	35.6	41.0	46.3
Calorific Value(KJ/Kg)	38119	39065	42707
Specific Gravity at 25^{0}C	0.899	0.878	0.834
Carbon Residue (%)	1.20	0.15	0.10

Table 2: Fuel Properties of two Biodiesel and Diesel

3.2.Comparison Of The Effect Of Loads On The Performance Of Biodiesels

The performances of two transesterified vegetable oils and diesel are shown in Fig. 3(a)-3(b). It is observed that biodiesels of jatropha, karanja show higher in brake specific fuel consumption (BSFC) and lower in brake thermal efficiency than diesel fuel. Transesterifiedkaranja oil (100%) has shown better efficiency than jatrophawhere asjatropha has shown better in BSFC. The differences in performance of different biodiesels are due to variation in combustion characteristics, specific gravity, cetane number and calorific value.

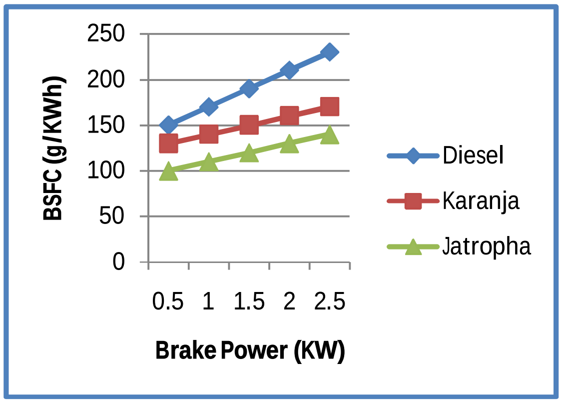

Figure 3(a): Brake specific fuel consumption vs. brake power of diesel fuel, 100% biodiesel of jatropha, karanja.

The blends of biodiesels and diesel show different results. Blend of jatropha biodiesel shows better performance (Table 2) than others. With increasing the percentage of blend the BSFC is increased and efficiency is decreased which is also reported by Raheman et al [12].

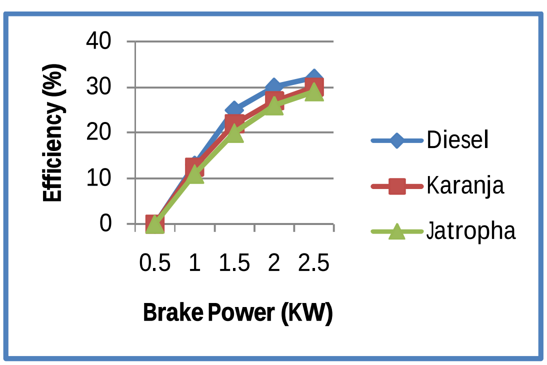

Figure 3(b). Brake thermal efficiency at various brake power of diesel fuel, 100% biodiesel of jatropha, karanja.

3.3.Comparison Of The Effect Of Loads On The Emission Of Biodiesels

It is observed that with increasing loads, NO_x emission is increased as shown in Fig. 3(c). The NO_x of biodiesel increases slightly with load where as diesel fuel shows a steady increase throughout the load. With increasing load, fuel consumption rate increase and hence more heat release during burning. NO_x emission increases with increasing temperature of combustion chamber. Biodiesel has low calorific value than neat diesel and therefore the rate of increase of NOx is low with load than diesel fuel. With increasing the percentage of biodiesel in blends, NO_x emissions decrease that is due to decrease of the calorific value of blends and hence less exhaust gas temperature. Jatropha blends show lowest NO_x emission than others.

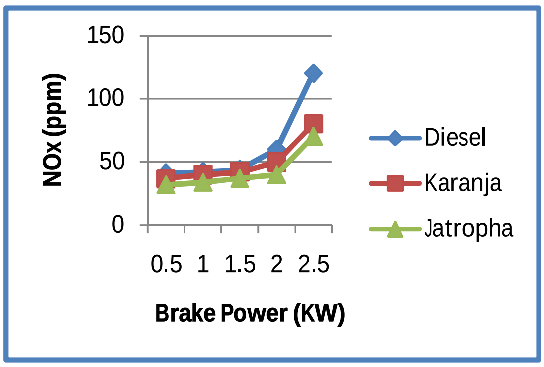

Figure.3(c): Nitrogen oxide vs. brake power of diesel fuel, 100% biodiesel of jatropha, Karanja

Hydrocarbon emission of biodiesel as shown in Fig. 3(d) is lower than diesel that is due to better combustion of biodiesel. Higher percentage of biodiesel in blends gives less hydrocarbon emission. Smoke, CO and particulates shown in Figures 3(e)-3(f) of two biodiesel are lower than diesel fuel that indicates good impact on the environment and living beings. Higher concentration of biodiesel in blends show lower CO emission because of higher ignition temperature of biodiesel than diesel give better combustion of blends and hence less exhaust emissions.

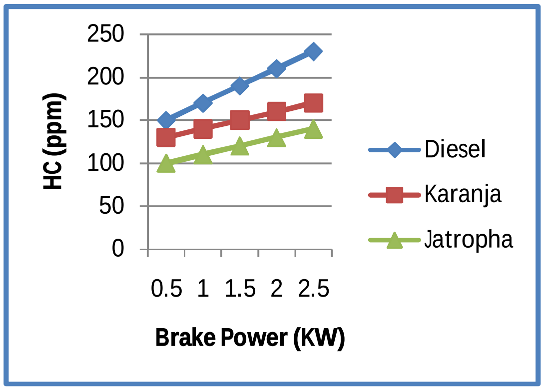

Figure3(d): Unburned hydrocarbon vs. brake power of diesel fuel, 100% biodiesel of jatropha, karanja.

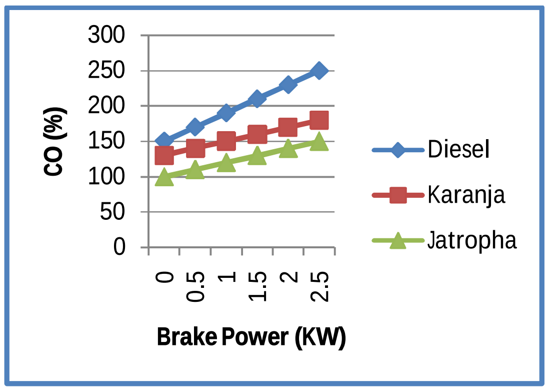

Figure 3(e):Carbon monoxide vs. brake power of diesel fuel, 100% biodiesel of jatropha,Karanja

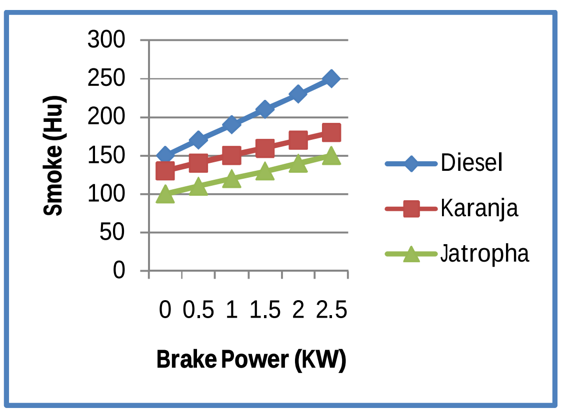

Figure 3(f): Smoke vs. brake power of diesel fuel,100% biodiesel of jatropha, karanja.

3.4.Exhaust Gas Temperature

The exhaust gas temperatures of different biodiesel at various loads are compared with that of diesel fuel in Fig. 3(g). The exhaust gas temperatures of 100 % biodiesel and its blends show always lower than that of diesel fuel. The exhaust gas temperature of blends decreases with increasing amount of biodiesel. This is due to less calorific value of biodiesel than diesel fuel. Blends of karanja show higher exhaust gas temperature than jatropha. This is due to difference in calorific value of oils and variation in combustion of blends.

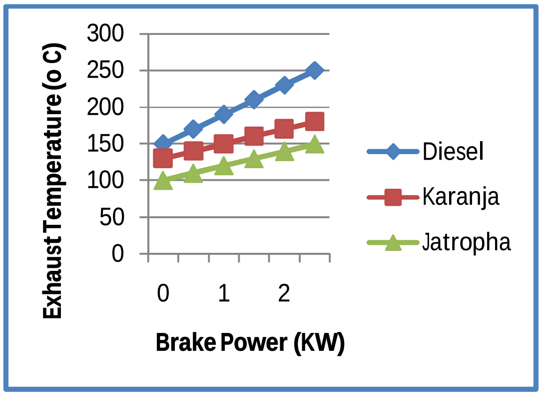

Figure 3(g):Exhaust gas temperature vs. brake power of diesel fuel, 100% biodiesel of jatropha, karanja.

4. Conclusion

Biodiesel from karanja oil, jatropha oil pure or blended with diesel fuel, have shown very satisfactory results as alternative fuel for diesel engines. Out of the two biodiesels, jatropha is promising to yield good performance and low emissions at each load in all respects. Comparing the emission characteristics such as CO, NOx, HC, smoke of two biodiesels, jatropha is very promising. Considering the above-mentioned points, it can be concluded that the diesel engine can run very satisfactorily using 100% of biodiesel at 45^0bTDC timing. Any diesel engine can be operated with 100% biodiesel as a prime mover without any modification of engine.

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