Experimentation on Chemical Feasibility of Karanja Seed Oil to Use as In Diesel Engines Using 4-Stroke Single Cylinder DI Diesel Engine Test Rig

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Abstract

The objective of this work is tomake an experimental investigation onchemical feasibility of karanja seed oilby modified the fuel using karanja methyl ester(biodiesel)blends withmineral diesel. This experimentation evaluatethe performance and emission characteristicsof 4-stroke, single cylinder, DI diesel enginetest rig. The karanja biodiesel blended withdiesel in various proportions like 10%,20%,30%,40%,50%, and 100% by volume studiedunder the various resistance load conditionsin compression ignition (diesel) engine. In theperformance parameters brake thermalefficiency and mechanical efficiency werebetter than diesel and in other very closerto the diesel. In the emission characteristics carbon dioxide, carbon monoxide, nitric oxide and hydrocarbons were resulting very higher than the mineral diesel.

Keywords- Biodiesel, Emission, Karanja oil, Methyl ester, Performance.

I. INTRODUCTION

In the present year the vegetable oils are widely studying because of better performance, renewable in nature and easy availability in India. This work evaluate the performance and emissions parameters like brake thermal efficiency, specific energy consumption, exhaust gas temperature,Mechanical efficiency, nitric oxide emission, carbon monoxide emission, carbon dioxide emission, and unburnt hydrocarbons emission. There are only two methods to use the vegetable oils in compressed ignition engine, one is using by modify the engine and other is to modify the diesel to use in the engine by taking the blending process either by volume proportions or mass proportions. Here researchers use the blending of biodiesel in various proportions as 10%, 20%, 30%, 40%, 50%, and 100% by volume with pure mineral diesel. The biodiesel is the methyl ester formation of vegetable oil which prepared by the process known as the transesterification process. This process is actually used to remove the saturated and unsaturated acids from the vegetable oils in which alcohol is used as a catalyst and known as the alcoholysis chemical reaction process. This methyl ester form of oil is blend with diesel have make a fuel having better properties to use in compressed ignition (diesel) engine. The performance and emission parameters were resulted the variations to various blended proportions fuel with diesel and evaluate their feasibility.

II. PREVIOUS RESEARCH

Many researchers have been experimented on the biodiesel production and performance and emissions parameters at various conditions. Shikha Khandelwal et al. [1] evaluate the energy consumed by karanja and neem trees at the stage during growth cycle and conversion to biodiesel. Yashvir Singh et al. [2] compared the variation of performance and emission characteristics of two biodiesels karanja and jatropha. K.V. Yathish et al. [3] carried out the effect of variables on the reaction and investigate the optimum conditions in the presence of KOH as catalyst. Bobde S.N. et al. [4] detailed the properties of pongamia pinnata (karanja) for the biofuel production. Bobde S.N. et al. [5] they produced methyl ester (biodiesel) by the way of transesterification from karanja (pongamia pinnata) which gives good result. Hossain Mohammad Imran et al. [6] using Karanja (pongamia pinnata) seeds as a raw material for the production of biodiesel and transesterification experimental process involved. Hitesh J. Yadav et al. [7] give an overview to biodiesel prepared from the non-edible oil of Karanja by transesterification of the crude oil with methanol in the presence of NaOH as catalyst. Venkata Ramesh Mamilla et al. [8] they deals with the study of the potential substitution of Karanja methyl ester blends for diesel as fuel for automobiles and other industrial purposes. V.C. Bhattacharyulu et al. [9] overcome the problem of high viscosity of vegetable oil by one possible method oscillatory baffled reactors.Nagarhalli M.V. et al. [10] investigation an attempt has been made to use blends 10% to 90% of two biodiesels (karanja and jatropha) oils to run a single cylinder, 4 stroke, constant speed, and D.I. diesel engine. V.V. Prathibha Bharathi et al. [11] studied about influence of exhaust gas recirculation (EGR) in the cylinder upon the performance and emission of a single cylinder diesel direct injection engine is presented. N. Panigrahi et al. [12] studied the production process, fuel properties, oil content, engines testing and performance analysis of biodiesel from karanja oil which is known as Karanja oil methyl ester (KOME). Lohith N. et al. [13] investigated the Karanja methyl ester (KOME) as alternative fuel for compressed ignition engine. H.K. Amarnath et al. [14] compared the performance and emissions of Karanja, Jatropha and Palm oil in a four stroke diesel engine. K. Sivaramakrishnan et al. [15] optimized the direct injection (DI) single cylinder diesel engine with respect to brake power, fuel economy and emissions through experimental investigations and DOE methods. Nagarhalli M.V. et al. [16] analyzed the emission and performance characteristics of a single cylinder 3.67 kW, compression ignition engine fuelled with mineral diesel and diesel Karanja biodiesel blends at fuel injection pressures of 190 bars, 200 bars and 210 bars. Siddalingappa R. Hotti et al. [17] investigates the performance and combustion characteristic of single cylinder, naturally aspirated, water cooled, DI diesel engine running on karanja oil (K100) and blends with diesel K10, K15, and K20 and the experimental results were compared with that of diesel. P.V. Rao [18] studied the effect of properties of Karanja (Pongamia pinnata) methyl ester on combustion, and NOx (oxides of nitrogen) emissions of a diesel engine. Ramchandra S. Jahagidar et al. [19] conducted an experiment on single cylinder diesel engine fuelled with the blends of Karanja and Diesel. Engine performance is also evaluated using pure Karanja fuel without any modification in a present engine. Anand Kumar Pandey et al. [20] investigate the effects of esterified karanja oil biodiesel on turbocharged CIDI engine of military on the basis of performance, emissions and wear.[21] Prepared biodiesel from the non-edible oil of Karanja by transesterification of the crude oil with methanol in the presence of NaOH as catalyst. A maximum conversion of 92% (oil to ester) was achieved at 60°c.Sharanappa K. Godiganur et al. [22] investigated as potential substitutes for current high pollutant fuels obtained from the conventional sources. The process of transesterification of vegetable oil with methyl alcohol provides a significant reduction in viscosity, thereby enhancing the physical properties of vegetable oil.Nagarhalli M.V. et al. [23] carried out the emission and performance characteristics of a single cylinder 3.67 kW, compression ignition engine fuelled with mineral diesel and diesel-biodiesel blends at an injection pressure of 200 bars.Dilip Kumar Bora et al. [24] presented the effects of biodiesel blends namely B20K fuel (80% diesel+20% karanja biodiesel) on single cylinder diesel engine performance and lubricating oil under two long duration endurance test of 512h SAE grade 15 w 40 engine oil was used for both the tests. Vigya Kesari et al. [25] assessed genetic diversity among 10 systematically characterized candidate plus trees (CPTs) of P. Pinnata from north Guwahati. Sagar Pramodrao Kadu et al.[26] study deals the performance of a four stroke, single cylinder C.I. engine by preheated neat Karanja oil is done from 30°C to 100°C. The performance of the engine was studied for a speed range between 1500 to 4000 rpm, with the engine operated under full load conditions. M.K. Ghosal et al. [27] studied out the performance of a compression ignition engine (direct injected, 4-stroke 2-cylinder engine) by using karanja methyl ester from non-edible vegetable oil (Pongamia glabra) and its blends with diesel fuel. Dipak Patil et al. [28] presented the work on performance analysis as Karanja (Pongamia pinnata) Biodiesel purchased from authorized agencies, and their important physical & chemical properties were tested & compared. It is found that these properties are approximately similar to diesel fuel and suitable to use in diesel engine. S. Sreenatha Reddy et al. [29] discussed the transformation process of jatropha and karanja oil in order to obtain biodiesel by means of transesterification, as prepared in the laboratory. S. S. Karhale et al. [30] carried out the performance test to evaluate and compute power output of karanja methyl ester and its blends with diesel from 20%, 40%, and 60% by volume for running a diesel engine at two injection pressures 180kg/cm² and 145kg/cm² and temperatures 30, 50, and 70°c. Venkata Ramesh Mamilla et al. Surendra R. Kalbande et al. [31] produced the biodiesel from non-edible oils by using bio-diesel processor and the diesel engine performance for water lifting was tested on bio-diesel and bio diesel blended with diesel. The developed bio-diesel processor was capable of preparing the oil esters sufficient in quantity for running the commonly used farm engines. N. Stalin et al. [32] evaluate the performance of IC engine using karanja biodiesel blending with diesel and with various blending ratios have been evaluated. The engine performance studies were conducted with a prony brake-diesel engine set up.The tests indicate that the dual fuel combination of B40 can be used in the diesel engines without making any engine modifications. N. Prakash et al. [33] produced the biodiesel through transesterification of karanja oil in the presence of a base catalyst (KOH) to yield methyl ester of fatty acids (biodiesel) and glycerin. David K. Daniel et al. [34] derived biodiesel from karanja oil, using the chemical and enzymatic route. The enzymatic processing route was found to overcome the drawbacks of the chemical conversion process. L.C. Meher et al. [35] deal with the transesterification of pongamia pinnata (karanja) oil by means of methanol to study the feasibility of Methanolysis process by using the potassium hydroxide catalysts. Vivek et al. [36] initiated to investigate the potential of karanja oil as a source of biodiesel. The main objective was to study out the feasibility of karanja oil for the production of biodiesel and optimization of different parameters for high yield/conversion of karanja oil to biodiesel.

III. DATA COLLECTION & EXPERIMENTATION

For this experiment, all the oil samples have been purchased from the market. The oil sample details with their properties,

TABLE 1. Oil sample details with properties

Property	Karanja oil	Karanja biodiesel	Diesel
Specific gravity	0.934	0.937	0.85
Viscosity(cst)/40°C	41.9	20.4	2.86
Flash Point (°C)	232	204	76
Calorific Value(MJ/Kg)	40.75	35.94	44.01
Cloud Point (°C)	8.3	10	6.5
Pour Point (°C)	6	6	3.2

A. SAMPLE PROCESSING

The testing sample of karanja oil biodiesel which was blended with mineral diesel by volume has made using glass. For making the 100ml fuel of 10% blending then take 10ml of karanja biodiesel and mix it with 90ml of mineral diesel. In this way 10%, 20%, 30%, 40%, and 50% of karanja biodiesel blended fuel was prepared.

B. EXPERIMENTAL SETUP

The figure below is showing the setup of 4-stroke, single cylinder, DI diesel engine test rig.

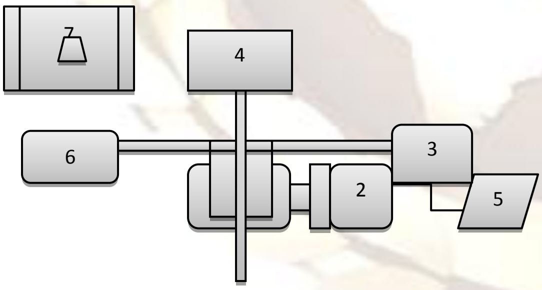

Fig.1 Experimental set up of DI diesel engine.

1. Engine, 2. Dynamometer, 3. Air drum, 4. Fuel tank, 5. Resistance load, 6. Gas Analyzer, 7.Computer control system, 8.Measuring tube.

TABLE 2. Engine specification

Make	Anil
Type of Engine	4-stroke, single cylinder, DI diesel engine
Speed	1500
Bore	89
Stroke	105
Compression ratio	18.5
Method of cooling	Air cooled

The experiments were carried out by using various blends of karanja biodiesel (10, 20, 30, 40, 50, 100) with diesel at different load conditions on the engine keeping all the independent variables same. The engine performance test was done twice for all blends except the KME100 and average was taken and emission readings were taken thrice and average was taken.

IV. RESULTS AND DISCUSSIONS

The outcomes of performance and emissions parameters by the given instrumentation are shown in graph below. In the graphs, horizontal axis shows the resistance and the vertical axis shows the respected determined terms.

1. BRAKE THERMAL EFFICIENCY

Figure 2 shows that all the blends are better than mineral diesel. But 100% of karanja biodiesel is good as the resistance load is increased.

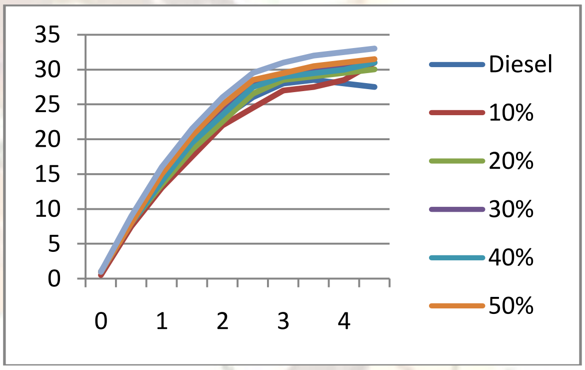

Fig.2 Brake thermal efficiency with load.

2. BRAKE SPECIFIC ENERGY CONSUMPTION

The figure 3 showing brake specific energy consumption with load in MJ/KW hr. All the resistance loading conditions have karanja biodiesel and their blends with mineral diesel lower than diesel.

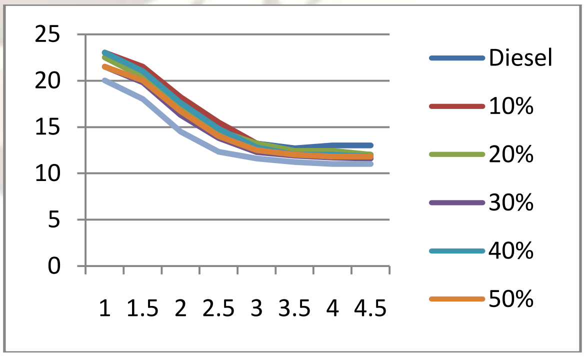

Fig.3 Brake specific energy consumption with load.

3. EXHAUST GAS TEMPERATURE

The exhaust temperature is increase with the concentration of karanja biodiesel in blended fuel is increases. The figure 4 shows the exhaust gas temperature variation with resistance load in temperature.

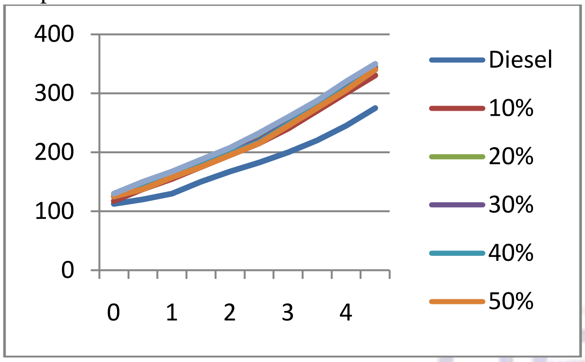

Fig.4 Exhaust gas temperature with load.

4. MECHANICAL EFFICIENCY

The mechanical efficiency is good with 30% blend of karanja biodiesel at lower loading but other blends are almost equal. The figure 5 is showing the mechanical efficiency percentage.

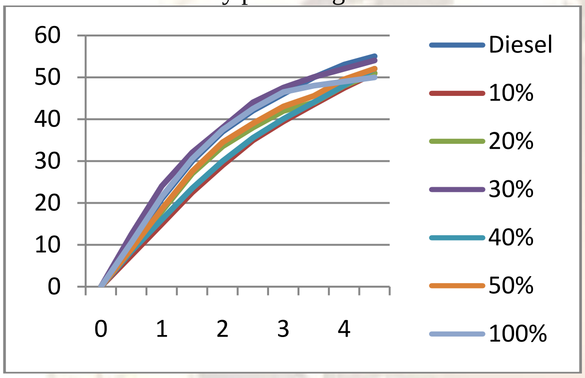

Fig.5 Mechanical efficiency with load

5. NITRIC OXIDE EMISSION

As the concentration of blending is increased the nitric oxide emission increases but, 30% karanja biodiesel blending concentration have better than other. Figure 6 shows the nitric oxide emission with resistance loading is measured in ppm percentage presents in the fuel.

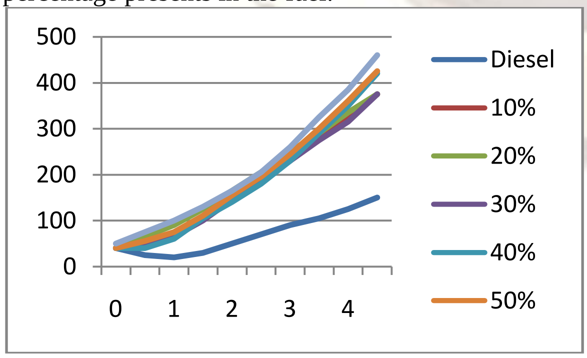

Fig.6 Nitric oxide emission with load

6. CARBON MONOXIDE EMISSION

Figure 7 is showing the carbon monoxide emission with the resistance load in percentage in which 50% and 100% of karanja biodiesel blending concentration are lower in CO emission at all loading conditions.

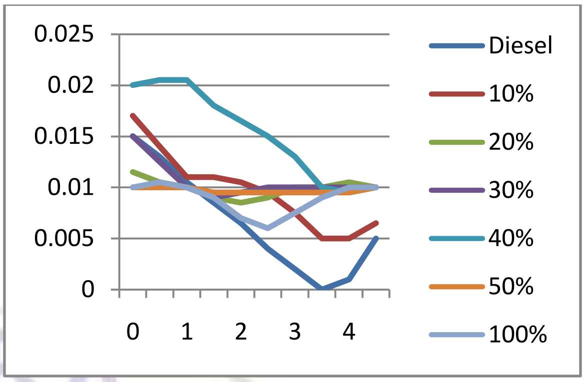

Fig.7 Carbon monoxide emission with load

7. CARBON DIOXIDE EMISSION WITH LOAD

As the figure 8 is showing the carbon dioxide emission percentage with resistance load. The 20% and blending concentration of karanja biodiesel have lower carbon dioxide emission in higher loading but 30% concentration is better in overall loading conditions. The 50% blending property is showing same results to 30% in lower loading conditions.

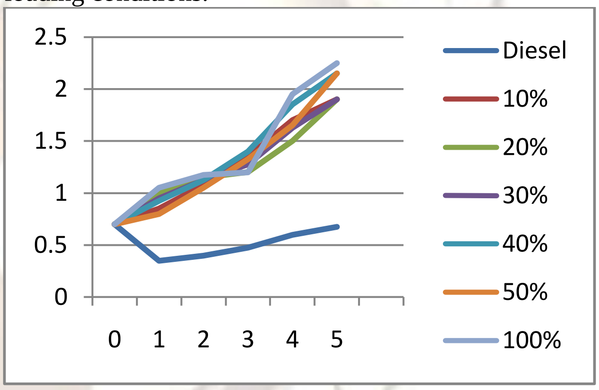

Fig.8 Carbon dioxide emission with load

8. UNBURNT HYDROCARBON EMISSION WITH LOAD

Figure 9 below is showing the unburnt hydrocarbon emission with resistance loading in ppm percentage. The 20% of blending concentration of karanja biodiesel is better than other concentrated blends in hydrocarbon emissions.

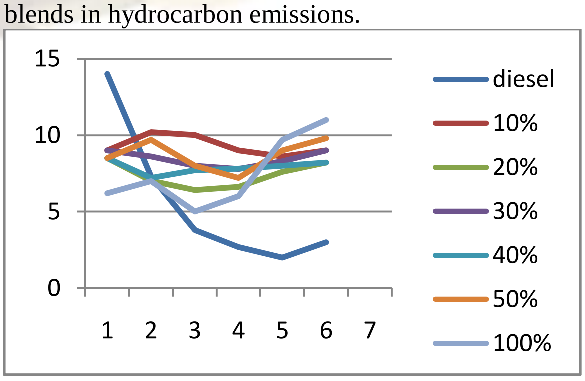

Fig.9 Unburnt hydrocarbon emission with load.

V. CONCLUSION

From the results it can be concluded that,

1. All the blends are better in performance parameters.
2. Brake thermal efficiency and brake specific energy consumption graphs are showing all the blends good as load increases.
3. 30% blending concentration showing better mechanical efficiency than other at all loading conditions.
4. In exhaust gas temperature all blends are higher than diesel.
5. Blends in emission characteristics are higher than diesel but 30% biodiesel blend has relatively better with respect to other.

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