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EXPERIMENTAL INVESTIGATION OF COMPARATIVE PERFORMANCE OF 4-STROKE 4-CYLINDER C.I. ENGINE OPERATING ON METHANOL , PETROL

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ABSTRACT

Extensive research is under execution for attention diesel fuel through out the world as well as in india. The major research for this need are of two type , first is related to environment i.e. global warming due to conventional hydro carbon diesel fuel and second is economical i.e. increase the demand ,which causes increases in per barrel rate of this non- renewable source. The main objective of this work is to obtain a feasible solution to reduce fuel consumption .As we know in any country the main energy source for vehicle are petroleum product (i.e. petrol and diesel). The work is carried out on vegetable oil (non-edible). Karanja oil use for blending with petrol and mthanol in diesel. The purpose of using petrol and mthanol is to reduce viscosity of karanja oil. The testing of this blend fuel is carried out on a four stroke, four cylinder diesel engine. This work presents the experimental investigation performance characteristics of a diesel engine fueled with karanja oil (KO) and its 3.0 vol%, 5 vol%, 7.0 vol% and 10vol% blends with methanol (MKO), petrol (PKO) and both improving agents applied in equal proportions as 50:50 vol% (MPKO). The purpose of this work is to examine the effects of KO inclusion in Diesel fuel on the brake specific fuel consumption (bsfc) of a Diesel engine, its brake thermal efficiency, brake mean effective pressure, mechanical efficiency and volumetric efficiency, the tests were performed in a 4-strokes, 4-cylinder, and naturally aspirated, air-cooled and direct injection stationary diesel engine, diameter of cylinder is 78mm and stroke length is 92mm at the different engine speed under full-load conditions. The results obtained with karanja oil blends were compared with the diesel fuel as reference fuel. The engine torque and power obtained with Karanja oil blends were less, and the specific fuel consumption was found to be higher, which could be attributed to lower calorific value of blends, this work says that the performance of the engine for the blends of BPMKD10 is nearly pure diesel but fuel consumption increases in little amount. But we reduce about 20% consumption of petroleum product, which is using only 70% diesel and 30% mixture of one liter fuel, We also save non- renewable source i.e. diesel . The production of biodiesel from these oil provides numerous local, regional and national economic benefits. To develop biodiesel into an economically important option in India biotechnological innovations to increase the seed yield are essential.

KEYWORDS: Diesel Engine 4-stroke 4-cylinder, Diesel, Karanja oil, Methanol, Petrol, Performance.

INTRODUCTION

An energy crisis is the great bottleneck in the supply of energy resources to an economy. In popular literature though, it often refers to one of the energy sources used at a certain time and place, particularly those that serve as fuel for vehicles. There has been an enormous increase in the global demand for energy in recent years as a result of industrial development and population growth. Supply of energy is, therefore, far less than the actual demand. If oil production remains constant until it's gone. There is enough to last 42 years. Oil wells produce less as they become depleted which will make it impossible to keep production constant. Nearly everyone realizes oil will become scarce and expensive within the life times of living humans. Inevitably, there will be a transition to sustainable energy sources. The transition may be willy-nilly or planned-the choice is ours.World energy consumption has increased 17-fold in the last century and emissions of CO2, CO, SO2 and NOx from fossil-fuel combustion are the main causes of atmospheric pollution. Worldwide petroleum reserves are expected to be depleted in less than 40 years at the present rate of consumption. In this scenario, bio-fuels and pure non eating vegetable oils have emerged as alternative sources of energy and offering many other benefits including sustainability, reduction of greenhouse gas emissions, rural development and security of supply. Bio-fuels will mitigate the vulnerability or the adverse effects of use of fossil fuels. Several developed countries have introduced policies encouraging the use of bio-fuels made from grains, vegetable oil or biomass to replace part of their fossil fuel use in transport in order to achieve the following goals; to prevent environmental degradation by using cleaner fuel, to reduce dependence on imported, finite fossil supplies by partially replacing hem with renewable, domestic sources and to provide new demand for crops to support producer income and rural economics. Compression ignition (CI) engines are used to move major portion of the world's goods, power much of the world's equipment, and generate electricity more economically than any other device in their size range. Increasing industrialization of developing countries is resulting in increased demand for diesel worldwide. Substitution of this demand with straight vegetable oils (SVOs) is comparatively environmentally benign compared to mineral diesel and biodiesel [1]. The continuous increasing demand for energy and the decreasing petroleum resources has led to the search for alternative fuel which is renewable and sustainable. Vegetables oils are simplest route of bio fuel utilization in direct injection compression ignition (DICI) engines however several operational and durability problems are encountered while using straight vegetable oils in CI engines due to their high viscosity and low volatility. Reduction of viscosity by blending or exhaust gas heating leads to savings in chemical processing cost incurred on trans-esterification. This article presents the comparative bench testing results of a four stroke, four cylinder, direct injection, unmodified, naturally aspirated diesel engine operating on karanja oil (KO) and its 2.5 vol%, 5 vol%, 7.5 vol% and 10 vol% blends with ethanol (EKO), petrol (PKO) and both improving agents applied in equal proportions as 50:50 vol% (EPKO).The purpose of this research is to examine the effects of KO inclusion in Diesel fuel on the brake specific fuel consumption(bsfc) of a Diesel engine, its brake thermal efficiency, brakemean effective pressure, mechanical efficiency and volumetric efficiency. The brake specific fuel consumption at maximum torque (517 g/kW h) for EPKOis higher by 13.8% relative to Diesel fuel. It is difficult to determine the KO concentration in Diesel fuel that could be recognized as equally good for all loads and speeds. The maximum brake thermal efficiency varies from 0.157to 0.181 for EPKO and from 0.182 to 0.198 for Diesel fuel. Addition into KO of ethanol and petrol its viscosity at ambient temperature of diminishes to a great extent and for blend EPKO10 is almost equal to diesel [27].Utilization of locally produced and processed fuel strengthens economy and energy security. Newer options of alternative fuels should be technically feasible, economically competitive, environment friendly and provide energy security without compromising the engine performance and emitting lesser quantity of harmful pollutant species [2]. Even Rudolf Diesel, the inventor of CI engine expressed the possibility of using vegetable oil as CI engine fuel during 1900 world exhibition in the Paris and demonstrated using peanut oil as fuel in his newly invented diesel engine [3]. Vegetable oils can be described as fatty acids with carbon chains similar in structure, length and carbon to hydrogen ratio (C:H) as that of conventional diesel [4]. However, they differ from the latter because of having oxygen in their molecular structure.They also have higher kinematic viscosity and density, lower calorific value, cetane number and stoichiometric ratio compared to diesel [5-8]. Density of some oils like orange oil is reported to be lower than diesel [7]. Vegetable oils can be used directly or blended with diesel to fuel compression ignition engines. Blends of vegetable oils with diesel have been used successfully by various researchers in several countries [6-13]. The use of vegetable oil results in increased fuel consumption i.e. increased brake specific fuel consumption (BSFC). Various studies found higher CO and HC emissions with vegetable oils and their blends, and lower NOx and particulate emissions compared to diesel [14-19]. Engine performance and emissions tests conducted by several studies indicated good potential for most of the vegetable oils as potential CI engine fuels [20-24]. Currently, conversion of vegetable oils into fatty acid methyl ester by trans-esterification is the most suitable route of vegetable oil utilization in CI engines. However trans-esterification process requires chemicals and process energy inputs, which may not be easily available in rural areas. Keeping this in mind, utilization of Karanja oil was investigated in a typical diesel engine widely used in India for decentralized electricity generation, agriculture and irrigation. Karanja also known as Honge and PongamiaPinnata grows throughout India and extends further eastwards, mainly in south-eastern Asia, East Fiji and Australia [21, 22, 24]. In this study, blending process was used to lower the viscosity of Karanja oil in order to eliminate various operational difficulties associated with vegetable oils. The present research is aimed at exploring technical feasibility of using Karanja oil blends

MATERIALS AND METHODS

EXPERIMENTAL SETUP

Karanja oil used in the investigation wascharacterized for its viscosity, density, calorific value and flash point. Performance characteristics of mthanol, petrol, & karanja oil and diesel blends were evaluated in a four stroke, four cylinder compression ignition engine. Technical specifications of the test engine are given in

S. No.	Engine Parameters	Specification
1	Name of Manufacturer	Kirlosker Ltd.
2	Rated Speed	2500 rpm
3	Brake Power	25KW
4	Fuel Used	Diesel
5	Stroke Length	92mm
6	Diameter Of Cylinder	78mm
7	Compression Ratio	18
8	Anemometer Diameter in mm	68
9	No. of Cylinder	4
10	No. of Stroke	4
11	Dynamometer	Hydraulic

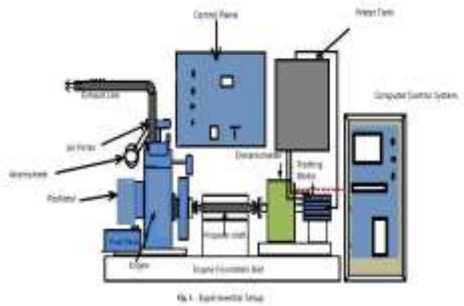

Fig-Experimental setup

RESULTS AND DISCUSSION

For calculation Formula are Used

1. Brake Power (kW) = $\{W*N\}/ 2000$
2. Indicated Power (kW) = $(k*Pm*L*A*N*n)/60$
3. Mechanical Efficiency (%) = B.P./I.P.
4. Volumetric Efficiency (%) = $ma/ (\rho a*Vd)$
5. Indicated Thermal Efficiency (%) = I.P./(mf*C.V.)
6. Brake Thermal Efficiency (%) = B.P./(mf*C.V.)
7. Indicated specific Fuel Consumption (kg/Kwh) = mf/I.P.
8. Brake Specific Fuel Consumption (kg/Kwh) = mf/B.P.
9. Displace Volume (Vd in m3/s) = $k*n*\pi/4*D2*L*N/60$
10. Mass flow rate of Air (ma in kg/s) = Pa*v*a

Where,

W = Load in kg , D = Diameter of Cylinder in m.
N = Revolution per minute (RPM), n = 1/2for four stroke engine.
K = No. of cylinder , n = 1 for two stroke engine.
Pm = mean effective pressure bar , B.P .= Brake power in KW.
L = Length of stroke in m , I.P .= Indicated Power in KW.
A = Area of Cylinder in $m^{2.}$

Performance Characteristics Curves:

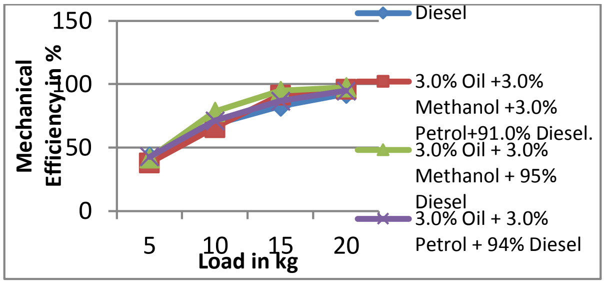

***Fig:4.1:** Comparison of Mechanical Efficiency for BPMKD3.0, BMKD3.0, BPKD3.0 and Diesel*

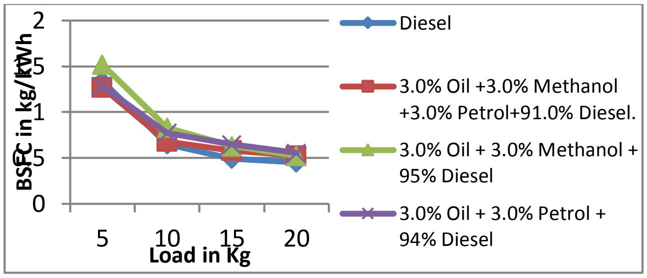

Fig: 4.2: Comparison of Break Specific Fuel Consumption for BPMKD3.0, BMKD3.0, BPKD3.0 and Diesel.

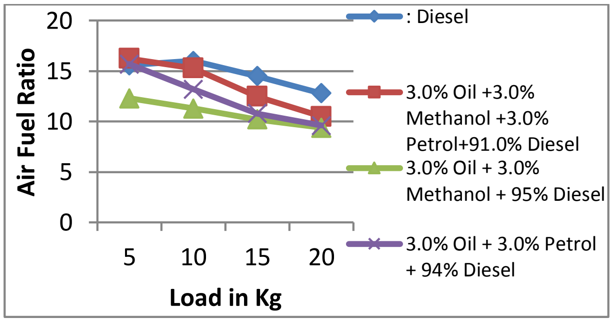

Fig: 4.3: Comparison of air fuel ratio for BPMKD3.0, BMKD3.0, BPKD3.0 And diesel

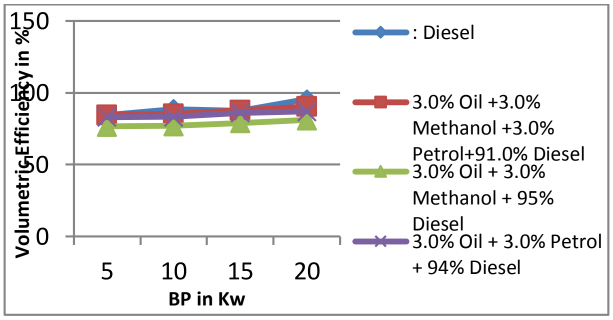

Fig:4.4: Comparison of volumetric efficiency and brake power for BPMKD3.0, BMKD3.0,BPKD3.0 And diesel

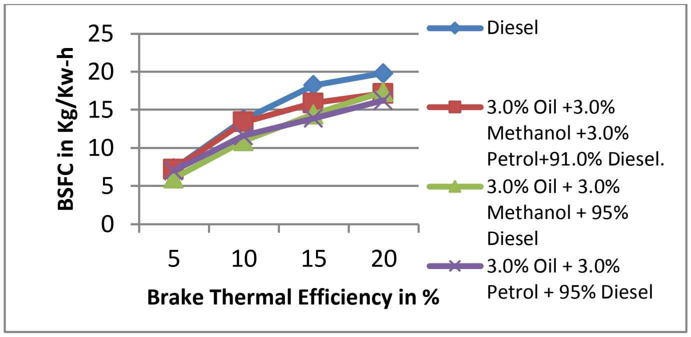

Fig:4.5: Comparison of brake specific fuel consumption and brake thermal efficiency for BPMKD3.0, BMKD3.0, BPKD3.0, And diesel

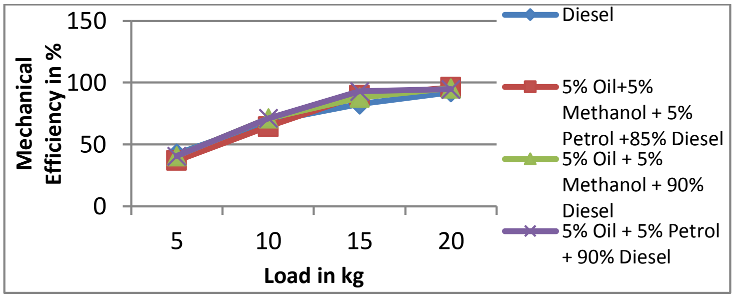

Fig:4.6: Comparison of Mechanical Efficiency for BPMKD5.0, BMKD5.0, BPKD5.0 and Diesel.

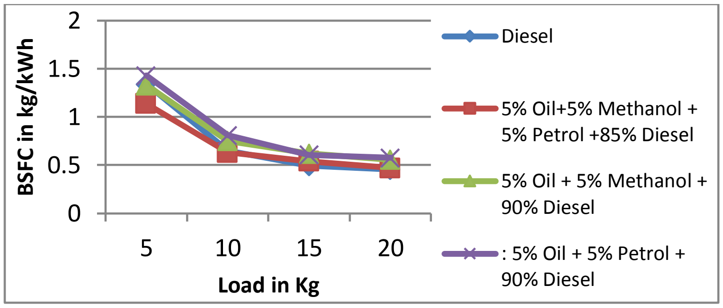

Fig: 4.7: Comparison of Break Specific Fuel Consumption for BPMKD5.0, BMKD5.0, BPKD5.0 and Diesel.

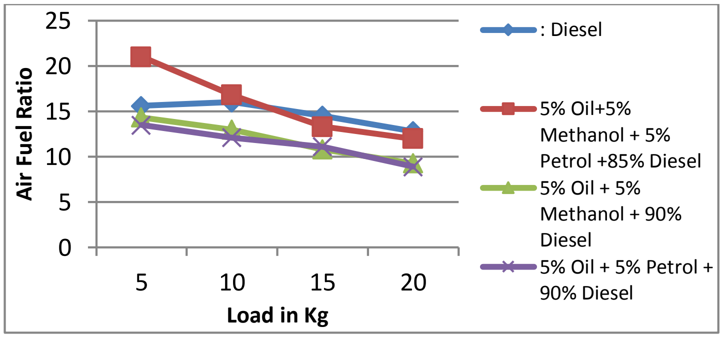

Fig: 4.8: Comparison of air fuel ratio for BPMKD5.0, BMKD5.0, BPKD5.0 and diesel

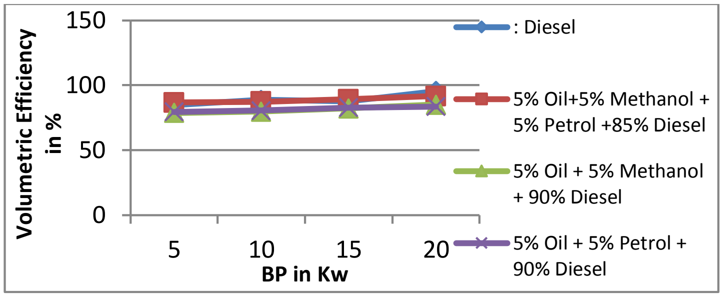

Fig:4.9: Comparison of volumetric efficiency and brake power for BPMKD5.0, BMKD5.0,BPKD5.0 And diesel

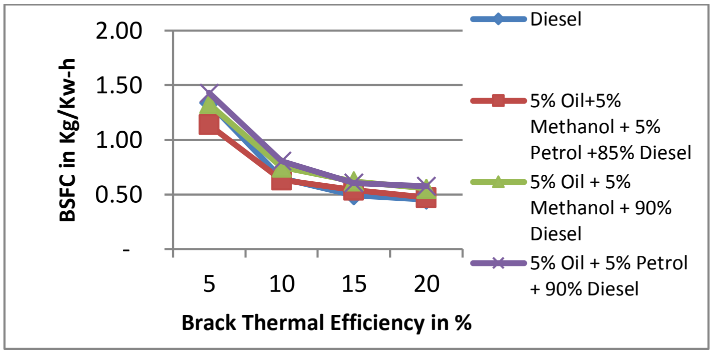

Fig:4.10: Comparison of brake specific fuel consumption and brake thermal efficiency for BPMKD5.0, BMKD5.0, BPKD5.0, And diesel

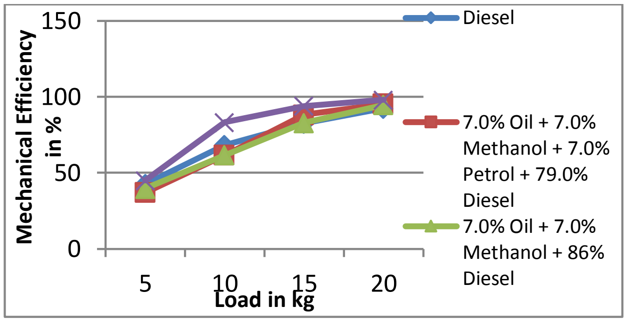

Fig:4..11: Comparison of Mechanical Efficiency for BPMKD7.0, BMKD7.0, BPKD7.0 and Diesel.

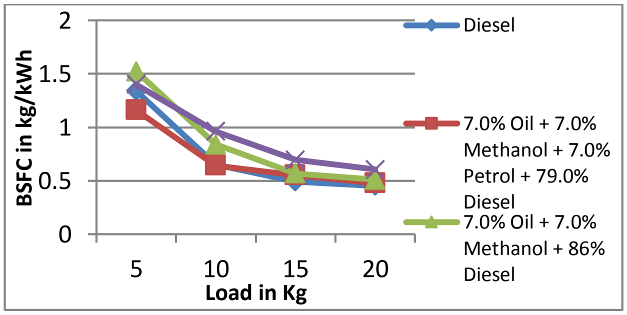

Fig: 4.12: Comparison of Break Specific Fuel Consumption for BPMKD7.0, BMKD7.0, BPKD7.0 and Diesel.

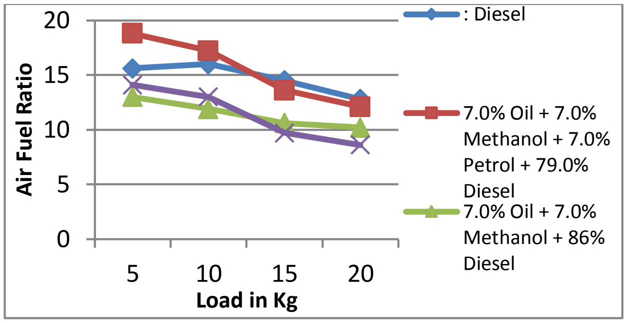

*Fig: 4.13: Comparison of air fuel ratio for BPMKD7.0, BMKD7.0, BPKD7.0 And Diesel *

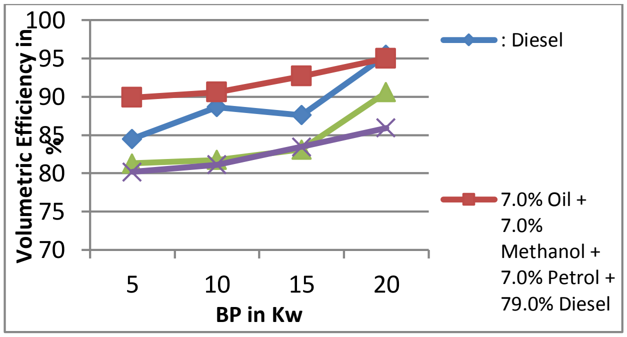

Fig:4.14: Comparison of volumetric efficiency and brake power for BPMKD7.0, BMKD7.0,BPKD7.0 And Diesel

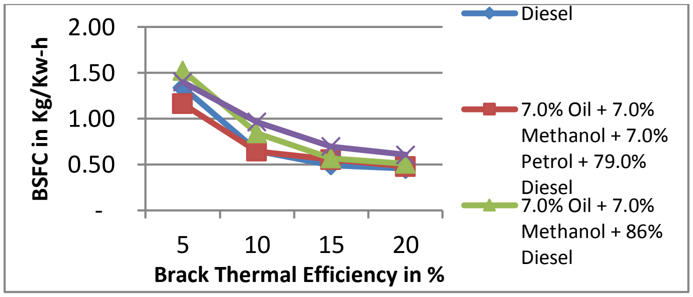

Fig:.4.15: Comparison of brake specific fuel consumption and brake thermal efficiency for BPMKD7.0, BMKD7.0, BPKD7.0, And Diesel

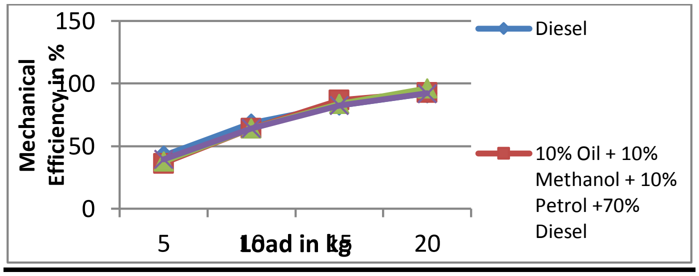

Fig:4.16: Comparison of Mechanical Efficiency for BPMKD10, BMKD10, BPKD10 and Diesel

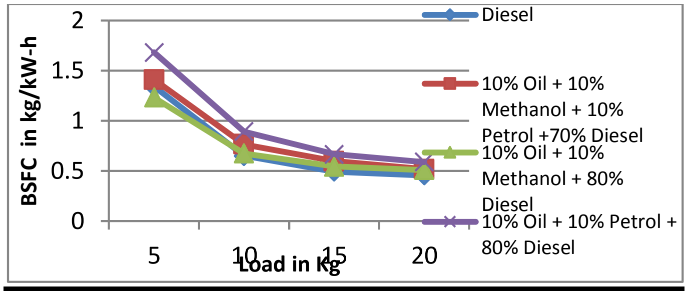

Fig: 4.17: Comparison of Break Specific Fuel Consumption for BPMKD10, BMKD10, BPKD10, and Diesel.

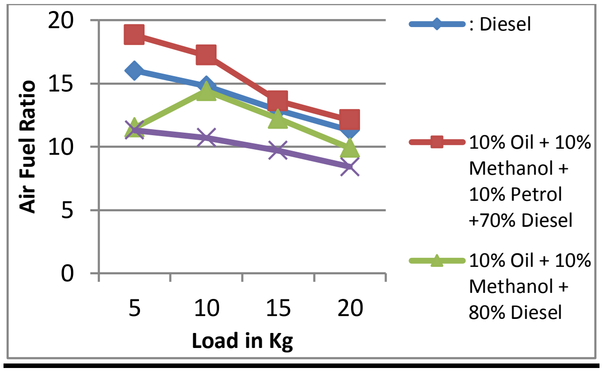

Fig: 4.18: Comparison of air fuel ratio for BPMKD10, BMKD10, BPKD10 And Diesel

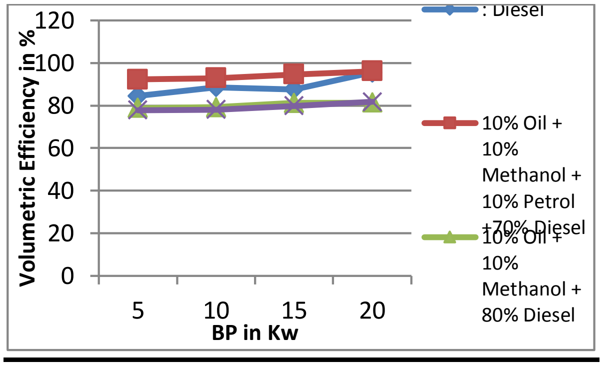

Fig:4.19: Comparison of volumetric efficiency and brake power for BPMKD10, BMKD10,BPKD10 and Diesel

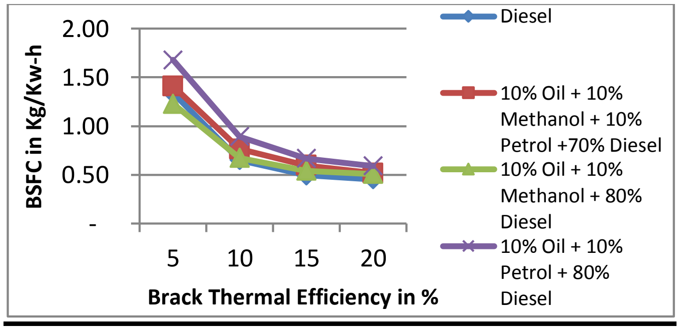

Fig:4.20: Comparison of brake specific fuel consumption anbrake thermal efficiency for BPMKD10, BMKD10, BPKD10, and Diesel

Experiments were conducted for engine performance of various blends of Karanja oil with diesel, ethanol and petrol. BSFC was found to increase with higher proportion of Karanja oil in the blend of compared to diesel for the entire operating load range represented in Fig(.4.1-4.20) . Calorific value of Karanja oil is lower compared to diesel Table-1, therefore increasing proportion of Karanja oil in the blends result in lower calorific value of the fuel, therefore BSFC increases. Thermal efficiency of Karanja blends was lower than l diesel. Mechanical efficiency of blend BPMKD10 at engine loads was observed to be more than that of diesel fig4.16.. Relatively higher viscosity and poor volatility of Karanja oil leads to poor fuel atomization and mixing of air and fuel spray, which leads to incomplete combustion in fuel rich regions inside the combustion chamber. Therefore, thermal efficiency is found to be lower for higher blends compared to diesel. The exhaust gas temperature for all blends of Karanja oil was higher. For blend BPMKD10 we see that there is only 70% diesel and we achieve performance equivalent to diesel. Thus we are able to reduce petroleum product

CONCLUSION

Direct-injection stationary diesel engine was operated under steady state at different engine loads to investigate the performance, of Karanja oil blends vis-à-vis base line diesel. Fuel consumption and thermal efficiency are relatively inferior for all Karanja oil blends compared to diesel. HC emissions were lower for Karanja oil blends than diesel for the whole engine operating range across all blend concentrations. CO and NO emissions were slightly higher for higher Karanja oil blends. Smoke capacity was lower for lower Karanja oil blends compared to diesel. In summary, Karanja oil's higher concentration blends are not suitable as alternate fuels in unmodified diesel engines. Injection timing optimization with unheated blends and pre heating the Karanja oil may be potentially techno economically feasible methods to use Karanja oil in diesel engines. However, lower concentration blends (up to 10% volume) can be readily used as alternate fuels to augment diesel supplies.

FUTURE SCOPE

1) Exhaustive engine test can be performed with varying fuel injection pressure and temperature.
2) Endurance test can be carried out using clean and neat Karanja oil with its blends with diesel.
3) Scope for reducing the viscosity of Karanja oil by different methods such as adding additives. Thermal cracking, degumming ann pyrolysis, can be carried out and then testing the performance.
4) Further study for the deposit for carbon in combustion chamber and dilution of lubricants.
5) Storing and handling of Karanja oil and its blend is equally important and to needs future use.
6) Efficiency and power output of diesel engine based on Karanja oil and its blends can be tested by heat recovery from exhaust gases.
7) To find the various constituents responsible for effective use.
8) To find the proper utilization of by-product.
9) To improve the quality of biodiesel.
10) To produce biodiesel from different non-edible oil.

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REFERENCES

1) Esteban B, Baquero G, Puig R, Riba JR, Rius A., "Is it environmentally advantageous to use vegetable oil directly as biofuel instead of converting it to biodiesel"?, Biomass and Bioenergy, Vol.35, No.3, pp. 1317-1328, March 2011.
2) Agarwal AK, "Biofuelsapplications as fuels for internal combustion engines", Progress in Energy and Combustion Science Elsevier, vol.33,pp.233-271.2007,
3) Bryant L, "The development of the diesel engine", Technology and culture, vol.17. The Johns Hopkins University Press, pp.432-46, 1976.
4) Srivastava A, Prasad R, "Triglycerides-based diesel fuels", Renewable &Sustainable Energy Reviews,IJEE, vol.4, pp.111-133, 2000.
5) Wander PR, Altafini CR, Moresco AL, Colombo AL, Lusa D, "Performance analysis of a mono-cylinder

diesel engine using soy straight vegetable oil as fuel with varying temperature and injection angle", Biomass and Bioenergy Elsevier, vol.35, issue9, pp.3995-4000, 2011.

6) Agarwal D, Agarwal AK, "Performance and emissions characteristics of Jatropha oil (preheated and blends) in a direct injection compression ignition engine", Applied Thermal Engineering, vol.27, pp.2314-2323, 2007.
7) Purushothaman K, Nagarajan G, "Performance, emission and combustion characteristics of a compression ignition engine operating on neat orange oil", Renewable Energy, vol.34, issue1, pp.242-245, 2009.
8) Devan PK, Mahalakshmi NV, "A study of the performance, emission and combustion characteristics of a compression ignition engine using methyl ester of paradise oileeucalyptus oil blends", Applied Energy,vol.86, pp.675-680,2009.
9) Agarwal AK, Dhar A, "Comparative performance, emission and combustion characteristics of rice-bran oil and its biodiesel in a transportation diesel engine", Journal of Engineering for Gas Turbines and Power, Transactions of ASME, vol.132, issue6, pp.064503-1-064503-4, 2010.
10) Agarwal AK, Dhar A, "Experimental investigation of preheated Jatropha oil fuelled direct injection compression ignition engine: Part I, performance, emission and combustion characteristics", Journal of ASTM International, vol.7, pp.1-13, 2010.
11) Lujaji F, Kristóf L, Bereczky A, Mbarawa M, "Experimental investigation of fuel properties, engine performance, combustion and emissions of blends containing croton oil, butanol, and diesel on a CI engine", Fuel, vol.90, issue2, pp.505-510, 2011.
12) Labeckas G, Slavinskas S, "Influence of fuel additives on performance of directinjectiondiesel engine and exhaust emissions when operating on shale oil", Energy Conversion and Management,vol.46, pp.1731-1744, 2005.
13) Karabektas M, Ergen G, Hosoz M, "The effects of preheated cottonseed oil methyl ester on the performance and exhaust emissions of a diesel engine", Applied Thermal Engineering,vol.28, pp.2136-2143, 2008.
14) Pugazhvadivu M, Jeyachandran K, "Investigations on the performance and exhaust emissions of a diesel engine using preheated waste frying oil as fuel", Renewable Energy,vol.30, issue14, pp.2189-2202, 2005.
15) Herchel TC, Shiga MS, Karasawa T, Nakamura H, "Performance and emission characteristics of a diesel engine fueled with coconut oil diesel fuel blend", Biomass and Bioenergy, vol.20, pp.63-90, 2001.
16) Kalam MA, Masjuki HH, "Emissions and deposit characteristics of a small diesel engine when operated on preheated crude palm oil", Biomass and Bioenergy, vol.27, pp.289-297, 2004.
17) Altin R, Cetinkaya S, Yucesu HS, "The potential of using vegetable oil fuels as fuel for diesel engines", Energy Conversion and Management, vol.42, pp.529-538, 2001.
18) MisraRD, Murthy MS, "Performance, emission and combustion evaluation of soap-nut oil diesel blends in a compression ignition engine", Fuel, vol.90, pp.2514-2580.
19) Haldar SK, Ghosh BB, Nag A, "Studies on the comparison of performance and emission characteristics of a diesel engine using three degummed non-edible vegetable oils", Biomass and Bioenergy, vol.33, pp.1013-1080, 2009.
20) Leevijit T, Prateepchaikul G, "Comparative performance and emissions of IDIturbo automobile diesel engine operated using degummed, de-acidified mixed crude palm oilediesel blends", Fuel, vol.90, pp.1487-1491, 2011.
21) Bajpai S, Sahoo PK, Das LM, "Feasibility of blending karanja vegetable oil inpetro-diesel and utilization in a direct injection diesel engine", Fuel, vol.88, pp.705-711, 2009.
22) Agarwal AK, Rajamanoharan K, "Experimental investigations of performance and emissions of Karanja oil and its blends in a single cylinder agricultural diesel engine", Applied Energy, vol.86, pp.106-112, 2009.
23) Nwafor OMI, Rice G, "Performance of rapeseed oil blends in a diesel engine", Applied Energy, vol.54, pp.345-354, 1996.
24) Agarwal AK, Dhar A, "Karanja oil utilization in DI engine by preheating: experimental investigations of

engine performance, emissions and combustion
25) Characteristics", Part I. Journal of Automobile Engineering, Proceedings ofIMechE, Part D, vol.224, pp.73-84, 2010
26) GvidonasLabeckas, StasysSlavinskas , "Comparative performance of direct injection diesel engine operating on ethanol, petrol and rapeseed oil blends", Energy conservation and Management Elsevier, vol.50, pp.792-801, 2009.
27) Avinash Kumar Agarwal, AtulDhar, "Experimental investigations of performance, emission and combustion characteristics of Karanja oil blends fuelled DICI engine", Renewable Energy, vol.52, pp.283-291, 2013.
28) Rakesh Vishwakarma, A.C. Tiwari, Nitin Shrivastava, Comparative Performance of Diesel Engine Operating onMethanol, Petrol & Karanja Oil Blends , Vol. 3, Issue .1 (2014) ISSN 2319-8753

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