ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

Comparative Performance of Diesel Engine Operating on Ethanol, Petrol &Karanja Oil Blends

Rakesh Vishwakarma[1], A.C. Tiwari[2], Nitin Shrivastava[3]

PG student, Department of Mechanical Engineering, UIT, RGPV Bhopal, Madhya Pradesh, India[1]

Professor, Department of Mechanical Engineering, UIT,RGPV Bhopal, Madhya Pradesh, India[2]

Associate Professor, Department of Mechanical Engineering, UIT, RGPV Bhopal, Madhya Pradesh, India[3]

Abstract: The continuous increasing demand for energy and the decreasing petroleum resources has led to the search for alternativefuel which is renewable and sustainable. Vegetables oils are simplest route of biofuel 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.

Keywords: Diesel Engine, Diesel, Karanja oil, Ethanol, Petrol, Performance**.**

I. INTRODUCTION

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 ethanol in diesel. The purpose of using petrol and ethanol is to reduce viscosity of karanja oil. The testing of this blend fuel is carried out on a four stroke, four cylinder diesel engine.

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]. 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

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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 in direct injection compression ignition engine without any substantial engine hardware modification.

Important properties of diesel,karanjaoil, ethanol and petrol.

Table 1

S. No.	PropertyParameter	Dieselfuel	Karanja Oil	Ethanol	Petrol
1	Density @ 20^0C, g/cc	0.842	0.924	0.789	0.755
2	Viscosity @ 40^0C, mm^2/s	2.94	40.2	1.4	0.60-0.75
3	Flash point, ^{o}C	68	225	21	40-45
4	Auto-ignition temp, ^{o}C	230	320	420	300
5	Cloud point, ^{o}C	-5	3.5	$\leq$-35	-30 to 50
6	Pour point, ^{o}C	0	-3	$\leq$-40	$\leq$-50
7	Cetane number	51.6	42	8	20-25
8	Sulphur content, mg/kg	33	0.025	-	100
9	Contamination, mg/kg	0.2	-	-	-
10	Acid Value, mg KOH/g	0.06	4-12	-	0.03
11	Oxygen Content, wt%	0.4	11	4.8	0
12	Calorific Value, MJ/kg	40	36.601	26.8	42.4
13	Ash content, mass-%	0.01	2-3	-	$\leq$0.01
14	Water content, mg/kg	28	150	~50000	-

II. EXPERIMENTAL SETUP

Karanja oil used in the investigation was characterized for its viscosity, density, calorific value and flash point. Performance characteristics of ethanol, 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 Table 2.

ISSN: 2319-8753

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Table 2

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

Engine tests were carried out at constant fuel injection pressure for diesel, as well as Karanja oil blends with Ethanol and Petrol (2.5%, 5%, 7.5%,10% v/v) i.e. BPKD2.5, BPKD5, BPKD7.5, BPKD10 and BEKD2.5, BEKD5, BEKD7.5, BEKD10, and also BPEKD2.5, BPEKD5, BPEKD7.5, BPEKD10 respectively. Four engine load conditions investigated for every test blend were 2.5%, 5%, %, 7.5%, 10% and compare it with diesel performance.

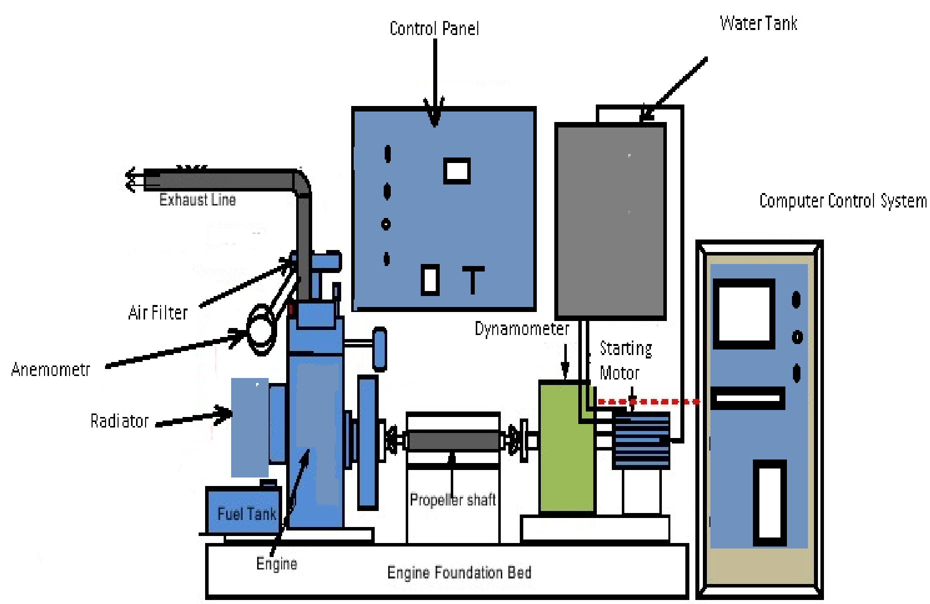

Fig. 1. Experimental Setup

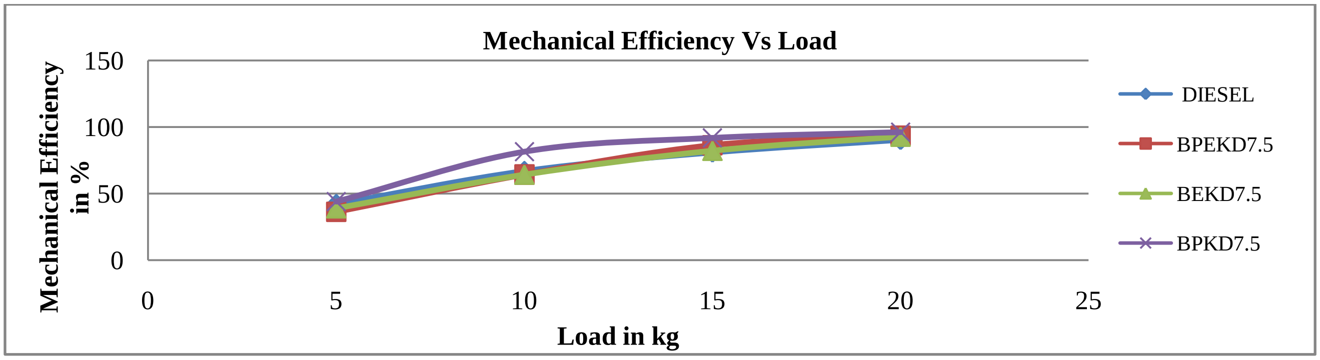

Fig : 2Comparasion of Mechanical Efficiency for BPEKD2.5, BEKD2.5, BPKD2.5 and Pure Diesel

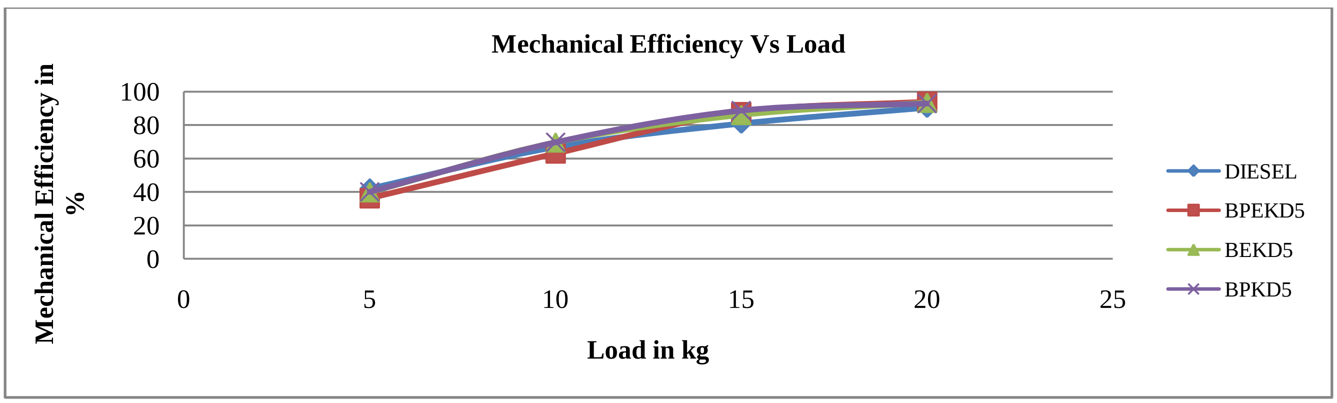

Fig : 3Comparasion of Mechanical Efficiency for BPEKD5, BEKD5, BPKD5 and Pure Diesel

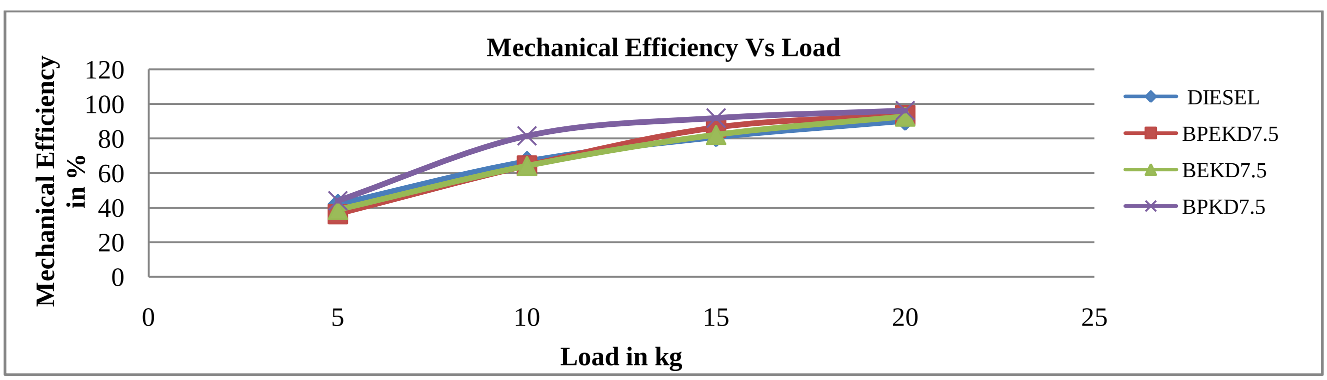

Fig : 4Comparasion of Mechanical Efficiency for BPEKD7.5, BEKD7.5, BPKD7.5 and Pure Diesel

ISSN: 2319-8753

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(An ISO 3297: 2007 Certified Organization)

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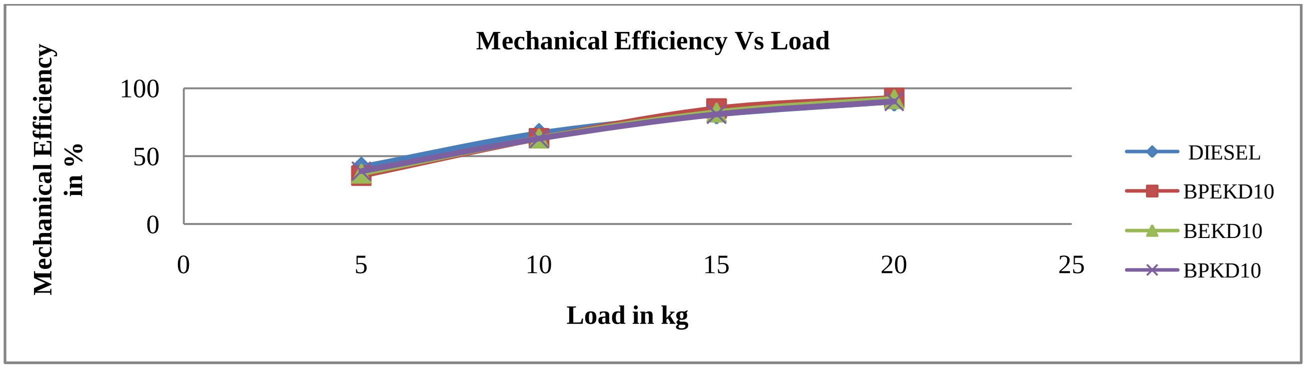

Fig : 5Comparasion of Mechanical Efficiency for BPEKD10, BEKD10, BPKD10 and Pure Diesel

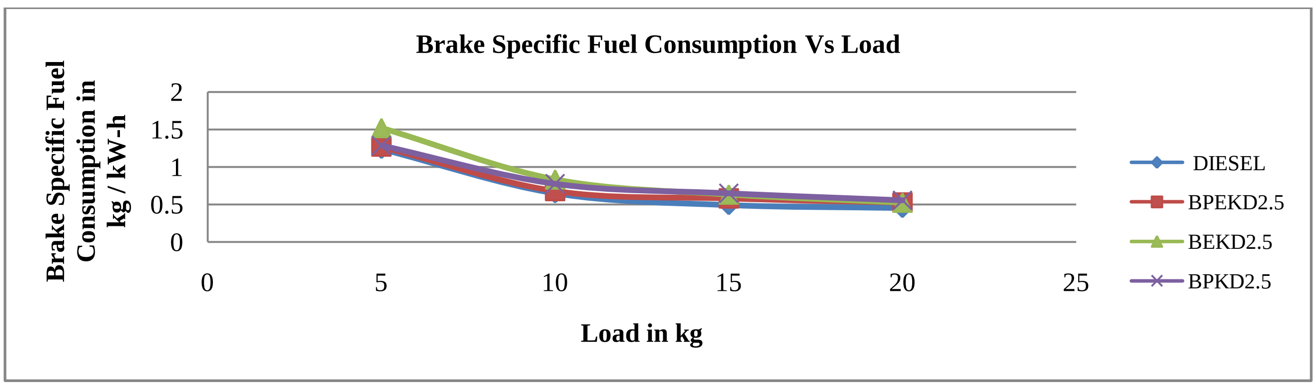

Fig : 6 Comparasion of Break Specific Fuel Consumption for BPEKD2.5, BEKD2.5, BPKD2.5 and Pure Diesel

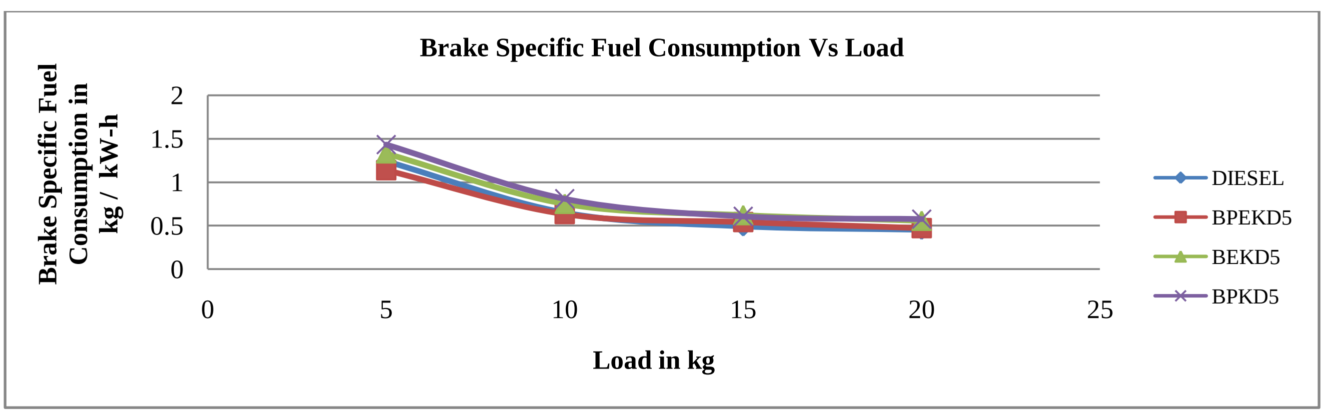

Fig : 7 Comparasion of Break Specific Fuel Consumption for BPEKD5, BEKD5, BPKD5 and Pure Diesel

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ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 3, Issue 1, January 2014

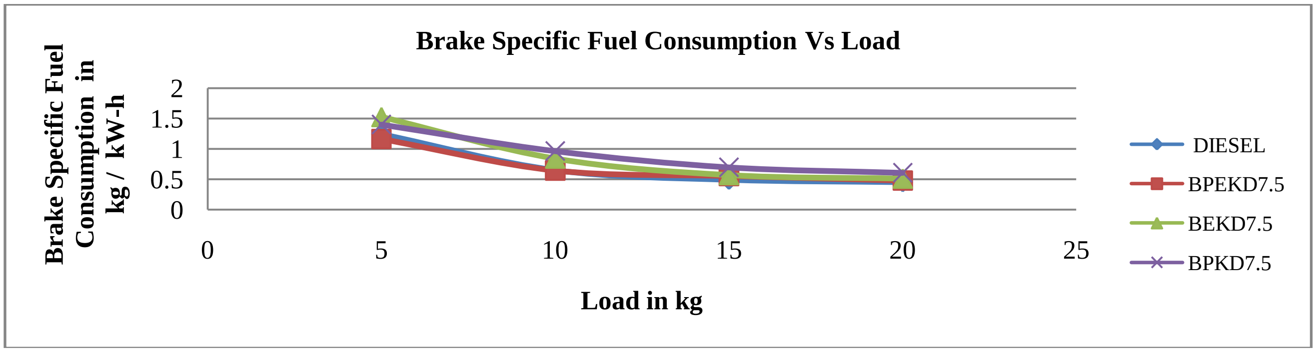

Fig : 8Comparasion of Break Specific Fuel Consumption for BPEKD7.5, BEKD7.5, BPKD7.5 and Pure Diesel

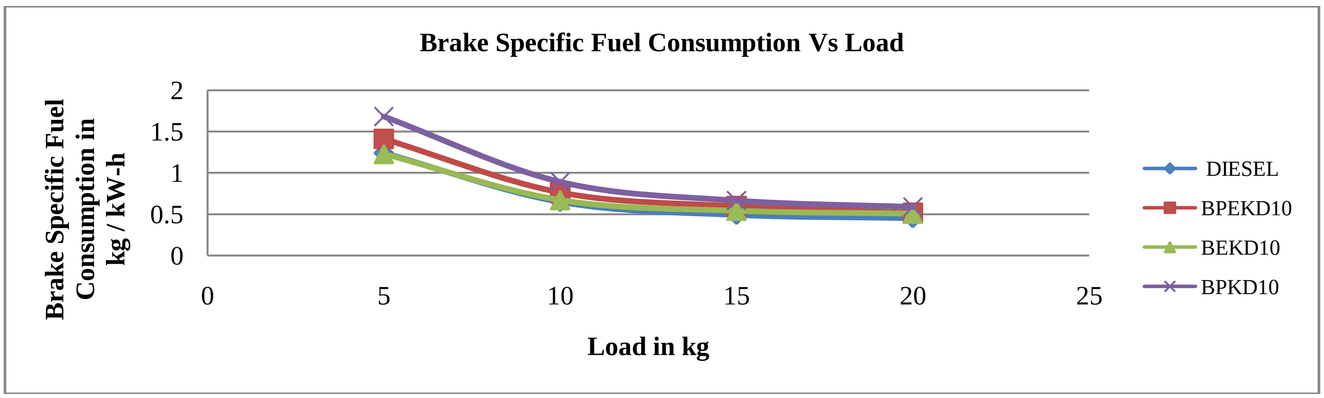

Fig : 9Comparasion of Break Specific Fuel Consumption for BPEKD10, BEKD10, BPKD10 and Pure Diesel

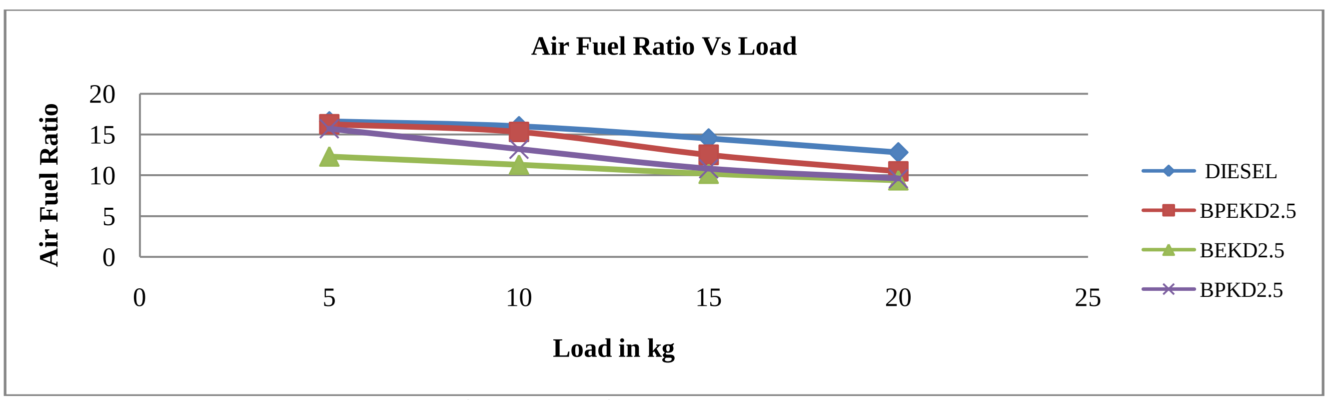

Fig : 10Comparasion of Air Fuel Ratio for BPEKD2.5, BEKD2.5, BPKD2.5 and Pure Diesel

ISSN: 2319-8753

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Vol. 3, Issue 1, January 2014

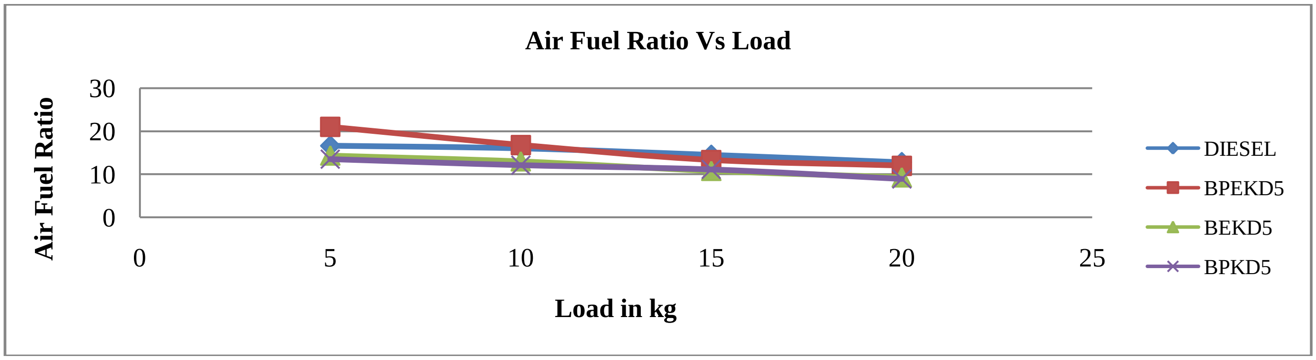

Fig : 11Comparasion of Air Fuel Ratio for BPEKD5, BEKD5, BPKD5 and Pure Diesel

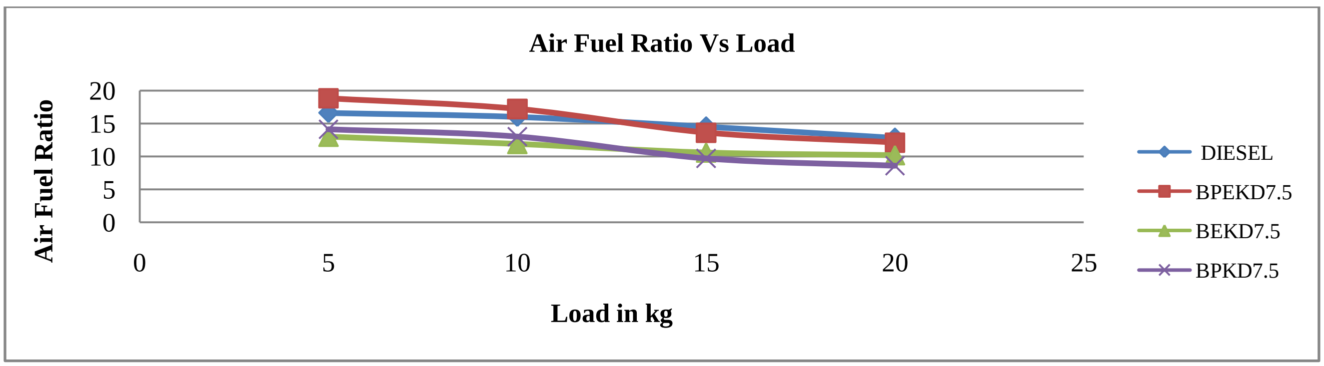

Fig : 12Comparasion of Air Fuel Ratio for BPEKD7.5, BEKD7.5, BPKD7.5 and Pure Diesel

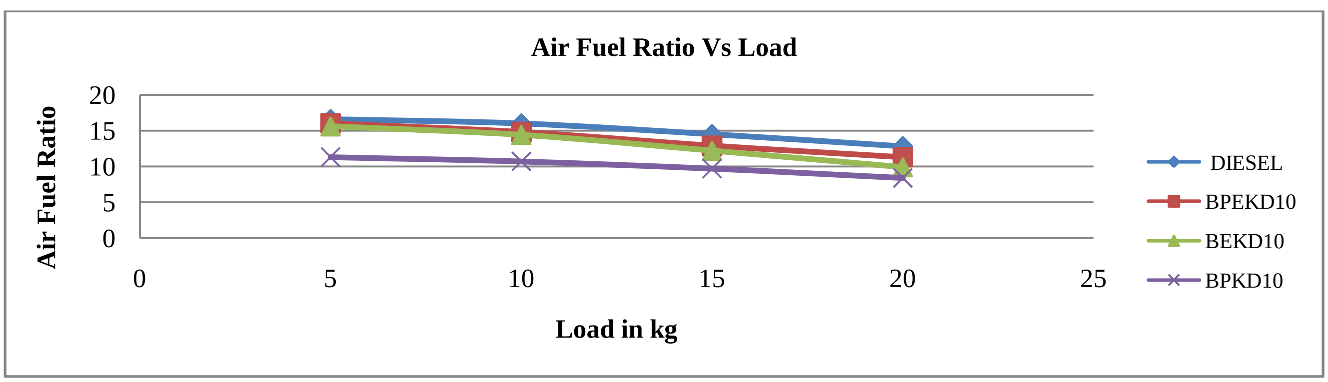

Fig : 13Comparasion of Air Fuel Ratio for BPEKD10, BEKD10, BPKD10 and Pure Diesel

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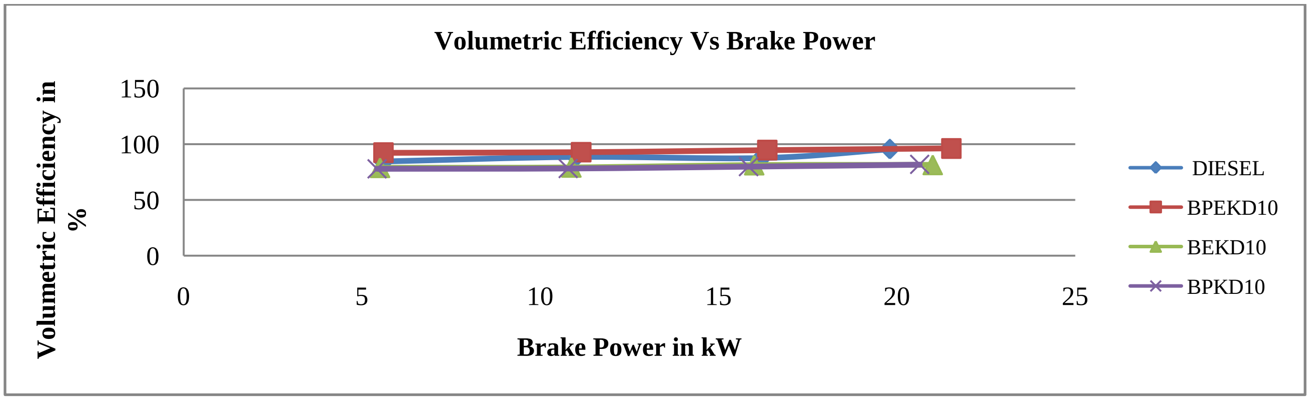

Fig : 14Comparasion of Volumetric Efficiency for BPEKD10, BEKD10, BPKD10 and Pure Diesel

III. RESULT AND DISCUSSION

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. 6-9. Calorific value of Karanja oil is lowercompared 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 Karanjablends was lower than l diesel. Mechanical efficiency of blend BPEKD10 at engine loads was observed to be more than that of diesel (fig.5). Relatively higher viscosity and poor volatility ofKaranja 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 oilwas higher. For blend BPEKD10 we see that there is only 70% diesel and we achieve performance equivalent to diesel. Thus we are able to reduce petroleum product consumption 20% by volume. We also observe that volumetric efficiency also improve for blends of BPEKD10 (fig.14). India imports nearly 70% of its annual crude petroleum requirement, which is approximately 110 million tons. The prices are in the range of US$ 50-70 per barrel, and the expenditure on crude purchase is in the range of Rs.1600 billion per year, impacting in a big way, the country's foreign exchange reserves. Using BPEKD10 blend we save around 300 billion per year and also reduce exhaust emission (HC).

IV. CONCLUSION

Direct-injection stationary diesel engine was operated under steady state at different engine loads to investigate the performance, of Karanja oil blends vis-a-visbaselinediesel. Fuel consumption and thermal efficiency are relatively inferior for all Karanja oil blends compared to diesel. HCemissions 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 blendscompared to diesel. In summary, Karanja oil's higherconcentration blends are not suitable as alternate fuels in unmodifieddiesel 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.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support rendered by University Institute of Technology, Bhopal in preparation of this manuscript.

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 characteristics", Part I. Journal of Automobile Engineering, Proceedings ofIMechE, Part D, vol.224, pp.73-84, 2010.

[25] 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.

[26]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.