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Performance Emission of N-Octanol - Biodiesel Blend in Diesel Engine

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Abstract: ***From last three decades scientists have explored the alternative fuel to substitute petroleum diesel for CI engine. One of the promising alternative fuel is biodiesel which has potential to substitute the conventional fossil fuels in near future. In the present study the author has considered Karanja biodiesel blended with n-octanol as an oxygenated blend to evaluate the performance, emissions and combustion features of diesel engine. The obtained results were improved relative to mineral diesel. The increment of BTE by 10.40% and decrement of BSEC by 13.20% were observed by using the blend KME80O20compared with neat JME at full load . Significant reduction in emission of HC-15.68%, CO-44.73%, smoke opacity -19.31%compared than diesel and reduction in NOx 3.04 % compare to neat KME were observed for KME80O20.This signifies improved combustion characteristics while utilizing n-octanol up to 20% as blend with KME in CI engine.***

Keywords: Biodiesel, brake mean effective pressure Performance and emission, n-Octanol, Transesterfication.

I. INTRODUCTION

The world become a single window due to rapid growth in transportation sector. The transportation sector mostly used compression ignition engine higher efficiency, reliability, adaptability, heavy duty performance and robust in structure .The CI engine fueled with mineral diesel. The use of mineral fuel enhanced the pollution and global warming .The main constituent of air pollution are CO,CO2,NOx,SO2,PM.The IEA 2018 reported that CO2 emission from the combustion of fuel was over two third of total GHG in 2015, which come from mainly burning of fossil fuel in which power plant and road transport emission is a measure parts[1].The road transport sector emitted 20% of CO and39 % of NO_X of total emission of all sector in 2017 . [2].The concern of depletion of fossil fuel and environment degradation force the scientist to explore the renewable energy resource who help the mitigate the both cause. Biodiesel is a one of the renewable fuel which can be use an alternative diesel fuel. It is made from renewable sources that is vegetable oil, animal fats, microbes. Basically vegetable oil and animal fats are triglyceride or ester of fatty acid with Glycerol. Biodiesel derived from chemical reaction called as transesterification. In this reaction triglyceride react with alcohol in presence of catalyst and make corresponding alkyl ester of fatty acid that is found in parent neat oil , and glycerol is separated from triglyceride[3].The biodiesel is a mono alkyl ester of long chain fatty acid .It is biodegradable in nature and low emission profile.[4]. The biodiesel is better than diesel fuel in terms of its properties such as sulphur content, flash point, aromatic content and produce by different methodology i.e. Pyrolysis, trans esterification[5].Biodiesel is first choice of researchers among the all alternative fuels due to oxygenated in nature and bio origin which help in decrement greenhouse gas and PM emission .Worldwide many researchers have done investigation and experimentation on diesel engine with minimum modification by using edible, non-edible oil , animal fat ,WCO biodiesel and observed that Non-edible vegetable oils are promising substitutes for traditional edible food crops , used in the synthesis of biodiesel . Among them, Pongamiapinnata oil, also known as Karanja oil, is considered as a good candidate with potential availability in India.[6].The performance and emission analysis carried by many researcher on CI engine fueled with blend of biodiesel with diesel and neat biodiesel. The performance and emission of diesel engine marginally improve compare than diesel except NO_x when blend of diesel with biodiesel was used. However decrement in performance and emission except NO_x was observed when engine fueled with neat biodiesel. Various scientist was reported that the blending of higher alcohol in biodiesel overall improved the combustion and emission quality of biodiesel.[7],[8].The performance and emission of C I engine depends upon the physicochemical characteristic of fuel i.e. cetane number, calorific value, viscosity, density, Oxygen contain. The biodiesel have higher cetane number than base line petroleum diesel which improve the combustion process. The reduction in emission was acknowledged by use of biodiesel except NO_x. The NO_x emission of biodiesel is the main difficulty in use of biodiesel. Sahoo et al.investigated the blend of methyle ester of Jatropha, Polanga and karanja blende with diesel and neat biodiesel .They reported that reduction of PM 16.43%to 42.06% compare than base line diesel. This decrement in PM in case of use of all biodiesel blend and neat biodiesel is due to the absence of sulphur, aromatic and enrichment of oxygen contain which plays a vital role for complete combustion of fuel.[9]. Vedaraman et.al. investigated performance and emission characteristic fueled with salmethyl ester.

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They reported that emission of CO, HC and NOx are reduced by 25%, 45% and 12%, respectively compared to base line diesel without significant difference in thermal efficiency due to available of oxygen in fuel[10] .Chauhan et.al evaluated the performance of Diesel engine without any modification fuel with Karanja biodiesel with different compositions at 5%, 10%, 20%, 30% and 100% with mineral Diesel.

They observed that BTE was about 3 to 5% lower with Karanja biodiesel and its blends with mineral diesel with respect of fossile diesel.[11]. Sinha et.al investigated the performance of CI engine fuel with Jatropha biodiesel blende with n-butanol and n-octanol .They reported that The BTE of all blended fuel was lower than diesel but blend of n-octanol with JOME give a better result than n-butanol and improved the BTE by maximum up to 16.68% compared with JOME and 3.94% lower when compared with diesel [12]. Sidharth investigated the performance emission of diesel engine fuel with ternary blend of WCO biodiesel,Octanol and diesel .They was reported that BTE and BSEC of 10O10WB80D blend was better due to more oxygen content of octanol/biodiesel and higher cetane number of biodiesel. However, when they compared to diesel, HC emissions for ternary fuel blend 20O10WB70D was slightly higher due to more octanol fraction .[13]

II. MATERIALS, METHOD AND CHARACTERIZATION OF BLEND

Table:- I: Physicochemical Property of Fuels

Parameter	D-100	KVO	KME-100	O-100	KME90 O10	KME80 O20
Density @ 15ºC Kg/cum	824.36	917.28	883.28	827.29	0.877	0.8718
Kinematic viscosity at 40ºC (cst)	2.72	34.78	5.72	5.59	5.706	5.718
Caloriefic value KJ/Kg	45674	38556	41365	38480	41095.45	40820
cetane index	46	37	53	39	51	50

In this experiment karanja biodiesel produced by trans esterification of Karanja vegetable oil Through methanolysis with help of alkali catalyst KOH and blended with n-Octanol. The blend of n-octane with karanja biodiesel 10% and 20% on volume basis was prepared . The physiochemical analysis was carried out as per ASTM standard and depicted in table no 1.It was observed that characteristic of blend within the range of ASTM D6751.

III. EXPERIMENTAL SET UP

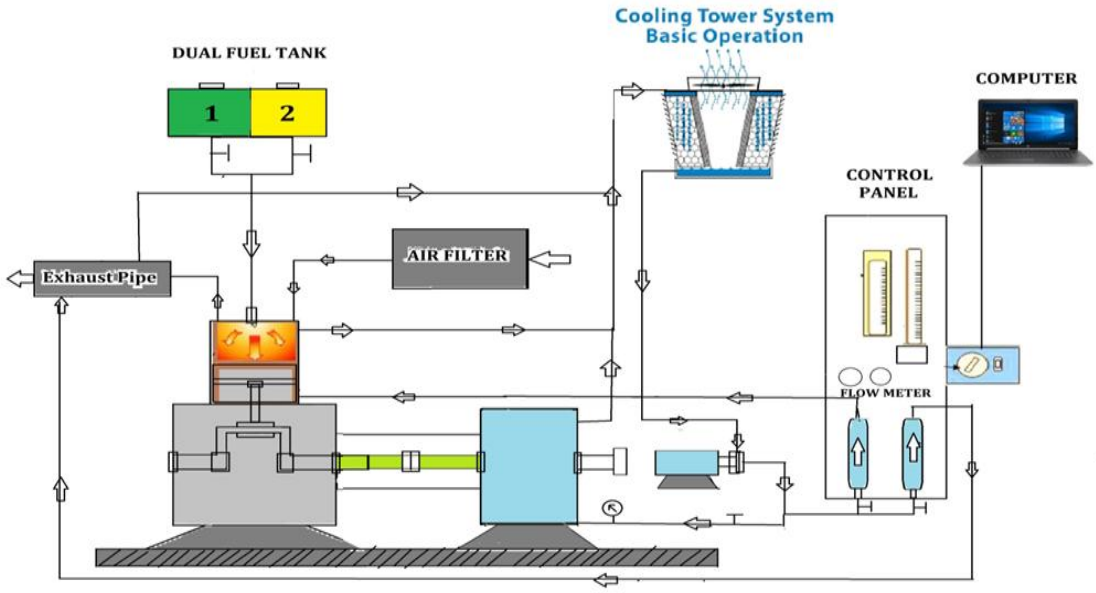

Fig 1 Schematic Diagram of Experimental Set up

A experimental set up was constructed, comprising of kirloskar make single cylinder water cooled direct injected, unmodified research engine with eddy current dynamometer. The engine technical specification are presented in Table 2. A full schematic diagram of experimental set up depicted in fig no.1.

Table. II: Technical Specification of Engine

Technical Specification of Engine	
Make ,Model	kirloskar TV1,
Compression Ratio	17.5:01
Engine Type	Direct injected water cool,VCR CI Engine
Displacment (C C)	665.45 CC
Stroke Length	110 mm
Bore Dia.	87.5mm
Rated power at 1500 rpm rated speed	5.2 Kw
No.of Cylinder	1
Connecting Road Length	234 mm
Dynamometer Arm length	185 mm

The Performance and emission analysis were carried out with neat biodiesel, blends and compared with base fuel mineral diesel.

The evaluation of performance, emission and combustion analysis has been carried out on single cylinder water cooled engine at constant speed, fueled with KOB100 and blend KOB90O10, KOB80O20 .

IV. RESULTS AND DISCUSSION

4.1.Performance and emission investigation

4.1.1 Brake Thermal Efficiency

All blend show lower BTE compared to base line petroleumdiesel. This was due to lower calorific and higher viscosityvalue of all tested fuel and blends. The graph show that BTE of all fuel gradually increases with increasing of load up to 80 % of loading due to improvement in combustion than marginally decreases for all fuels and blend due to low availability of oxygen and time. The BTE of tested fuels are are in range between13.06% to 31.36% among all the mineral diesel show the higher BTE and while KME is lower. Diesel has better fuel properties than other blend which help the diesel for better atomization and proper combustion. However blending of alcohol in biodiesel improve the BTE because alcohol has the volatile in nature and low viscosity than biodiesel [14]. The n-octanol has 195°C boiling temperature low viscosity which improve the atomization and air fuel mixing quality, resultant in improving of BTE. The blend KME80O20 show increase in BTE was by 10.40% compare than neat biodiesel of Karanja.The similar trend was observed by varios auther when they use blend of alcohol with diesel and biodiesel or biodiesel[15].

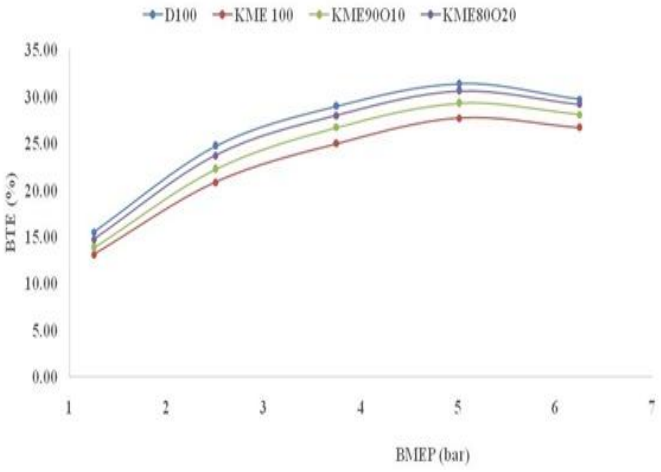

Fig.2.Variation of BTEwith BMEP

4.1.2 Brake specific energy consumption

The variation of brake specific energy consumption with respect to brake mean effective pressure depicted in fig.3 for various fuels .The brake specific energy consumption was decreases for all blend due to increasing of BTE with increasing load. However slightly increase on full load due to more quantity of fuel injected to full fill the engine load demand and low availability of oxygen .By blending of n-octanol improved the combustion quality hence decrement in BSEC. The BSEC of tested blend KME100,KME90O10,KME80O10 were observed and found that KME80O20 improve the BSEC by 13.20% compare to neat biodiesel at full load. The result are in similar line of investigation of various author [16].

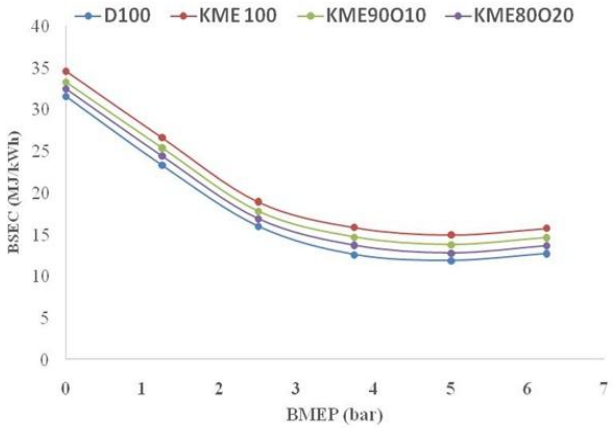

Fig.3.Variation of BSEC with BMEP

4.1.3 Hydrocarbon emission

Fig.4 show the the variation of hydrocarbon emission with variation of load of different test fuel. .It was observed that HC emission gradually increase with increment of load for all fuels.The hydrocarbon emission takes place due to poor combustion and presence of unburnt fuel in clearance volume, valve port and between the cylinder lining and piston.The fuel have higher proportion of aromatic and olefinselement , produce higher HC emission. Biodiesel emits lower HC emission than base diesel due to higher cetaneno. and higher oxygen contain facilitate homogeneous mixture in pre combustion stage which help proper combustion .n-Octanol have lower boiling point which leades to slightly more HC emission.than biodiesel but lower than mineral diesel due to oxygenated in nature. The blend of higher alcohols with biodiesel are prolonging the ignition delay period which provide more time for proper mixing of fuel with air hence improve the combustion.Due to this KME80O20 emits low HC emission than KME90O10During the investigation it was observed that the Biodiesel emits 14.47 % lower HC emission than base diesel at full load however by blending of n-octanol in biodiesel aggravate the HC emission but KME80O20 still emits low HC by 7.89 % than base diesel..Pali et.al observed that by by blending of biodiesel in diesel has improved the HC emission of diesel due to oxygenated characteristic of biodiesel[17]. This is agreement with other studies.[15]

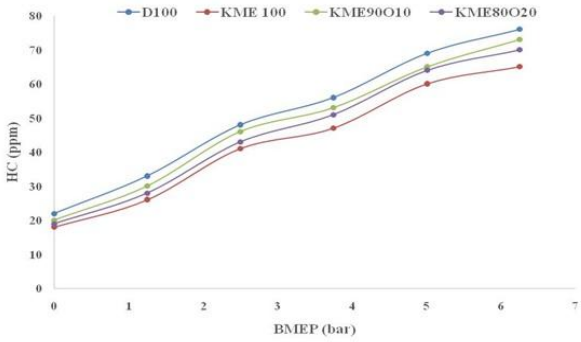

Fig.4.Variation of HC emission with BMEP

4.1.4 Carbon mono-oxide emission

The main source of CO emission is poor air –fuel ratio, presence of rich fuel and and lack of residence time and oxygen attendance in cylinder required for oxidization of CO to CO2.The CO is an intermediate combustion product in lack of oxygen ,generated in case of incomplete combustion takes place in CI engine. The fig.5 depicted the percentage of variation of CO with respect to BMEP. It was observed that CO emission nominally decreasing and show with small variation of all fuels up to medium load due to rich oxygen availability than all of the sudden increase for all fuels/blend on full load.KME80O20 blend show lower CO emission than other fuel due to reached oxygen availability and proper air-fuel mixture which help to oxidized the CO. The blend KME80O20 show the reduction in co by 44.73% at full load. The Jamrozik et .al observed the similar result[18].

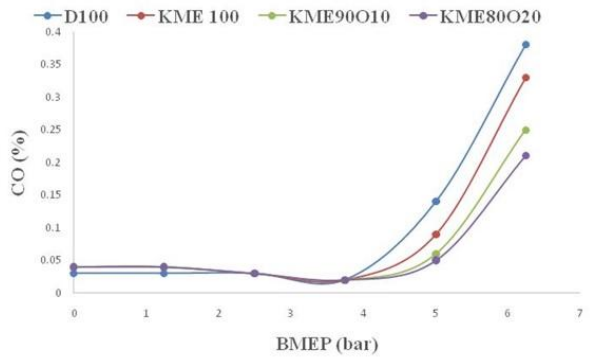

Fig.5.Variation of COemission with BMEP

4.1.5 Smoke Opacity

Smoke opacity is a measure of incomplete combustion of fuel in lack of Oxygen and found in form of particulate. Particulate formation takes place in CI engine combustion ,due to incomplete combustion of hydrocarbon fuels and lubricating oils and represented by presence of particulate in exhaust gas.

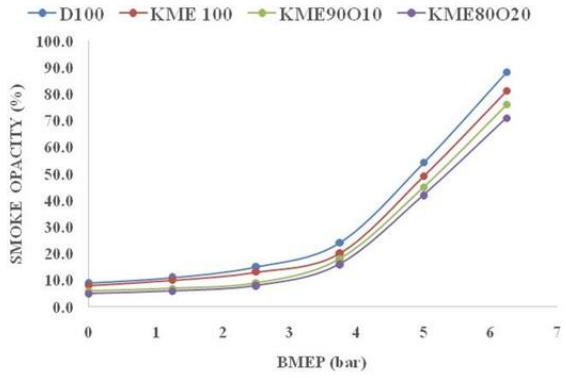

Fig.6.Variation of Smoke Opacity with BMEP

The variation of percentage of smoke opacity depicted in fig.6 with respect to BMEP. It was observed that smoke opacity increases with increment in engine loading due to fuel consumption gradually increase. Diesel emits more smoke compare than other fuel due to low availability of oxygen. The reduction in smoke emission was observed at all load with increasing the percentage of n-octanol.Lower the boiling point and vaporization characteristic of n-octanol improve the atomization quality of biodiesel resulted in decrement of smoke. The blend JME80O20 show better results and reduction in smoke opacity was observed by 19.31 % at full load compare to diesel. Mixed trend of smoke opacity are reported in literature review Josphine et al. and deep et.al. reported that lowest smoke opacity of use of higher alcohol blende fuel [19],[20]while Geetesh et .al reported higher smoke opacity when using biodiesel and butanol.[21],

4.1.6 NOx emission

In CI engine NOx emission consist of mainly nitric oxside (NO) and Nitrogen oxide NO2 is the lesser part in of NOx emission is more toxic than NO and has adverse effects on human health and the environment. The reason of NOx emission depent upon the fuel oxygen contain , high peak combustion temperature, and residence time of fuel in engine cylinder at peak temperature. Further more self Oxygen contain in karanja biodiesel might cause of high NOX emission. Higher cetane no and the extra oxygen available in biodiesel may prolong the combustion duration and provide more time for combustion cause NOx formation. By blending of n-octanol in biodiesel increase the ignition delay and provide lower residence time of combustion and higher value of latent heat of evoparation and lower colorific value of n-octanol may coause the decrement of combustion temperature reduction in NOx emission. [22],[23]

Fig 7 depicted the variation of NO_x emission in ppm with respect to BMEP for tested fuel blend KME90O10 show lower NOx than KME80O20 and KME100. The blend KME90O10 show the reduction in NOX by 10.09 % compare to neat biodiesel while KME80O20 show 7% reduction at full load. Ashok et .al observed the similar trend when use the blend of n-octanol and CalophyllumInophyllum biodiesel. [24].

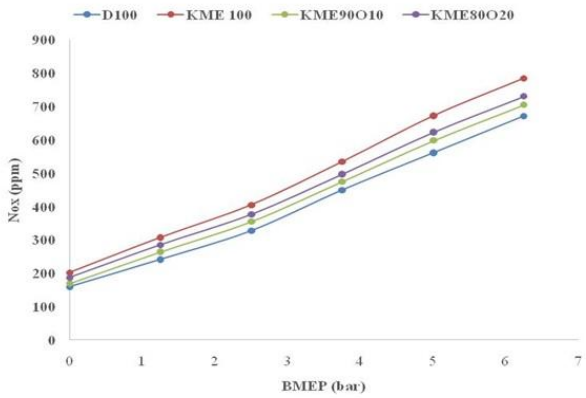

Fig.7 .Variation of NO_x emission with BMEP.

V. CONCLUSION

In this study performance and emission of single cylinder CI engine fueled with blend of n-octanol with KME by V/V in percentage of 10 % and 20% investigated .The performance and emission of CI engine studies at various load and compare with neat KME and base diesel and following conclusion are made .

1. The BTE of all fuel/blend was lower compare than base diesel but blend of n-octanol in JME improve the BTE of JME by 10.40%.
2. The BSEC of tested blend KME100,KME90O10,KME80O10 were observed and found that KME80O20 improve the BSEC by 13.20% compare to neat biodiesel at full load.
3 It was observed that the blend KME80O20 reduce the HC emission by 15.68 % , CO by 44.73% ,smoke opacity by 19.31 % compared than base diesel at full load.
4. The blend KME90O10 show the reduction in NOX by 4.43% compare to neat biodiesel at full load.

It is concluded that blend of n-octanol and KME can substitute the mineral diesel.

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