IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

PERFORMANCE ANALYSIS OF 4-S DIESEL ENGINE WITH KARANJA OIL METHYL ESTERS WITH IGNITION IMPROVER

Anam Vamsi Kumar1, S.Venkateswara Rao2 and C.Naga Bhaskar[3]
P.G Scholar[1], Assistant Professor[2] and Professor[3], Department of Mechanical Engineering, NRI Institute of Technology,
Agiripalli, Vijayawada, A.P., India.

Abstract: The present study covers the various aspects of biodiesels fuel derived from Karanja seed oil and also the study of performance and emissions on four stroke compression ignition engine. Crude Karanja seed oil is converted to Karanja seed oil methyl esters by transesterification process. The obtained biodiesel properties are measured experimentally and analyzed with diesel. The performance and emission parameters of biodiesel blends were compared with the diesel and from the result analysis the optimum Karanja seed oil blend is found. After finding optimum blend, the tests were conducted on the same engine with addition of DMC (Dimethyl carbonate) as a fuel additive at 5%, 10% and 15% on volume basis and evaluate its effects on diesel engine characteristics. The main purpose of fuel additives is to improve the combustion process and reductions of exhaust emissions. Finally, the experimental outcomes are analyzed with the diesel. The blend KSOME15 with DMC10% is shows better performance and lower emissions. Finally, results show the improvement in engine performance and reduction of emission parameters needs to justify the potentiality of the Karanja seed oil methyl ester as alternative fuel for diesel engine without any modification.

***Index Terms* – Karanja oil, Biofuel, Alternative fuels, Performance of biofuels.**

I. INTRODUCTION

Biodiesel is defined as mono alkyl esters of long chain fatty acids derived from vegetable oils or animal fats which conform to ASTM D6751 specifications use in diesel engines. Biodiesel refers to the pure fuel before blending with diesel fuel. Biodiesel is the name of a clean burning alternative fuel, produced from domestic, renewable resources. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in CI engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics. It is less harmful to the environment for it contains practically no sulfur and substantially reduces emissions of UHC, CO, poly cyclic aromatic and particulate matter.

Biodiesel is intended to be used as a replacement for petroleum diesel fuel, or can be blended with petroleum diesel fuel in any proportion. Biodiesel does not require modifications to a diesel engine to be used. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulphur and aromatics.

Biodiesel is a clean burning renewable fuel made using natural vegetable oils and fats. Biodiesel is made through a chemical process which converts oils and fats of natural origin into fatty acid methyl esters (FAME). Biodiesel is not vegetable oil. “The use of vegetable oils for engine fuels may seem insignificant in past. But such oils may become in the course of time as important as petroleum and the coal tar products of the present time.”

In this project we tried to investigate the potential use of Karanja seed oil methyl esters as bio-diesel. During the course of this project we have actually prepared Karanja seed oil methyl ester. Various experiments were conducted on KSOME and the results were recorded. We collected the results of Karanja seed oil methyl esters from various journals and research papers. The results of KSOME were compared with conventional diesel. In recent years the use of fuel additives with diesel and biodiesel blends are gaining interest to enhance the engine characteristics and rapid reductions in exhaust emissions.

The fuel additives are mainly used to improve the fuel properties up to certain extent for various fuels due to more stable, low viscosity value, higher cetane value and rich inherent oxygen concentration produces the clean combustion of fuels in the engine cylinder and lower the tailpipe exhaust emissions.

Fuel additives are used in diesel engines because there can improve the performance parameters and combustion characteristics and reduce tail pipe emissions as CO, HC, NO_x and other parameters.

A. Veereshbabu et al., [1] They was studied Biodiesel was prepared from the non-edible oil of pongamia pinnata L. By Transesterifiction of the crude oil with methanol in the presence of NAOH as catalyst. Crude pongamia oil was transesterified using NAOH as catalyst and methanol to form biodiesel. The conversion was 94% at 60^0c with 1:10 molar ratio (oil: methanol) for NAOH (1wt. %) catalyzed transesterification. The fuel properties especially viscosity (4.71cst at 40^0C) and flash point (170^0C) of the transesterified product as biodiesel compared well with accepted biodiesel standards as ASTM and German standards.

Ram Prakash et al.,[2] In their work the performance analysis of Compression Ignition Engine using alternative fuels as Rice bran oil and their ester after esterification has successfully compared and the responses observed were specific fuel consumption , brake thermal; efficiency ,exhaust gas temperature, Smoke density, CO and HC emissions. These responses obtained from the vegetable oils and its blends were compared to the diesel fuel. Different comparative graph its obtained and successfully compared. S SRagit et al., [3] They were conducted experiments using neem oil methyl ester (NOME) was tested in 4-stroke single cylinder water cooled diesel engine. Brake thermal efficiency of NO100 has been found 63.11% higher than that of diesel at part load whereas it reduces 11.2% with diesel fuel at full load. As NOME is concerned, HC is reduced at all load condition, whereas smoke is also reduced at full load condition. NOx has reduced slightly at all load condition, and EGT showed increasing trend at full load condition. Other emissions (CO, CO2 and O2) do not contribute bad effect on engine. Thus, NOME can be a substitute for diesel fuel in diesel engine.

Sharanappa Godiganur [4] An experimental investigation is conducted to evaluate the effect of using blends of mahua biodiesel with conventional diesel fuel, with 10%, 20%, 40%, 60% and 80% (by volume) Maua biodiesel, on the performance and exhaust emissions of a three cylinder naturally aspirated, air cooled, direct injection, Kirloskar HA394 engine. The tests are conducted using each of the above fuel blends, with the engine working at constant speed and five loads.

II. STEPS INVOLVED IN TRANSESTIRIFICATION PROCESS

1. Catalyst is dissolved in alcohol using a standard agitator or a mixer.
2. Alcohol catalyst mix is then charged into a closed reaction vessel and bio lipid (Vegetable or animal oil or fat) is added.
3. Reaction mixture is kept just above the boiling point of alcohol with a recommended reaction of around 1-8 hours.
4. Un-reacted or excess alcohol is recovered by distillation which is recycled back.
5. The products containing the glycerol and ester namely the biodiesel are separated using a continuous decanter (with glycerin as underflow and biodiesel as overflow). Centrifuge is used to separate the two materials faster. Once separated from glycerin biodiesel is purified by washing gently with warm water to remove residual catalyst or soaps, dried and sent to storage.

III. ENGINE SETUP AND EXPERIMENT PROCEDURE

3.1 Description

A water cooled single cylinder vertical diesel engine is coupled to a rope pulley brake arrangement to absorb the power produced necessary weights and spring balances are induced to apply load on the brake drum suitable cooling water arrangement for the brake drum is provided. Separate cooling water lines are provided for measuring temperature. A fuel measuring system consists of a fuel tank mounted on a stand, burette and a three way cock. Air consumption is measured by using a mild steel tank which is fitted with a orifice and a U-tube water manometer that measures the pressures inside the tank. Also digital temperature indicator with selector switch for temperature measurement and a digital rpm indicator for speed measurement are provided on the panel board. A governor is provided to maintain the constant speed. For measuring the emissions the gas analyser is connected to the exhaust flow.

3.2 Procedure

Note down engine specifications and ambient temperature.

1. Calculate full load (W) that can be applied on the engine from the engine specifications.
2. Clean the fuel filter and remove the air lock.
3. Check for fuel, lubricating oil and cooling water supply.
4. Start the engine using decompression lever ensuring that no load on the engine and supply the cooling water
5. Allow the engine for 10 minutes on no load to get stabilization.
6. Note down the total dead weight, spring balance reading, speed, time taken for 10cc of fuel consumption and the manometer readings.
7. Repeat the above step for different loads up to full load.
8. Allow the engine to stabilize on every load change and then take the readings.
9. Before stopping the engine remove the loads and make the engine stabilized.
10. Stop the engine pulling the governor lever towards the engine cranking side. Check that there is no load on engine while stopping.

IV. RESULTS AND DISCUSSIONS

The experiments are conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500 rpm) with varying loads. The addition of fuel additives are DMC with different proportions like 5%, 10% & 15%. The various performance parameters such as brake thermal efficiency, mechanical efficiency, volumetric efficiency, brake specific fuel consumption, and air-fuel ratio are discussed below.

4.1 Brake Thermal Efficiency

The variation of brake thermal efficiency with brake power is shown in Fig.1. From the plot it is observed as the load increases there is a considerable increase in the BTE. The BTE of diesel at full load is 34.45% while the blends of KSOME15 is 34.06%, KSOME15D80DMC5% is 33.73%, KSOME15D75DMC10% is 35.73% and KSOME15D70DMC15% is 34.16%, among the four the maximum BTE is 35.73% which is obtained for KSOME15D75DMC10%. The increment in BTE due to better combustion because of adding fuel additive or ignition improver it effects to decrease the viscosity of KSOME.

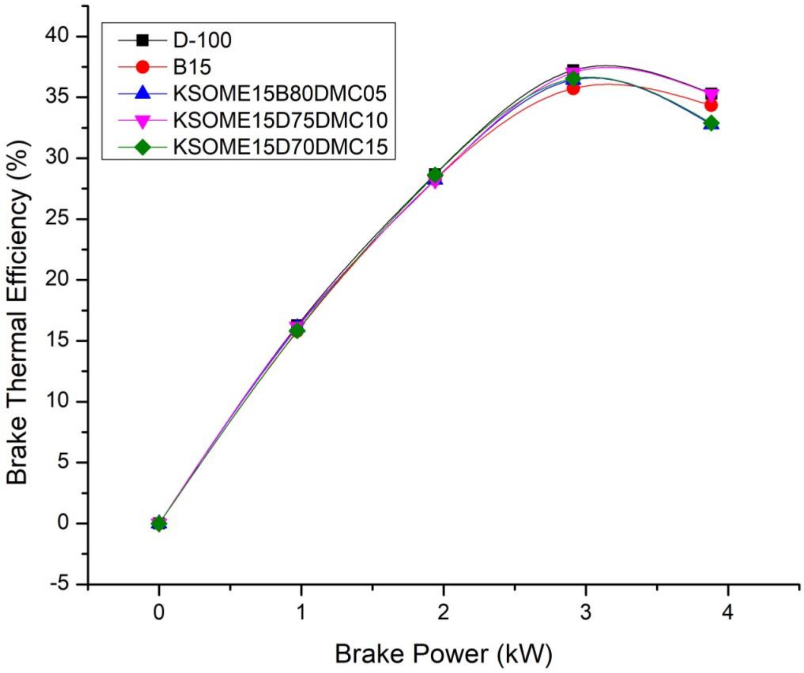

Figure 1. Variation of Brake thermal efficiency with Brake Power Using DMC Blends

4.2 Brake Specific Fuel Consumption

The variation of brake specific fuel consumption with brake power is shown in Fig.2. The plot it is observed that as the load increases the fuel consumption decreases, the minimum fuel consumption for KSOME15D75DMC10% is 0.25 kg/KW-hr as to that of KSOME15 is 0.256 kg/KW-hr. The BSFC of after adding Fuel additive of KSOME is decrease up to 2.4% as compared with optimum blend at full load condition the BSFC obtained are 0.246, 0.256 for diesel and KSOME15, DMC concentrations are 5%,10% &15% are 0.26, 0.25, and 0.279 kg/KW-hr respectively.

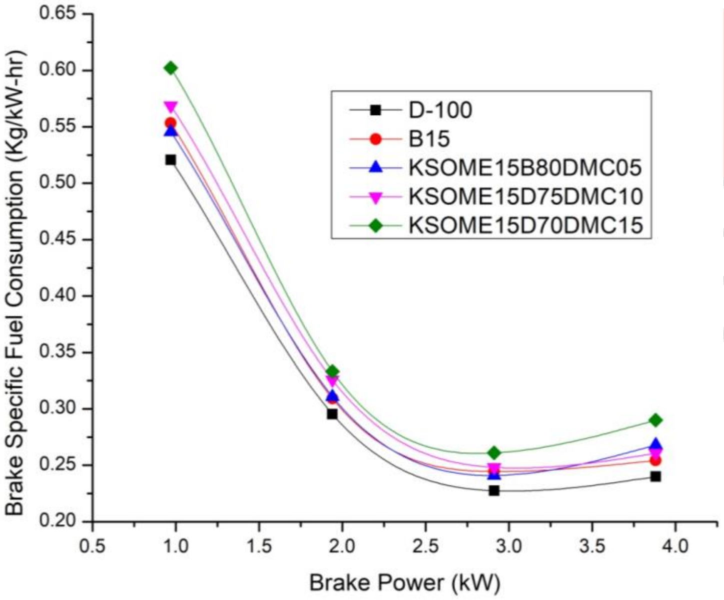

Figure 2. Variation of Brake specific fuel consumption with Brake Power Using DMC Blends

4.3 Mechanical efficiency

The variation of mechanical efficiency with brake power is shown in Fig.3. From the plot it is observed that optimum blend and other blends are like DMC (5, 10 & 15%) slightly decreases at full conditions. The efficiencies obtained are 76.38%, 7.43% for diesel, KSOME15 and for DMC concentrations are 76.38%, 72.57%, and 73.49% there is a considerable change in mechanical efficiency using KSOME Blends.

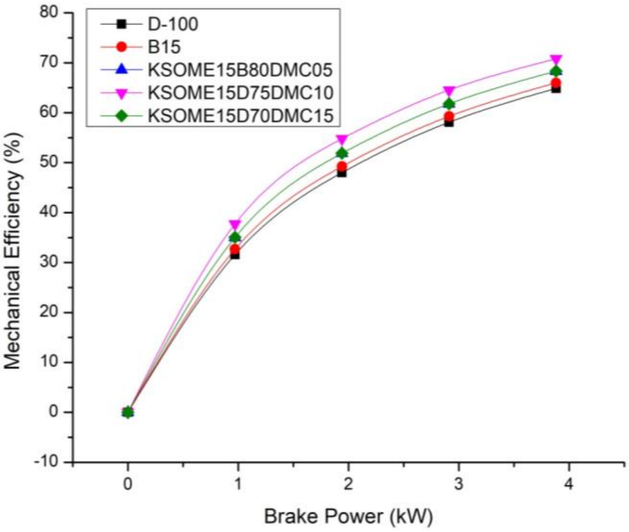

Figure 3. Variation of Mechanical efficiency with Brake Power Using DMC Blends

4.4 Volumetric Efficiency

The variation of volumetric efficiency with brake power is shown in Fig.4. The blend B15 contains 76.1% at full load condition, but in case after adding fuel additive blends slightly variation at compared with optimum blends. At full load 76.87%, 76.1% for diesel, KSOME15 and for DMC Blends are 79.34%, 75.91% and 76.25% respectively.

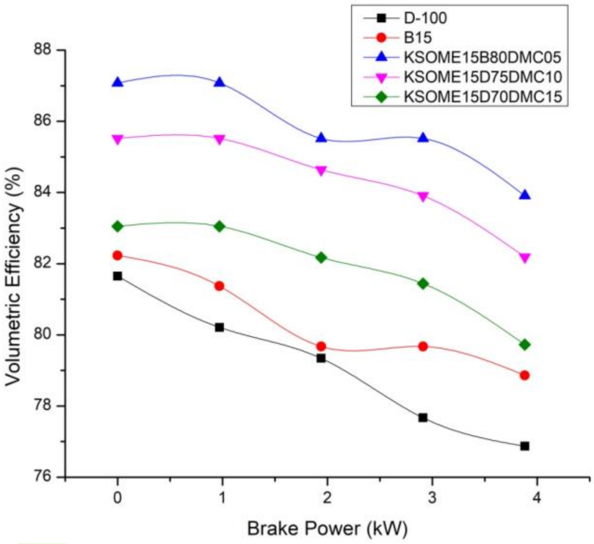

Figure 4. Variation of Volumetric Efficiency with Load Using DMC Blends

4.5 Air-Fuel Ratio

The variation of Air Fuel ratio with brake power is shown in Fig.5. From the plot it is observed that A//F ratio decreases by the addition of DMC blends. As the load increases more power is to be developed by the engine to compensate the load. The only way to increase the more power development is to inject the more amount of fuel into the cylinder which tends to reduce the air-fuel ratio.

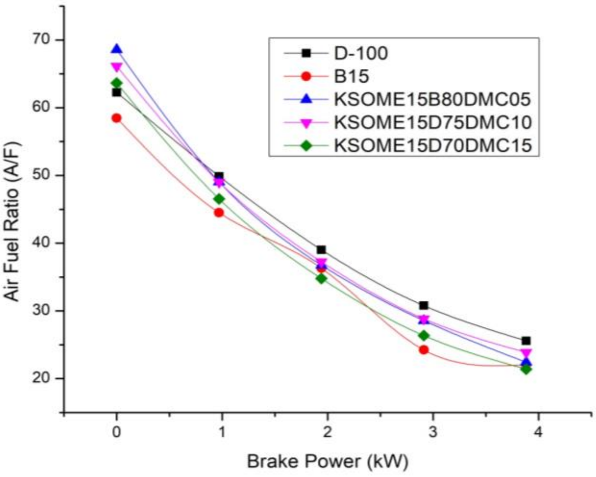

Figure 5. Variation of Air-fuel ratio with Brake Power Using DMC Blends

4.6 EMISSION ANALYSIS USING KSOME15 BLEND WITH DMC:

The experiments conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500rpm) with optimum blend and varying loads. Various emission parameters in the sense of oxides of nitrogen, HC, CO, and other parameters are discussed below.

4.6.1 Oxides of Nitrogen

The variation of NO_x emission with brake power is shown in Fig.6. The plot it is observed that the oxides of nitrogen emissions for all the fuel tested followed an increasing trend with respect to load. The results are obtained ad 1476 ppm, 1509 ppm and 1540 ppm, 1500 ppm and 1473 ppm for the fuels of diesel, KSOME15 and DMC Blends respectively. After adding the fuel additives like 5%, 10% and 15% concentrations there having a better combustion characteristics occurred in the engine cylinder.

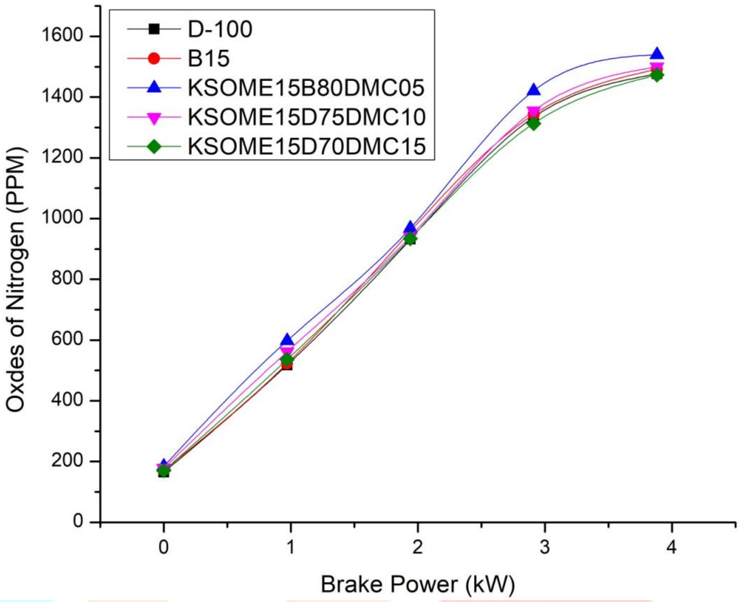

Figure 6. Variation of NO_x with Brake Power Using DMC Blends

4.6.2 Carbon Monoxide Emissions

The variation of CO emission with brake power is shown in Fig.7. The plot it is observed that the CO concentrations are decreases for the blends of DMC as 5%, 10% and 15% respectively. At full load conditions the CO emission obtained are 0.153%, 0.161% for diesel and KSOME15 blend and 0.131%, 0.117% and 0.112% are for DMC Blends respectively.

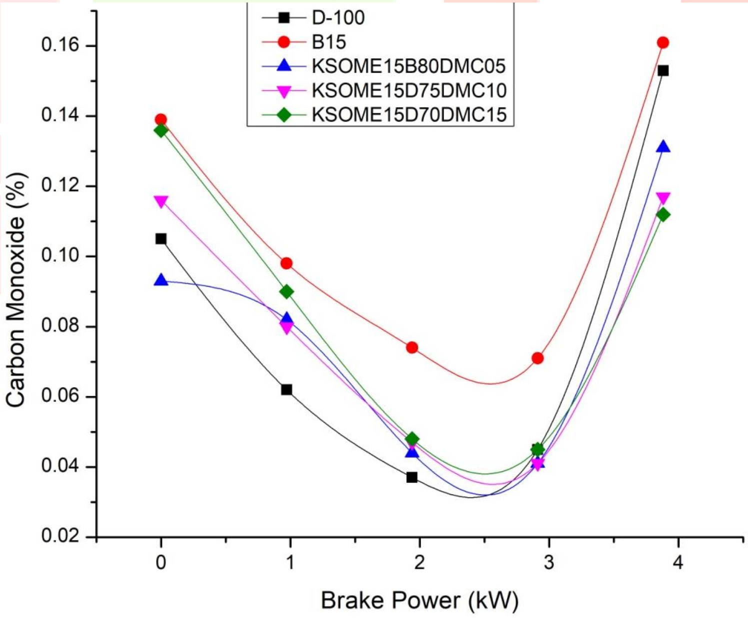

Figure 7. Variation of CO emissions with Brake Power Using DMC Blends

4.6.3 Unburned Hydrocarbon Emission

The variation of HC emission with brake power is shown in fig 7. From the plot it is observed that the HC emissions are obtained as 47ppm, 41ppm for diesel and KSOME15 Blend for DMC blends results are obtained as 36ppm, 32 and 29ppm respectively that the HC emissions decreases with increase in load for adding fuel additive blends.

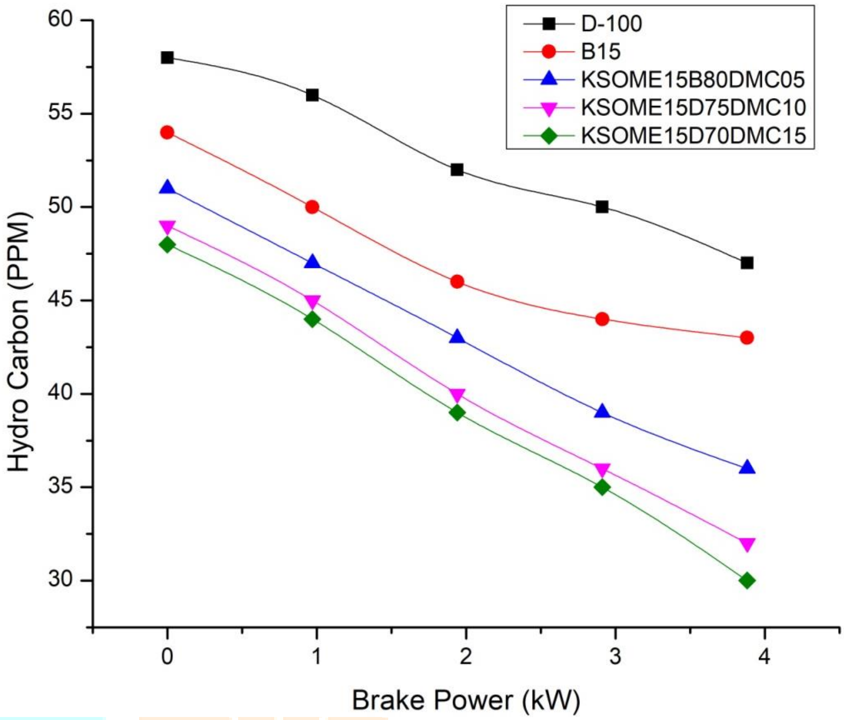

Figure 7. Variation of HC emission with Brake Power Using DMC Blends

4.6.4 Carbon Dioxide Emissions

The variation of CO_2 emission with brake power is shown in Fig 8. The plot it is observed that the CO_2 emission increased with increase in load for all blends. The lower percentage of KSOME blends emits less amount of CO_2 in comparison with diesel. DMC blends emits very low emissions. Using higher content TSOME blends, an increase in CO_2 emission was noted, which is due to the high amount of oxygen in the specified fuel blends which converting CO emissions into CO_2 emission contents.

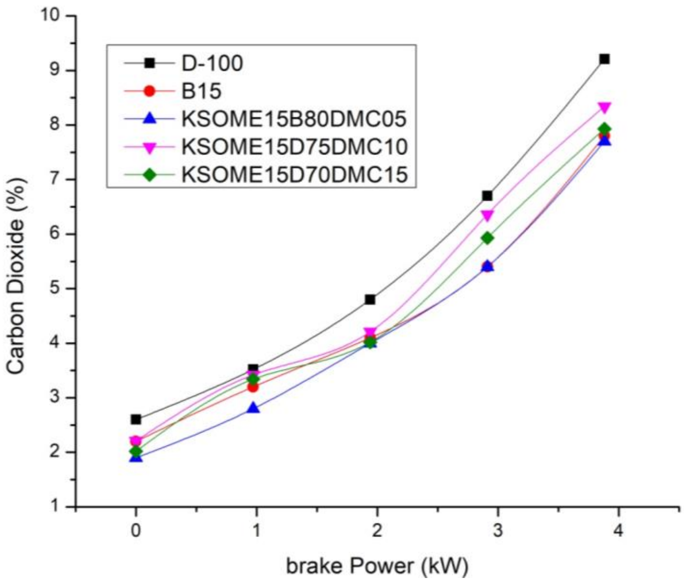

Figure 8. Variation of CO_2 with Brake Power Using DMC Blends

4.6.5 Smoke opacity

The variation of smoke opacity with brake power is shown in Fig.9. The plot it is observed that the smoke is nothing but a solid soot particles suspended in exhaust gas. Various loads for different blends like KSOME15, KSOME15D80DMC5%, KSOME15D75DMC10% and KSOME15D70DMC15% tested fuels. The results obtained as 68.26%, 61.4% for diesel and KSOME15, for DMC blends as 59.03%, 57.95% and 55.54% respectively. It is observed that smoke is lower for DMC Blends compared to the diesel and kSOME15 blend.

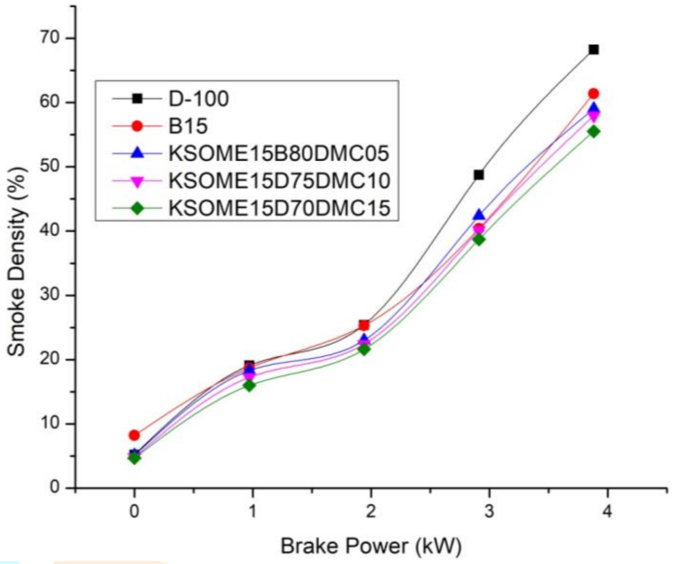

Figure 9. Variation of Smoke opacity with Brake Power Using DMC Blends

4.6.6 Un used oxygen

The variation of O_2 emission with brake power is shown in Fig.10. From the plot it is observed that at full load conditions the O_2 emission obtained as 7.85%, 7.73% for diesel, KSOME15 blend, for DMC blends of 5%,10% and 15% concentrations are 7.56%, 7.6% and 7.99% respectively. The increment of unused oxygen due to CO emission is not converted into CO_2 by using available O_2 because of the high viscosity of KSOME.

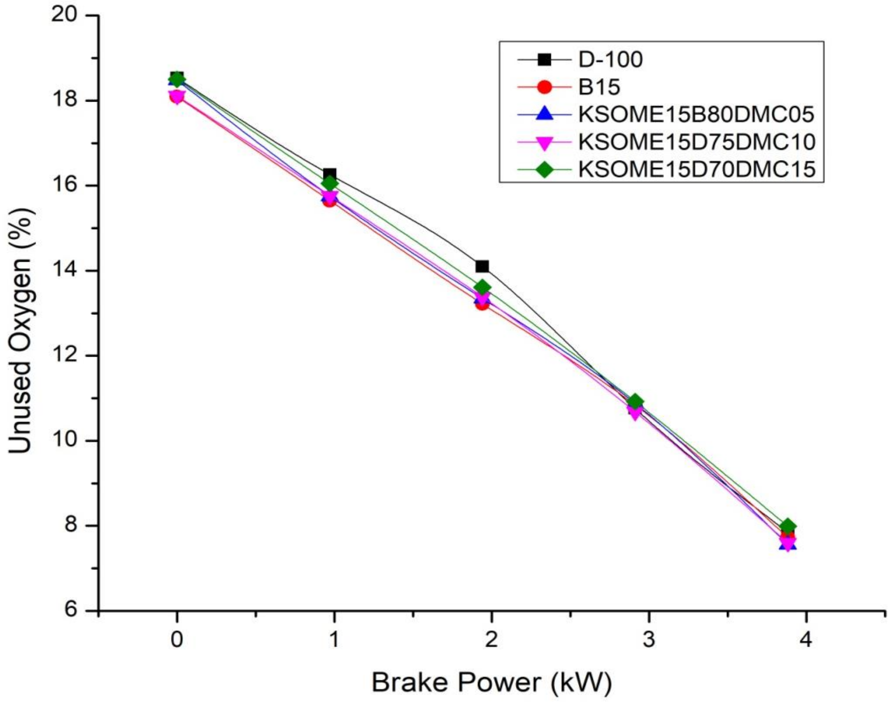

Figure 10. Variation O_2 emissions with Brake Power Using DMC Blends

V. CONCLUSION

- The maximum brake thermal efficiency for KSOME15D75DMC10% (35.26%) was higher than that of KSOME15 and nearer to diesel. The brake thermal efficiency increased in 2.67%, negligible decrease when compared with KSOME15 and diesel.
- Brake specific fuel consumption is decreases in blended fuels with added fuel additive. In KSOME15D75DMC10% fuel the BSFC is 2.4% lower than the KSOME15 and 1.6% higher than diesel.
- Significant reductions were obtained in unburned hydrocarbons emissions with KSOME15D75DMC10% blend compared with KSOME15 and diesel at maximum load of the engine.
- The significant decrease in CO_2 emissions were obtained with In KSOME15D75DMC10 as compared with diesel. The marginal decreases in smoke opacities compared with KSOME15.
- Maximum reduction in CO emissions with in KSOME15D75DMC10% was obtained compared with KSOME15 and diesel.

REFERENCES

[1]. A.Veeresh babu, B.V.Appa rao, and p. Ravi kumar 'Transesterification for the preparation of biodiesel from crude oil of pongamia pinnata". Journal of thermal science: vol.13 (2009), no.3,pp 201-206.

[2]. Ram Prakash, S.P Pandey, S.Chatterji, S.N. Singh "Emission analysis of CI engine using rice bran oil and their esters "Journal of engineering research and studies E-ISSN 0976-7916.

[3]. S SRagita, S K Mohapatra and K Kundu, "Comparative study of engine performance and exhaust emission characteristics of a single cylinder 4-stroke CI engine operated on the esters of hemp oil and neem oil." Indian Journal of Engineering & Materials Sciences Vol. 18, June 2011, pp. 204-210.

[4]. SharanappaGodiganur "Performance and Emission Characteristics of a Kirloskar HA394 Diesel Engine Operated on Mahua Oil Mmethyl Ester" Thammasat Int. J. Sc. Tech., Vol. 15, No. 3, July-September 2010.

[5]. S. Jindal. "Effect of engine parameters on NOx emissions with Jatropha biodiesel as fuel", International Journal of energy and environment, Volume 1, Issue 2, 2010 pp.343-350.

[6]. Vern Hofman and Elton Solseng "Biodiesel Fuel Use in an Unmodified Diesel Engine". An ASAE /CSAE Meeting Presentation, Paper No: MBSK 02-109.

[7]. S.Jaichandar and K.Annamalai, "The Status of Biodiesel as an Alternative Fuel for Diesel Engine –An Overview" Journal of Sustainable Energy & Environment 2 (2011) pages no: 71-75.

[8]. Dutra, Teixeira, Colaco, Alves, Caldeira and Leiroz, "Comparative Analysis of Performance and Emissions of an Engine Operating with Palm Oil methyl and Methyl esters and Their Blends with Diesel", 20th International congress of Mechanical Engineering, Gramado, RS, Brazil November 15-20, 2009.

[9]. Mushatq Ahmad, Shoaib Ahmed, Fayyaz-Ui-Hassan ,Muhammad Arshad,MirAjab Khan, Muhammad Zafar and Shazia Sultana, "Base Catalyzed Transesterfication of Sunflower Oil Biodiesel" African Journal of Biotechnology Vol.9(50), 13 December ,2010 pp. 8630-8635.