IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 16, Issue 6 Ser. I (Nov. - Dec. 2019), PP 24-31
www.iosrjournals.org

Performance of CI Engine on Particulate Matter Palm Biodiesel Is Blended To Diesel in Different Proportion- A Review

Vinay Malviya[1], Dr. Ajay Singh[2], Prof. Nitin Barodia[3]

[1.] *Research Scholar, Department of Mechanical Engineering, Radharaman Institute of Technology &science, Bhopal(M.P.)*

[2.] *Prof.& Head, Department of Mechanical Engineering, Radharaman Institute of Technology &science, Bhopal(M.P.)*

[3.] *Asst. Prof, Department of Mechanical Engineering, Radharaman Institute of Technology &science, Bhopal(M.P.)*

Corresponding Author: Vinay Malviya

Abstract: *This paper deals with performance and emission charaterstics of palm oil blended biodiesel in different proportion as fuel for four stroke single cylinder CI engine. The engine performance parameter like specific fuel consumption and brake thermal efficiency were investigated. Also engine emissions of CO_2, CO, HC and NO_x were analyzed and discussed. All experiments were carried out for different proportion biodiesel that was P0, P10, P20, P30 and P40 at various brake power. The results reveals that brake thermal efficiency and specific fuel consumption for P10 blend is comparatively equal to diesel fuel. Maximum brake thermal efficiency of 35.42% was achieved for P10 blend. It was observed that higher CO_2, CO, HC and NO_x produced all biodiesel blends as compared to diesel fuel. This might be due to the higher oxygen content in the biodiesel structure and also higher exhaust temperature during combustion which promotes the formation of more hazardous gas. Furthermore, P10 blend emissions are slightly higher than diesel.*

Date of Submission: 24-10-2019 Date of Acceptance: 09-11-2019

I. Introduction

The continuously increase in energy demand with economic and environmental consequences call for effective energy governance in India. In the progress of the world's societies and future of earth, availability of energy resource plays a critical role [1]. The human energy needs are currently fulfilled by petro-chemical sources, coal and natural gases, but these fossil fuels are continuously depleting and have damaging effect on environment. Energy consumption of world-wide has increased by 3-4 times in the last century. Power availability in India has increased and upgraded but demand was still more than the supply. Diesel fuel produces about 35000 MW of power to overcome the energy shortage [2]. Shortage of electricity is a serious issue. Electricity generation is subjected to expensive power plant. Social, environmental and technological benefits are the some of the criteria for the selection of energy source [3]. A large degree of caution is also needed for struggling country like India which may not have financial assets to jump directly to renewable source of energy. Global warming is a major phenomenon and there is an urgent requirement for the transfer of technology from non-renewable energy to renewable energy sources [4].

The vegetable oil was used as a fuel around 100 years ago by the inventor of diesel engine Rudolph Diesel. Rudolph Diesel used peanut oil in his CI engine. After exploration of fossil fuels they were continued to be major conventional energy source. With the increasing trend of industrialization and modernization the world energy demand are also increasing at a faster rate. Most of the countries import crude oil to fulfil their energy demands. Also these fossil fuels are dominant sources of carbon monoxide (CO), carbon dioxide (CO2), sulphur oxides (SOx) [5].

Biomass is a potential source for alternative ecofriendly fuel. Biomass is a general term for energy derived from plant and animal material through variety of conversion. There are plants that produce oil and hydrocarbon substance as part of natural metabolism. The use of vegetable oils directly in an engine is considered impractical because these oils contain free fatty acids (FFA), phospholipids, sterols and other impurities. This vegetable oil is converted into biodiesel by the process of esterification. Esterification is a reaction involving FFA and alcohol which yields fatty acid alkyl ester and water [6].

II. Literature Survey

Rubiat Mustak et al. [7] A lot of experimentation has been done to identify a good source of alternative. The existing studies have discovered that vegetable oils can be a good substitute for diesel fuel. But using vegetable oils directly in an engine is not feasible due to their high viscosity and low volatility. As a result blends of vegetable oils are used in engines as an alternative of diesel. . The effect of blending palm oil and kerosene alone with diesel is compared with the effect of blending palm oil and kerosene together with diesel. In order to compare the effects various fuel properties were measured. This study mainly concentrate on lower heating value (LHV) or lower calorific value (LCV) and density for various comparison purposes. Investigating the Effect of Blending Kerosene and Palm Oil with Diesel Fuel 2018.

Allen Jeffrey et al. [8] Effectiveness of Palm Oil Biodiesel on Performance and Emission Characteristics in a Compression Ignition Engine2017. As global warming and climate change issues are defying modern society sustainable development; biofuels, biodiesel included, are among promising solutions. Biodiesel is generally produced from renewable vegetable oils and animal fats via acid or base catalyzed transesterification. . The blends of palm bio diesel used in the test were B0(pure diesel), B15, B25. The engine performance was calculated through torque, power, and specific fuel consumption, while the emission were calculated through carbon monoxide (CO), hydrocarbon (HC), carbon dioxide (CO2), and oxides of nitrogen (NOx) pollutants. The result shows that higher content of palm biodiesel can reduce the emission of CO, HC, PM, and CO2. The optimal reaction conditions during esterification are ：2.3% weight of catalyst，reaction time of 120 min and a reaction temperature of 60℃. Under these conditions, a 85% yield of biodiesel was obtained.

N. Saifuddin et al. [9] Biodiesel is receiving increasing attention as an alternative fuel due to the ever-growing demand for energy,the biodiesel-diesel– bioethanol blends might be a good option. In this paper, the research work was carried out to study experimentally the performance and exhaust emission characteristics of a 25kW micro gas turbine engine (Capstone Model C30) fuelled with biodiesel-dieselbioethanol blends 2017. except nitrogen oxides (NOx) which contributed to the higher formation in comparison with the distillate diesel. Finally, B80E20 (80:20 of biodiesel-bioethanol) was proposed to be selected as an ideal blended fuel ratio to be applied in micro gas turbine engine due to its adaptability to replace diesel fuel, while showed better performance and emission properties as compared to the pure petroleum diesel.

Kiran Raj Bukkarapu et al. [10] Palm biodiesel is blended to diesel in different volume percentages to improve certain properties. This would help in having a good understanding of the dependence of the diesel properties on the biodiesel proportion. The properties of interest in the present work are density, kinematic viscosity, flash point and fire point of the blends which are determined and compared to petrodiesel 2017. Blends with higher palm content possess higher flash point and fire point. Apparently, blending worsens the conditions and hence might be of no use when compared to diesel, but when compared to neat palm biodiesel, blending helped in pulling down the density, viscosity, fire point and flash point of the latter.

Neeraj Goreya et al. [11] These sources include the various fossil fuels like the petroleum, coal and the natural gas. The burning of fossil fuels led to the production of the greenhouse gases increasing the levels of C02 in the atmosphere. The adverse effects are the global warming and the ozone layer depletion 2017. The exhaust emission characteristics of Tung biodiesel blends Bl0, B50 and B100 were compared with diesel. Based on the results of the present work, following conclusion was drawn. The optimum conditions for maximum yield of biodiesel production were obtained at a molar ratio of 5:1, reaction time 60 minutes and l.5% KOH concentration. A maximum yield of 94% was determined. The flash and fire point of Palm seed biodiesel were determined to be 1800C and 1940C respectively which are higher than diesel fuel. The optimum conditions for maximum yield of biodiesel production were obtained at a molar ratio of 5:1, reaction time 60 minutes and l.5% KOH concentration. A maximum yield of 94% was determined.

Jalal Ghazanfari et al. [12] Biodiesel is a biodegradable fuel contains fatty acid methyl or ethyl esters which are typically produced by the transesterification reaction among the triglycerides in the vegetable oils or animal fats and an alcohol such as methanol or ethanol. There are many resources of biodiesel production. In present study it was selected the palm oil to produce the ethyl ester biodiesel and the limiting factors for the use of palm oil biodiesel in a diesel engine in the context of the ASTM standards were discussed. The best efficiency is observed in range of 50–100% of engine load and the best efficiency is in range of B10–B40. Generally, by considering three parameters of engine power, BSFC and engine efficiency the B10 fuel of palm biodiesel offers the best performance, therefore it can be the recommended fuel for this study. . In present study, biodiesel was produce through transesterification process from palm oil and then the produced biodiesel was blended with diesel in different ratios (10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 vol.%). The properties of fuel samples were measured by ASTM standard. The results indicated that the thermophysical properties of palm biodiesel (Density, viscosity, cloud point and flash point) covers the ASTM standards 2017.

Azimah, R et al. [13] The aim of this study was to determine hydrolytic stability [acid value (AV)] and oxidative stability [peroxide value (PV) and conjugated dienes (CD)] of selected blended oils during potato frying. The blended oils were prepared by blending palm oil with corn oil (POCO), sesame oil (POSO) and rice bran oil (PORBO). Blended vegetable oils were prepared in a ratio of 1 to 1 (v/v) and tested for 0, 10 and 20 times after frying potato. AV and PV were determined by titration method, while CD was determined using the spectrophotometric method. Increasing frequency of oil frying contributed to increased level of AV in all blended oils. PVs were increased in all samples, with most noticeable increment observed in POSO, followed by PORBO and POCO 2017.

1. Experimental Procedure

The tests were conducted on a single cylinder four-stroke naturally aspirated water cooled diesel engine loaded with a rope brake dynamometer. The technical specification of the engine used for the investigation are given in table 3.1

1.1 Test Setup Specification

A single cylinder 4-stroke water-cooled direct injection diesel engine is used for investigation.

Table 3.1 Engine Specification

Engine parameter	Specifications
Engine	4-Stroke Single cylinder (Diesel Engine)
Rated Power	5 BHP
Speed	1500 rpm
Bore	87.5 mm
Stroke	110 mm
Volume	661 cc
Nozzle Type	Single hole
Cooling system	Water cooled

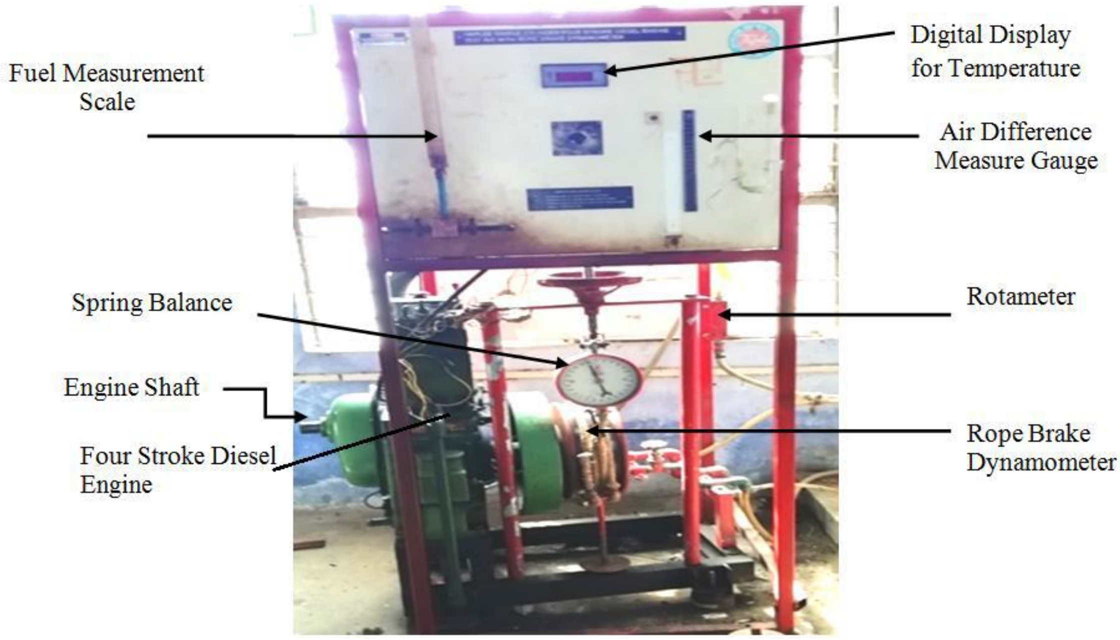

Fig.2 Actual view of experimental setup

The actual view of experimental setup is shown in Fig.2. The setup consists of single cylinder engine coupled with rope brake dynamometer. The dynamometer is used to load and unload the engine as per experiment requirement. In order to measure revolution of the engine shaft a sensor is coupled with the shaft to count the rpm of the shaft, and for measuring various exhaust the test engine is connected with a exhaust sensor. A sensor is coupled with the exhaust pipe outlet to sense various contents of exhaust gas and sent the result to CPU which in turn shows the results on the monitor screen. For cooling external jacket of the engine is coupled with water source. And the fuel tank is coupled with engine to supply the fuel to the cylinder. Experiments were conducted with palm oil and diesel blends having 0%, 10%, 20%, 30% and 40% palm oil on volume basis at different load levels. Tests of engine performance on pure diesel were also conducted as a basis for comparison. The percentage of blend and load, were varied and engine performance measurements such as brake specific fuel consumption, air flow rate, and emissions were measured to evaluate and compute the behavior of the diesel engine. Each time the engine was run at least for few minutes to attain steady state before the measurements were made. The experiments were repeated thrice and the average values were taken for performance and emission measurements.

III. Results and Discussions

The experiment was conducted on five types of palm oil blending ratio (palm oil blended with diesel) that are P0, P10, P20, P30 and P40 tested on diesel engine. The experiment was carried at Internal Combustion Engine Laboratory of Radharaman Institute of Technology & Science, Bhopal.

The parameters that have been tested for comparing five types of palm oil blending ratio are performance and emission tests. For the performance test, the terms that were considered are specific fuel consumption and brake thermal efficiency at different load. Also, for the emission test carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbon (HC) & oxides of nitrogen emission (NO_x) were considered at different load. The performance and emissions test for the five types of fuel were analysed and results obtained are graphically presented.

4.1. Variation of specific fuel consumption and brake power for different blending ratios The **v**ariation of specific fuel consumption of the engine for different blending ratios i.e. P0, P10, P20, P30 & P40 is shown in Fig. 4.1

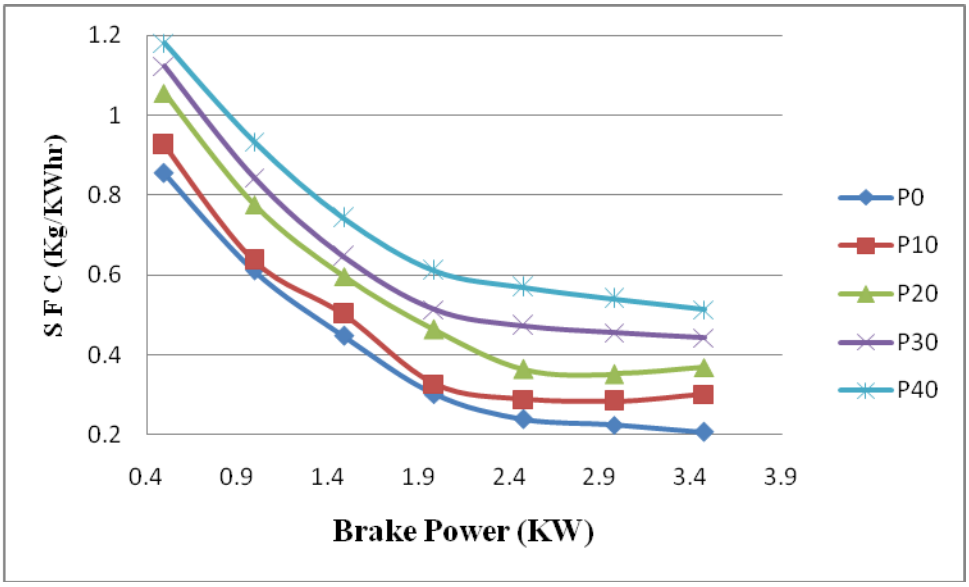

Fig. 4.1 Variation of specific fuel consumption and brake power for different blending ratios

It shows that the specific fuel consumption decreased with increase in brake power for different blending ratios. It was also observed that specific fuel consumption is slightly higher than diesel for different blending ratio.

It is found that the specific fuel consumption for the P10 blend is close to diesel. This is because of the combined effects of lower heating value, viscosity and the higher fuel flow rate due to high density of the blends. A higher proportion of Palm oil in the blends increases the viscosity which in turn increased the specific fuel consumption due to poor atomization of the fuel [14].

4.2 Variation of brake thermal efficiency and brake power for different blending ratios

The variation of brake thermal efficiency and brake power for different blending ratios i.e. P0, P10, P20, P30 & P40 is shown in Fig. 4.2

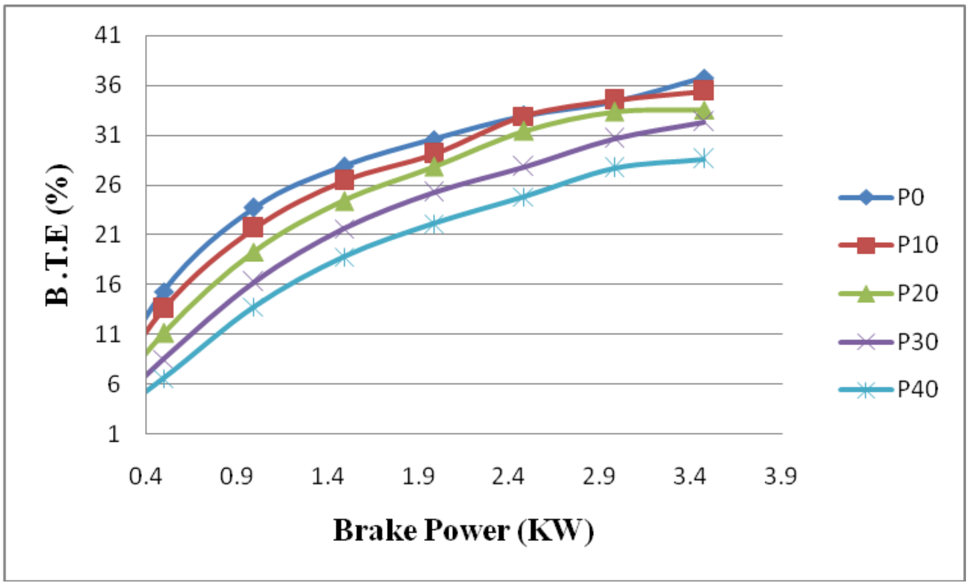

Fig. 4.2 Variation of brake thermal efficiency and brake power for different blending ratios

From the experimental investigation it was observed that brake thermal efficiency increased with increase in brake power. Also, it was found that brake thermal efficiency has decreased as the blending ratio increased.

It was observed that brake thermal efficiencies of all the blends were found to be lower at all load levels. Among the blends P10 is found to have the maximum thermal efficiency of 35.42% at a brake power of 3.4 kW which is very close to diesel. It was observed that as the proportion of Palm oil in the blends increases the thermal efficiency decreases. The decrease in brake thermal efficiency with increase in Palm oil concentration is due to the higher density of blends and has led to more discharge of fuel for the same displacement of the plunger in the fuel injection of pump and higher viscosity [15].

4.3 Variation of carbon dioxide and brake power for different blending ratios

The **v**ariation of carbon dioxide and brake power for different blending ratios i.e. P0, P10, P20, P30 & P40 is shown in Fig.4.3

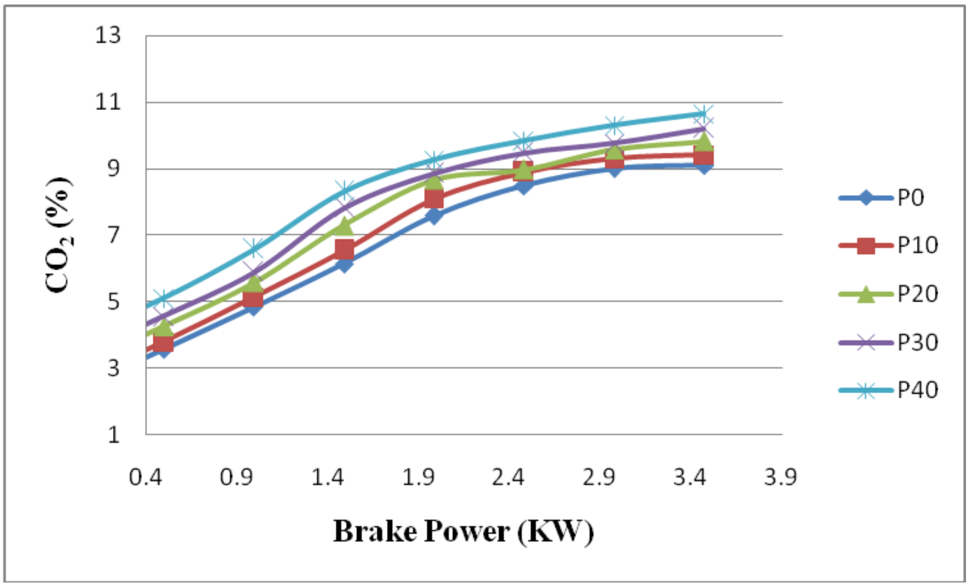

Fig. 4.3 Variation of carbon dioxide and brake power for different blending ratios

Test measurements reveal that the CO_2 emission for all blends were higher as compared to diesel at all loads. The rising trend of CO_2 emission with load is due to the higher fuel entry as the load increases. The increasing of CO_2 emission with load is might be due to the higher fuel consumption of biodiesel blended and due to the excess presence of oxygen in biodiesel molecular structure [16].

It was also found that CO_2 emission for P10 blend is very close to diesel.

4.4 Variation of carbon monoxide and brake power for different blending ratios

The variation of carbon monoxide and brake power for different blending ratios i.e. P0, P10, P20, P30 & P40 is shown in Fig. 4.4

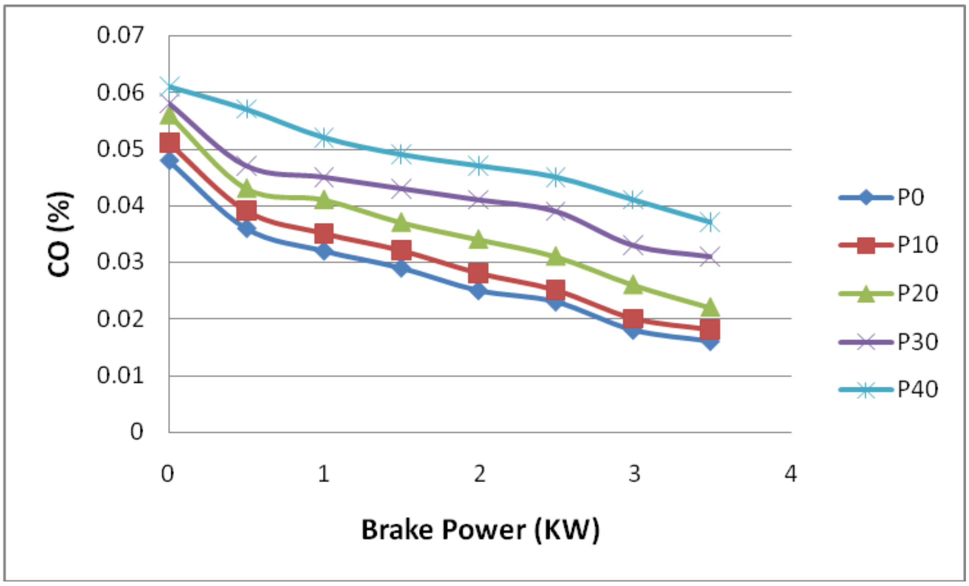

Fig. 4.4 Variation of carbon monoxide and brake power for different blending ratios

It was observed that the engine emits more CO for different blending ratio at part load conditions when compared to the diesel. This is due to the excess fuel of biodiesel blend required led to formation of more smoke and when there is insufficient oxygen to fully burn all the carbon into CO_2 [17].

4.5 Variation of Hydro carbon and brake power for different blending ratios

The variation of hydro carbon and brake power for different blending ratios i.e. P0, P10, P20, P30 & P40 is shown in Fig. 4.5

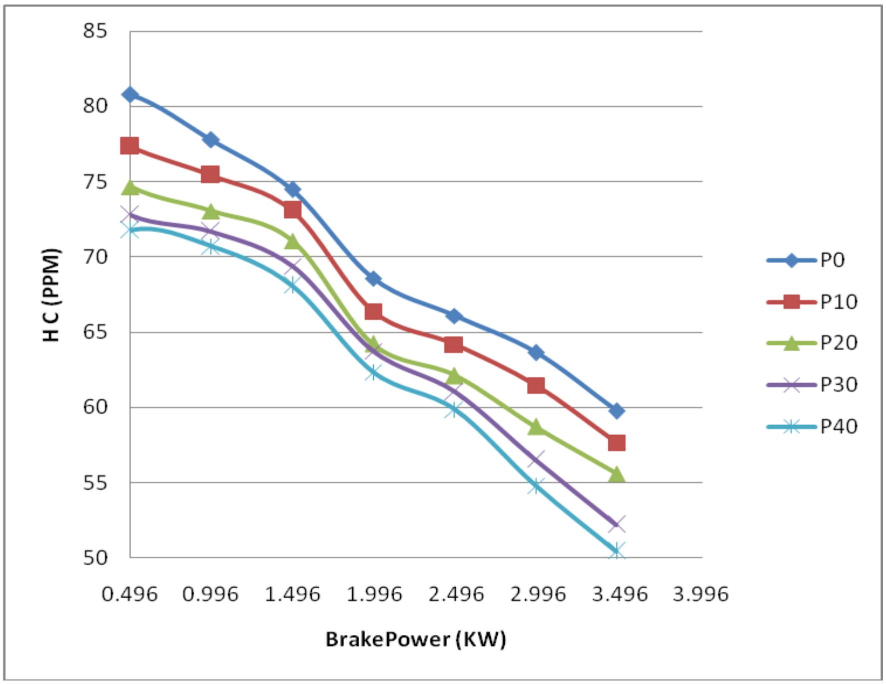

Fig. 4.5 Variation of hydro carbon and brake power for different blending ratios

It shows that HC emission decreases with increase in brake power. The HC emission for the blends also followed a similar trend but comparatively the values were lower. The presence of oxygen in the Palm oil aids combustion and hence the hydrocarbon emission reduced. However at higher loads the effects of viscosity have increased these emission levels for the blends.

4.6 Variation of oxides of nitrogen and brake power for different blending ratios

The **v**ariation of oxides of nitrogen and brake power for different blending ratios i.e. P0, P10, P20, P30 & P40 is shown in Fig. 4.6

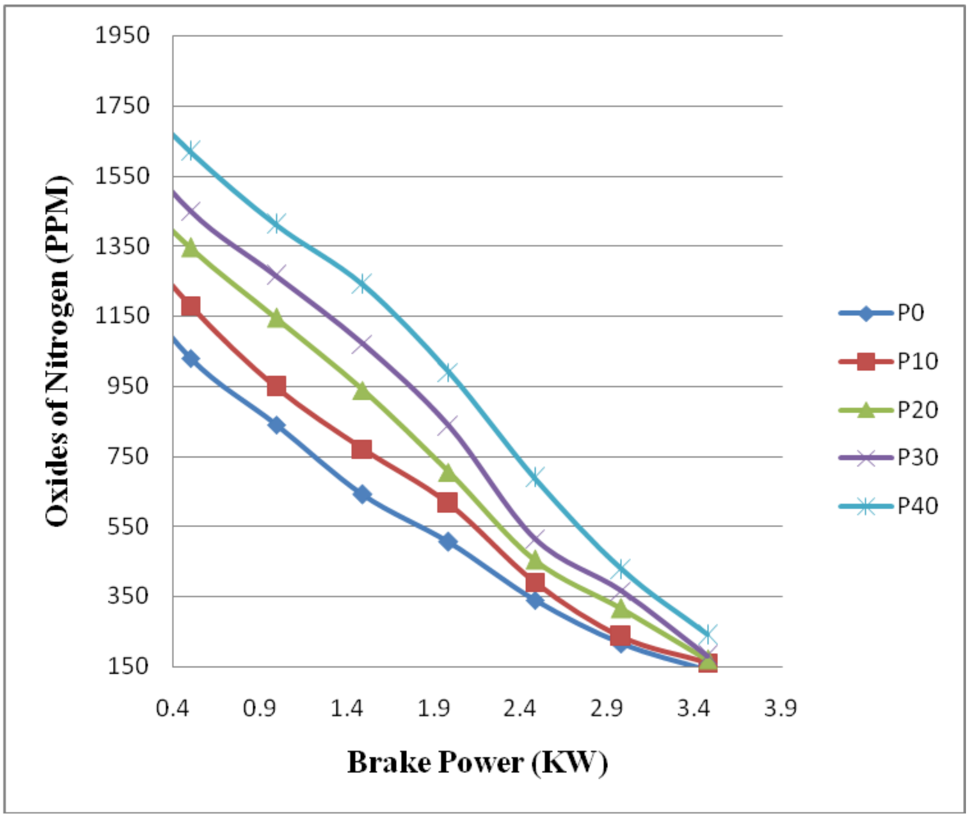

Fig. 4.6 Variation of oxides of nitrogen and brake power for different blending ratios

It shows that NO_x emission for diesel and all the biodiesel blends decreases with increase in brake power. However, it was found that higher NO_x was emitted by all biodiesel blend as compared diesel. It is caused by the higher oxygen content in the biodiesel structure and also higher exhaust temperature during combustion which promotes the formation of NO_x [18].

IV. Conclusion

1. The specific fuel consumption is closer to diesel for P10 among all blends. Blends up to 10% substantially increase CO_2 emission with a marginal decrease in brake thermal efficiency.
2. The exhaust gas temperature for P10 is higher than pure diesel, which in turn increased the NO_x emission
3. A maximum brake thermal efficiency of 35.42% was achieved for P10 while for diesel it was 36.76% for the same power output. An experimental investigation shows that blending of palm oil up to 10% with diesel for use in an unmodified diesel engine is viable.
4. Palm oil biodiesel produced from renewable biomass resources are easily available in market.
5. Experimental investigation also reveals that the emission produced by biodiesel bend is higher than diesel fuel due to higher oxygen content in the biodiesel structure. But emissions for P10 blend are much closer to diesel fuel.
6. From the findings it can be concluded that we can sustain for the energy requirement for a longer period of time by using the blending of palm oil biodiesel with pure diesel without much affecting the performance and exhaust emission characteristics

References

[1]. Monyem A., Gerpen J.H.V. “Biomass and Bioenergy”, Volume 20, pp. 317–325, 2001
[2]. Tormos B., Novella R., Garcia A., Gargar K. “Renewable Energy”, Volume 35, pp. 368–378 2010
[3]. Nurun Md., Rahman Md., Akhter Md., “Applied Thermal Engineering”, Volume 29, pp. 2265 -2270, 2009
[4]. Lapuerta M., Armas O., Fernandez F., “Progress in Energy and Combustion Science”, Volume 34, pp. 198-202, 2011
[5]. Lin CY, Lin CA., “Diesel engine performance and emission characteristics of biodiesel produced by preoxidation process”, Fuel, Volume 85, pp. 298-305, 2006
[6]. Vincete G, Martinez M, Aracil J., “A comparison of different homogeneous catalyst systems”, Bioresour Technol, Volume 92, pp. 297-305, 2004
[7]. Rubiat Mustak, Tanjim Ahmed “Investigating the Effect of Blending Kerosene and Palm Oil with Diesel Fuel” International Journal of Scientific & Engineering Research Volume 9, Issue 2, pp. 1271-1276 February-2018 .
[8]. Allen Jeffrey.J “Effectiveness of Palm Oil Biodiesel on Performance and Emission Characteristics in a Compression Ignition Engine” International Journal of Science, Engineering and Technology Research (IJSETR) Volume 6, Issue 4,pp. 546-550 April 2017.
[9]. N. Saifuddin, H. Refal1 and P. Kumaran “Performance and emission characteristics of micro gas turbine engine fuelled with bioethanol-diesel-biodiesel blends” International Journal of Automotive and Mechanical Engineering. Volume 14, Issue 1 pp. 4030-4049 March 2017 .
[10]. Kiran Raj Bukkarapu “Effects of blending on the properties of diesel and palm biodiesel” IOP Conf. Series: Materials Science and Engineering 330 (2018).
[11]. Neeraj Gorey “Characterization of Palm Oil as Biodiesel” IOP Conf. Series: Materials Science and Engineering 225 (2017).
[12]. Jalal Ghazanfari “Limiting factors for the use of palm oil biodiesel in a diesel engine” Ghazanfari et al., Cogent Engineering pp. 1-16 (2017).
[13]. Azimah, R. “Stability of blended palm oils during potato frying” International Food Research Journal (October 2017)volume 24, pp. 2122-2127
[14]. Ameya Vilas Malvade, Sanjay T Satpute “Production of Palm fatty acid distillate biodiesel and effects of its blends on performance of single cylinder diesel engine” Elsevier Procedia Engineering 64, pp. 1485 – 1494, 2013
[15]. Syarifah Yunus, Amirul Abd Rashid, Nik Rosli Abdullah, Rizalman Mamat, Syazuan Abdul Latip “Emissions Of Transesterification Jatropha-Palm Blended Biodiesel”, Procedia Engineering 68, pp. 265 – 270, 2013
[16]. A. M. Liaquat, M. A. Kalam, H. H. Masjuki, and A. Rezza, "An experimental study on exhaust emissions of a diesel engine using jatropha oil and palmdiesel with diesel fuel", Sci.Int(Lahore), pp. 245-249, 2010.
[17]. S. Jain and M. P. Sharma, "Study of oxidation stability of Jatropha curcas biodiesel/ diesel blends", Energy and Environment, vol. 2, pp. 533-542, 2011.
[18]. M. Lapuerta, O. Armas, and J. Rodriguez fernandez, "Effect of biodiesel fuels on diesel engine emissions," Progress in Energy and Combustion Science, vol. 34, pp. 198-223, 2008.

Vinay Malviya. “Performance of CI Engine on Particulate Matter Palm Biodiesel Is Blended To Diesel in Different Proportion- A Review.” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 16, no. 6, 2019, pp. 24-31