Performance Analysis of Diesel Engine using Moringa Oil Methyl Ester with Fumigation Technique

R.Pradeepraj, K.Rajan

Abstract: ***The paper investigated the effect of 1-hexanol fumigation in an engine performance using Moringa biodiesel blend. In this research, the biodiesel used is processed from Moringa Olifera seed. In this research tests were performed with the modification of a CI engine to carburet the hexanol into the intake manifold. Initially the experiment was conducted with diesel and Moringa biodiesel (MOME25), and then the test was conducted with various proportions of fumigated hexanol along with MOBD25. Results revealed that, the BTE was increased by 1.08% for MOBD25 with 10% n-hexanol fumigation compared with other diesel and other proportions of fumigations with MOBD25 blend. The NOx emission and smoke were diminished by 36% and 38% respectively for MOBD25 with 30% n-hexanol fumigation. It is concluded that 30% n-hexanol fumigation with MOBD25 blend drastically reduce the NOx emissions with the penalty of BTE.***

Keywords: ***Diesel Engine, Emissions, Fumigation, Moringa Olifera biodiesel, n-hexanol, performance.***

I. INTRODUCTION

Now a day's automotive vehicles running with diesel fuel remains a cause of major air pollution in all over the world. Due to increase in fuel prices, increase in demand of petroleum based fuel and strict emissions norms to search an alternative to diesel fuel such as alcohols and biodiesel. Bio diesel has more attractive due to it would be biodegradable, non-toxic and it could provide a viable alternative to diesel fossil fuel [1]. Vegetable oil used in diesel engine has certain disadvantages such as carbon deposit and gum formation [2] and it is overcome by trans-esterification of vegetable oil and preheating of the fuels to reduce the HC, CO and smoke emissions [3]. Several studies showed biodiesel can be used as fuel for engines. Lakshminarayana Rao et al. [4] examined the engine performance with blends of rice bran oil biodiesel and reported that all emissions were lowered except NOx. Ranganathan and Sampath [5] examined the cottonseed biodiesel in a diesel engine. The performance of a engine fueled with the blends of RSO were studied by the researchers [6] and found that it produces lower smoke emissions with the expense of fuel consumption.

Revised Manuscript Received on January 30, 2020.
***** Correspondence Author
K.Rajan*, Dr.M.G.R. Educational and Research Institute, Chennai, India.. Email: krajanmech@gmail.com.
R.Pradeepraj, Research Scholar/Mechanical, Dr.M.G.R. Educational and Research Institute, Chennai, India.. Email: drkr2k11@gmail.com.

Mixtures of waste cooking oil, rapeseed oil showed lower emissions and no change in cylinder pressure for neat biodiesel and its blends [7].
Corn oil exhibited a small increase of NOx emissions and decrease in other emissions when compared to diesel [8]. Saravanan et al [9] examined the Mahua biodiesel blends in engines.
Pradeepraj and Rajan [10] tested the engine using Moringa Olifera biodiesel blend
using of different injection pressures. Rajan et al. [11] have examined the engine with yellow oleander biodiesel with different injection pressures. Results revealed that lowered all emissions except the NOx for higher injection pressures. Quadaris et al.[13] conducted the research on CI engine using fumigated ethanol blends and reported that soot concentration was lowered by using 20% ethanol fumigation. Senthil Kumar and Rajan [14] examined the effect of RSME25with Diethyl carbonate (DMC) fumigation. It was found that CO and HC were decreased with 30% DMC fumigation and NOx and smoke opacity were lowered for RSME25. The objective of the research is to investigate the working characteristics of fumigated n-hexanol with MOME25 in engines.

II. PREPARATION OF MORINGA OLIFERA BIODIESEL

The method of translating high viscous oil into monoester is called transesterification. In this process, one litre of Moringa Olifera oil (MO) is heated in a flask and mixed with alcohol and KOH catalyst. This mixture is heated at constant reaction temperature of 65°C and stirred under constant speed. The mono ester is separated as an upper layer after eight hours of settling period, and glycerol settles down and is separated by decantation. In order to remove impurities, the monoester is washed with distilled water. The properties of diesel, Moringa Olifera oil biodiesel are given in Table.1.

Table I: Properties of test fuels

Properties	Diesel	MOME
Density (kg/m^3)	830	880
K.Viscosity (cSt)	3.9	5.18
Calorific value (MJ/kg)	43	36.4
Flash point (°C)	50	70
Cetane Number	48	52
Oxygen (%)	-	11

III. ENGINE SETUP

Table II: Specifications of the engine

Engine	Kirloskar, Vertical
Rated power	5.2 kW
Bore x Stroke	87.5mmx110mm
C.ratio	17.5:1
Capacity (cc)	661
Nozzle pressure	200bar
Injection timing	23^{o}bTDC

Kirloskar diesel engine with eddy current dynamometer was used to conduct the experiments. The test engine details are given in Tab. 1. The engine was modified to introduce the hexanol into the intake manifold by means of an electronic fuel injector. The gas and inlet and outlet water temperature was measured using K-type thermocouple. Tail pipe emissions and smoke measured by gas analyzer and smoke meter.

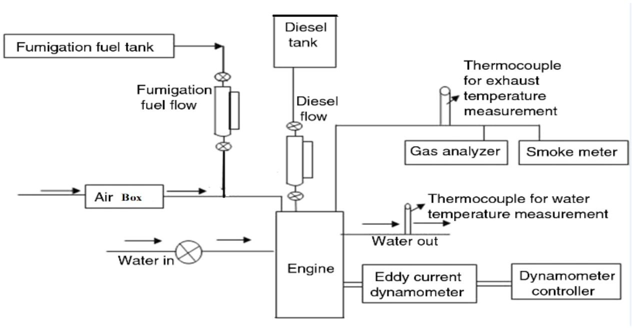

Figure 1 Test engine setup

IV. RESULTS AND DISCUSSION

Initially the engine is tested with diesel and MOME25 blend and then test was conducted with MOME25 at different proportion of fumigated hexanol like 10%, 20% and 30% proportions. All the performance end emission readings were recorded after the engine attained the warm up conditions.

The curve is plotted between BTE and BP for all fuels is represented in Fig. 2. There is an increase in BTE (29.1%) was observed for MOME25 with 10% fumigated hexanol which is due to the homogeneous mixture of hexanol and biodiesel are formed resulting in better combustion. At full load, the lower BTE was observed with 20% and 30% fumigated hexanol. The lower BTE with 20% and 30% fumigated hexanol may be due to non homogeneous air/hexanol mixture and high latent heat of the hexanol mixtures (Bhupendra Singh et al. 2011).

Fig. 3 depicts the BSEC variations with BP for the test fuels. BSEC decreases with an increase in fumigated hexanol with MOME25. The lowest BSEC observed for 10% fumigated hexanol which is 10.2MJ/kWh for other proportions the BSEC were increased which is attributed to lower energy content and high LHV of hexanol leads to higher fuel requirement the same power output (Cheng et al. 2008).

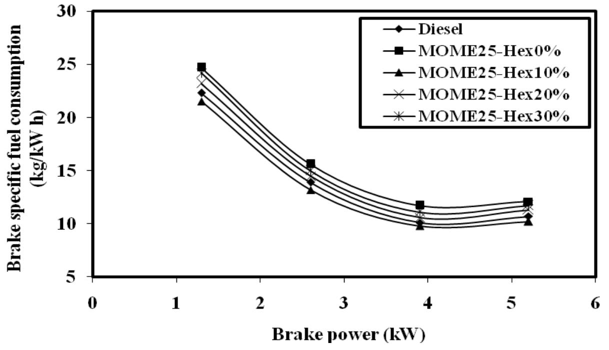

Fig 3. Graph for BSEC variations with BP

Fig. 4 illustrated the EGT variations with BP for the test fuels. The EGT for MOME25 with n-hexanol fumigations decreases at all loads due to the higher latent heat of hexanol. The EGT of MOME25 with 10%, 20% and 30% of fumigation of n-hexanol is 425^{o}C, 402^{o}C and 386^{o}C respectively, and for diesel and MOME25 is 439^{o}C and 456^{o}C respectively, because of its high LHV of n-hexanol resulting in lower EGT.

The CO variations against BP for all the fuels are presented in Figure 5. It is noticed that there is a biodiesel had lower CO emissions due to excess O_2 content in biodiesel. At full load, CO emission of MOME25 with 10%, 20% and 30% fumigated hexanol is 0.17%, 0.19% and 0.21% respectively, and for diesel and MOME25 is 0.162% and 0.121% respectively. The increases in CO may be attributed to the high evaporation characteristics of n-hexanol which cools the charge at full load (Senthil Kumar and Rajan, 2019).

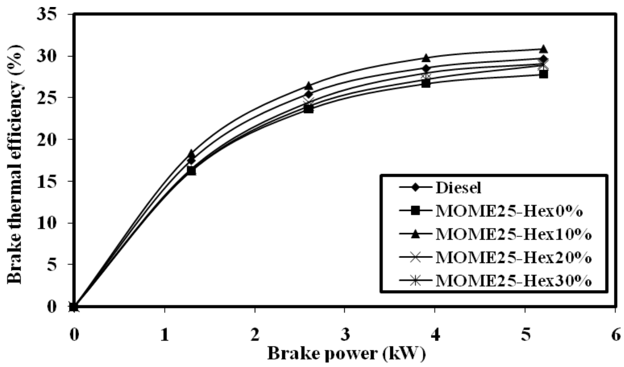

Fig 2. Graph for BTE variations with BP

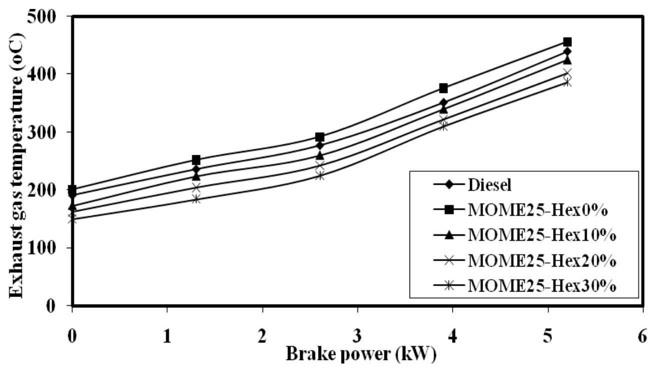

Fig 4. Graph for EGT variations with BP

Retrieval Number: B7242129219/2020©BEIESP
DOI: 10.35940/ijitee.B7242.019320
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

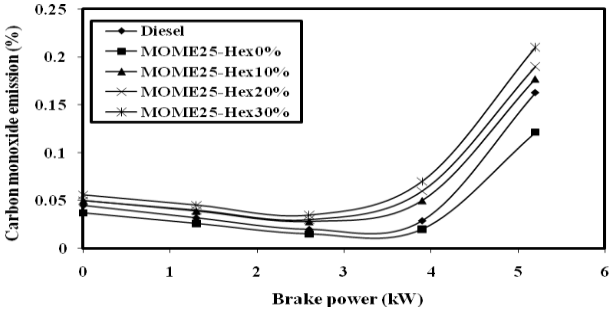

Fig.5 Graph for CO variations with BP

The variation of HC with BP with all fuels is depicted in Figure 6. It is found that there is an increase in HC for MOME25 which is due to inferior combustion of biodiesel and flame quenching on the cylinder wall.

HC emission of MOME25 with 10%, 20% and 30% fumigated hexanol is 67.5ppm, 72ppm and 75.4ppm respectively, and for diesel and MOME25 is 54ppm and 61ppm respectively. Higher HC emissions may be attributed to the high LHV of hexanol at higher engine load and also the insufficient oxygen available at fumigated mixture (Senthil Kumar and Rajan, 2019).

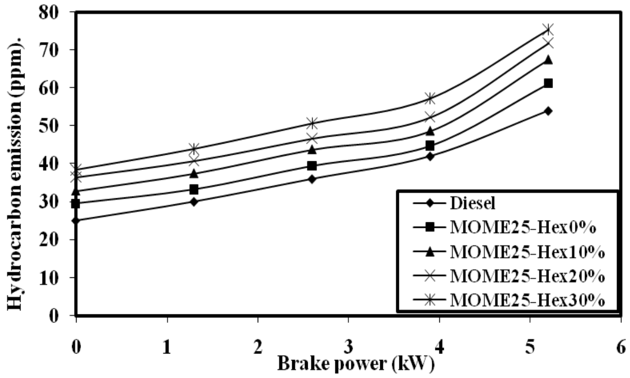

Fig 6. Graph for HC variations with BP

Figure 7 depicted the NO emission variations against BP at all loads. It is found that the NO emission increases steadily at higher engine loads and it is increased by 13% for MOME25 over diesel. NO emissions of MOME25 with 30% n-hexanol fumigation 618ppm followed by 20%(695ppm) and 10%(866ppm)fumigation. For diesel it is 959ppm. The NOx was decreased in the range of 10-36% for n-hexanol fumigation and it may be due to the high LHV of hexanol which decreases the cylinder temperature (Senthil Kumar and Rajan, 2019).

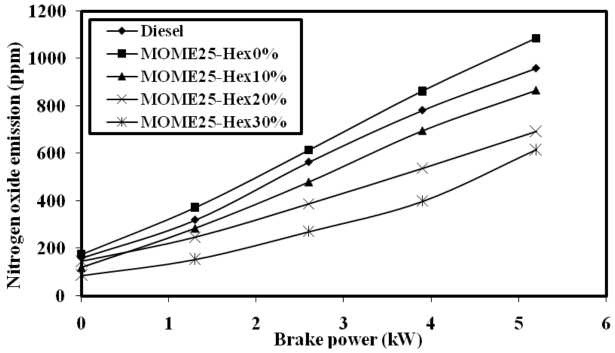

Fig 7. Graph for NO with BP

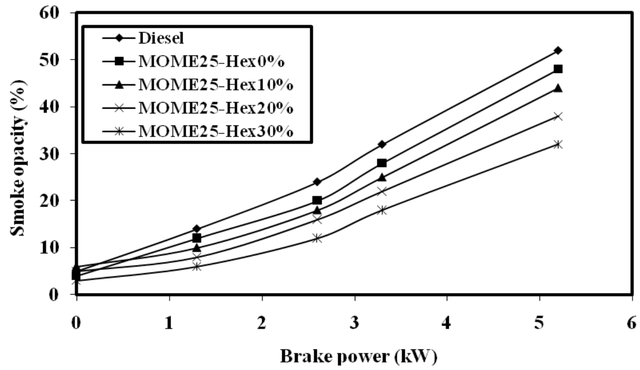

Fig 8. Graph for smoke opacity with BP

Figure 8 shows the smoke versus BP at different percentage of n-hexanol fumigation with MOME25 blend. The opacity of smoke decreases at all loads with a percentage increase in n-hexanol fumigation rate. Smoke obtained for MOME25 with 10%, 20% and 30% n-hexanol fumigation are 44%, 38% and 32% respectively and for diesel it is 52% and 48%. This decrease in smoke may be due with increased fumigation of n-hexanol formed homogeneous mixture that helps for burning faster higher oxygen in the fuel, resulting in reduced smoke opacity (Gowtham et al. 2019).

V. CONCLUSION

The outcome of the test results are concluded as follows.

- BTE of MOME25 with 10% fumigated hexanol is increased by 1.08% when compared with MOME25.
- CO emissions for MOME25 with hexanol fumigation were increased by 15-29% and the HC for MOME25 with hexanol fumigation were increased by 24-40% at maximum power.
- The NO was decreased by 10-36% for n-hexanol fumigation at all proportions at maximum power. Highest NO emission was decreased for MOME25 with 30% fumigation compared with MOME25.
- The smoke was decreased by 15-38% with an hexanol fumigation of hexanol fuel.
- On the whole, MOME25 with 30% n-hexanol fumigation can be utilized for the better supression of NO and smoke with the penalty of brake thermal efficiency at higher proportions of fumigations.

Retrieval Number: B7242129219/2020©BEIESP
DOI: 10.35940/ijitee.B7242.019320
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

REFERENCES

1. A.K.Agarwal, 2007. Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engine. Prog. Energy Comb 33:pp.233–71.
2. S.Ramkumar, V. Kirubakaran 2016. Biodiesel from vegetable oil as alternate fuel for C.I engine and feasibility, study of thermal cracking: A critical review. Energy Conv and Manag 118: pp.155–169.
3. A.K.Agarwal, K.Rajamanoharan, 2009. Experimental investigations of performance and emissions of Karanja oil and its blends in a single cylinder agricultural diesel engine. Appl Energy 86:pp.106–12.
4. G. Lakshminarayana Rao, S. Saravanan, S.Sampath, and K. Rajagopal. 2008. Combustion and emission characteristics of diesel engine fuelled with rice bran oil methyl ester and its diesel blends. Therm Sci 12(1):pp.139–50.
5. L.Ranganathan, S. Sampath. 2011. Study of the Performance and Emission Characteristics of a Diesel Engine using Cotton Seed Oil-based Fuels. International J of Amb Energy 32 (3): pp. 124–33.
6. AR.Manickam, K.Rajan, K.R.Senthil Kumar, N.Manoharan 2014. Experimental analysis of a Diesel Engine fuelled with Biodiesel Blend using Di-ethyl ether as fuel additives, International J of Engg and Tech, 6(5): pp.2412-2420.
7. K.Rajan, M. Prabhahar. KR.Senthil kumar 2014. Experimental studies on the performance, emission and combustion characteristics of a biodiesel-fuelled (Pongamia methyl ester) diesel engine with diethyl ether as an oxygenated fuel additive, International J of Amb Energy, doi.org/10.1080/01430750.2014.977494.
8. A. Ravichandran, K.Rajan, K.R.Senthil Kumar.2018 Effect of piston bowl geometry and different injection pressure on the performance, emission, and combustion characteristics of diesel engine using biodiesel blend. Therm Sci 22(3): 1445-1446.
9. N. Saravanan, G. Nagarajan, Sukumar Puhan. 2010. Experimental investigation on a DI diesel engine fuelled with Madhuca Indica ester and diesel blend. Biomass and Bioenergy 34 :pp. 838–843.
10. R.Pradeepraj, K. Rajan. 2019. An experimental investigation on diesel engine performance using Moringa Olifera biodiesel with the effect of different injection pressures, International Jl of Mech and Prod Engg Res and Deve,.11(4). DOI: 10.24247/ijmperdaug201954..
11. K.Rajan, K.R.Senthil kumar, M.Rajaram Narayanan, V. Mohanavel, 2019. Impact of nozzle opening pressure on the performance and emission behaviours of the CI engine using yellow oleander biodiesel, International J of Amb Energy. https://doi.org/10.1080/01430750.2019.1611642.
12. M.A.Qudais O. Haddad, M.Qudaisat. 2000. The effect of alcohol fumigation on diesel engine performance and emissions. Energy Conv and Manag, 41 (11):pp. 389-399.
13. S. SenthilKumar, K. Rajan 2019. Performance and emission characteristics of diesel engine using biodiesel with the effect of Dimethyl carbonate (DMC) fumigation Energy Sources, Part A: DOI: 10.1080/15567036.2019.1654565.

AUTHORS PROFILE

R. Pradeep raj, was born in the year 1990 in Vellore Tamil Nadu. He has completed undergraduate in Engineering from Anna University in the year 2011 and and post gaduate in Thermal Engineering from Dr.M.G.R university in 2013. He is doing Ph.D in Dr.M.G.R university, Chennai.

Dr.K.Rajan, was born in 1969 in Tamil Nadu and completed his B.E in Mech Engg in Bharathidasan University and M.E ICE from Anna University. He has received his Ph.D from Dr.M.G.R Educational and Research Institute, Chennai in 2011. He published 100 papers in international journals and conferences.