iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** V **Month of publication:** May 2019

DOI: https://doi.org/10.22214/ijraset.2019.5514

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

Performance Analysis of a 4-Stroke Twin Cylinder C.I Engine using Pine Oil Methyl Esters with Isopropyl Alcohol

P. Narendra[1], S. Venkateswara Rao[2], Ch. Naveen Kumar[3], Dr. K. Prasada Rao[4]
[1]PG Student, [2, 3]Assistant Professor, [4]Professor, Department of Mechanical Engineering, NRI Institute of Technology, Vijayawada

Abstract: Researches concerning the usage of biodiesel as the diesel fuel substitutes have recently been exaggerated due to the environmental welfare and depletion of fossil fuel. According to British Petroleum (BP's) statistical review of world energy-2015, the world's fossil fuel consumption was increased by 0.8 million barrel per day. In the year 2014, the fuel consumption has been augmented by 1.2%, 2.6% and 7.1% higher than that of the year 2013 level for United States (US), China and India respectively.The performance parameters obtained by the tests are to be compared with diesel base line data and optimum blend B25. The blend B25 showed best performances increase in brake thermal efficiency, decrease in BSFC. However, its diesel blends showed maximum brake thermal efficiencies. After finding the optimum blend test to be conducted on the engine to find out the performance and emission parameters by adding isopropyl alcohol to the optimum blend. The main purpose of adding the isopropyl alcohol is to know ignition and brake thermal efficiency. Finally results show engine performance have been to justify the potentiality of the Pine oil Methyl esters of as alternative fuel for compression ignition engine fuel.
Keywords: Twin cylinder Diesel engine, Biodiesel, Performance, Combustion, Oxides of nitrogen.

I. INTRODUCTION

Bio-diesel fuel is reliable, renewable, biodegradable and nontoxic. It is less harmful to the environment for it contains practically no sulfur and substantially reduces emissions of un-burnt hydrocarbons (HC), carbon mono-oxide (CO), sulfates, poly cyclic aromatic HC (PAH) and particulate matter. It has fuel properties comparable to mineral diesel and because of great similarity; it can be mixed with mineral oil and used in standard diesel engine with minor or no modifications at all. Bio-diesel works well with new technologies such as catalyst (which can reduce soluble fraction of diesel but not the solid carbon fraction), particulate traps an exhaust gas circulation. It can be produced from any kind of oil both vegetable and animal source. Used frying oil can also be used and, therefore, be very promising alternative for waste treatment. It can strengthen economy by creating more jobs and create independence from the imported depleting commodity, petroleum. It can also be used as a way of stimulating and supporting agriculture. World Health Organization (WHO) found that 80% of the world's city inhabitants inhale poor quality air and 3 million early deaths per year was caused by the contaminated environment. New Delhi was the most polluted mega-cities in the world followed by other megacities like Cairo and Dhaka. NASA identified the increasing trend of NOx emission in India and China. NOx decreased by 50% in US due to the usage of renewable sources, whereas China recorded 20%e50% increase in NOx. Hence by implementing the renewable energy sources into usage leads to the drop in NOx level and other harmful pollutants in the atmosphere. The above fact enhances the bio-fuel production in the developed and developing countries. In the year 2014, the global bio-fuel production increased by 7.4%. In the year 2014, India, US, France, Indonesia, Spain and China recorded 29.1%, 5.6%, 2.2%, 40.4%, 32.2% and 3.3% higher bio-fuel production level than that of previous year 2013 level. Biodiesel could be extracted from the materials containing fatty acids. Different varieties of bio-lipids like virgin vegetable oil, used vegetable oil, non-edible oils, animal fat based oils and algae are used to produce biodiesel. Most commonly used bio-fuel is biodiesel obtained from transesterification process of vegetable oils as methyl or ethyl esters. Meanwhile many studies concerning biodiesel extracted from waste cooking oil and animal fat oils are currently in trend. Camphor oil is extracted from the wood of Cinnammomum camphora. Its molecular formula is $C_{10}H_{16}O$. The camphor generally ignites well without generating any residue and also its lower viscous property are expected to improve the combustion in diesel blends. The key factor influencing the NOx emission variation is in cylinder temperature, which has been depicted theoretically by the previous authors . The relation between NOx emission and combustion temperature has been recorded by Behnam et al. In their study, the computational model has been used to analyze the reduction of NOx during the combustion of pulverized coal. Based on the simulation results, NOx level reached a peak stoichiometric value and then fell at both lean and rich concentrations of fuel.

Highest rate of NOx emission observed at higher fuel gas mixture temperature, due to the phenomena (Zeldovich mechanism) of dependence of thermal NOx on flame temperature. Zeldovich mechanism postulates that the formation of thermal NOx increases exponentially with higher temperature. Dependence of NOx emission on temperature of the flame has been analyzed for the variation of pulverized coal size in the range of 0.0001 me0.0004 m. They created a 2D combustion chamber mathematical model and observed that the increase in coal diameter resulted in higher flame temperature, which tends to higher NOx emission.

For advancement in injection timing, longer ignition delay period leads to higher amount of fuel burnt in pre mix combustion phase resulted in increased in-cylinder temperature, which is the reason for higher NOx concentration in emission. Meanwhile higher injection pressure leads to higher heat release rate at premixed combustion phase results in higher in cylinder temperature, which attributed to more NOx emission scale.

II. TRANSESTERIFICATION PROCESS

There are so many investigations on bio-diesel production of non-conventional feedstock of oils have done in last few years. Overview of Transesterification process to produce biodiesel was given for introductory purpose. It is reported that enzymes, alkalis, or acids can catalyse process. Alkalis result in fast process. It is mentioned that catalysed process is easy but supercritical method gives better result. Adaptation of the vegetable oil as a CI engine fuel can be done by four methods Pyrolysis, Micro emulsification, Dilution, and Transesterification. Out of these in this study Transesterification process is used.

In this experiment first 160ml of Methanol is take in conical flask .The amount of NaOH required is determined by titration process by slowly adding of Sodium hydroxide to ethanol.

A. Steps Involved in Transesterificaton 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 glycerine as underflow and biodiesel as overflow). Centrifuge is used to separate the two materials faster. Once separated from glycerine biodiesel is purified by washing gently with warm water to remove residual catalyst or soaps, dried and sent to storage.

We made the oil by extracting from the seeds by crushing process. Then the produced crude oil is filtered by using the serigraphy papers (A1,A2) filtered oil is preheated by direct heating. The molar ratio 16:1 we mixed methanol and NAOH by the titration up to dissolving the NAOH completely. This solution is mixed with crude oil

This solution is heated further to separate the glycerine and other fatty acids about 6hr. At constant temperature 60ºC-75ºC. The mixture solutions is cooled by using conical flask for 1day keeping in atmosphere. Then it formed 2 layers glycerine and pure bio-diesel.now the bio-fuel is separated and the blends are prepared with these bio-fuel. I had these blends are (B05, B15, B25, B35) in the performance and analysis criteria.

III. EXPERIMENTAL SETUP AND PROCEDURE

Experimental set up consists of a water cooled twin cylinder vertical diesel engine coupled to a rope pulley brake arrangement it shown in below, 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. 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 an orifice and a U-tube water manometer that measures the pressures inside the tank. For measuring the emissions the gas analyser is connected to the exhaust flow.

Fig1: Stroke Twin Cylinder diesel engine

This is a water cooled twin 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.

A. Procedure

Note down engine specifications and ambient temperature.

1) 1. Using Engine specifications , calculate maximum load on the engine.
2) Connect the water inlet of the calorimeter and the engine jacket to constant head water source. (5meters head)
3) Open the inlet gate valves of calorimeter and engine jacket to suitable desired flow rate.
4) Connect R.Y.B & Neutral line to loading system.
5) Connect the instrumentation power input plug to a 230 V single phase power source. Now all the digital meters, namely, RPM, voltmeter Ammeter & temperature indicator display the respective readings.
6) Fill up the diesel into the diesel tank mounted on the panel frame.
7) Check the lubricating oil level in the sump with the 'dipstick' provided.
8) Open the diesel cock provided underneath the diesel tank.
9) Ensure the MCB switch provided for the purpose engaging and disengaging the loading system should be in off.
10) Rotate the cranking handle anti clock wise direction and pull down the decompression lever simultaneously.
11) Now the engine will run at 1500 RPM approximately and record initial reading.
12) Note down all the required parameters mentioned below at no load
    a) Load (I) from Ammeter (i.e. I_1, I_2, & I_3 by rotating ammeter selector switch) Voltage (V) from voltmeter (i.e. V_1, V_2, & V_3 by rotating voltmeter selector switch)
    b) Time for 'x' CC fuel consumption in sec.
    c) Quantity of air from manometer by noting down limb heights.
13) Now load the engine by engaging MCB switch, can switch in anti-clock wise /clock wise direction in steps of ¼, ½, ¾ and full load and note down above parameters.
14) With the above parameters recorded at each load, calculate the performance parameters of the engine and draw the Engine performance Characteristics at constant speed.

To stop the engine push/pull the governor lever towards the engine cranking side.

IV. RESULTS AND DISCUSSION

The experiments are conducted on the four stroke twin cylinder water cooled diesel engine at constant speed (1500 rpm) with varying 0 to 100% loads with diesel and different blends of PSOME like B05, B15, B25 and B35.

The performance parameters such as brake thermal efficiency and brake specific fuel consumption were calculated from the observed parameters and shown in the graphs. The variation of performance parameters are discussed with respect to the brake power for diesel fuel, diesel-biodiesel blends and obtained optimum blend are discussed.

A. Brake Thermal Efficiency

The variation of brake thermal efficiency with load for different fuels is is shown below. In all cases, it increased with increase with brake power. This was due to reduction in heat loss and increase in power with increase in load. The maximum thermal efficiency for B25 at full load 43.47% was higher than that of diesel (42.06%). Increase in thermal efficiency due to percentage of oxygen presence in the biodiesel, the extra oxygen leads to causes better combustion inside the combustion chamber.

The increment of BTE was observed with B25 at full load is 3.35% higher than that of diesel fuel. In order to increase the brake thermal efficiency ignition improver is added in which B25D69DEE6 gives the brake thermal efficiency 47.23% which is more than that of B25 and diesel.

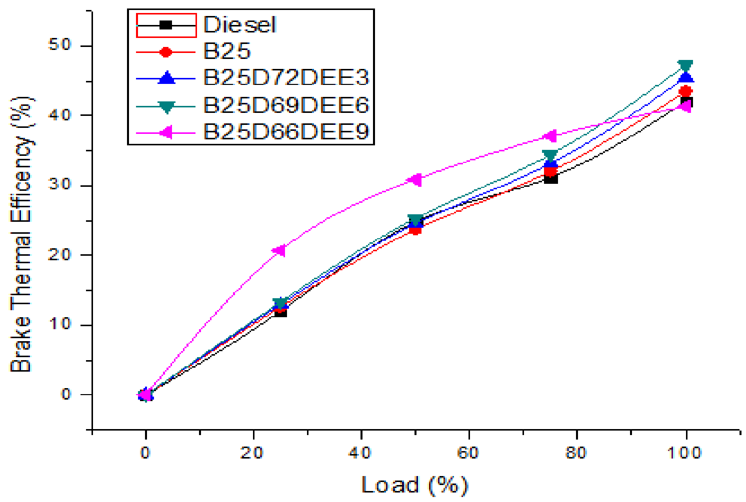

Fig.2. Variation of Brake Thermal Efficiency with load

B. *Mechanical Efficiency*

The comparison of Mechanical efficiency for various biodiesel blends with respect to load shown below. From the plot it is observed diesel and its blends like B25 nearly equal at full load conditions. But considerable improvement in mechanical efficiency was observed by the blends B25 is 79.15% because of lowest frictional powers compared to diesel. It is observed optimum blend add with ignition improver Diethyl Ether 6% slightly increases (79.34%) at full load conditions than B25 fuel. The increment mechanical efficiency (0.24%)because of lowest frictional powers compared to other blends.

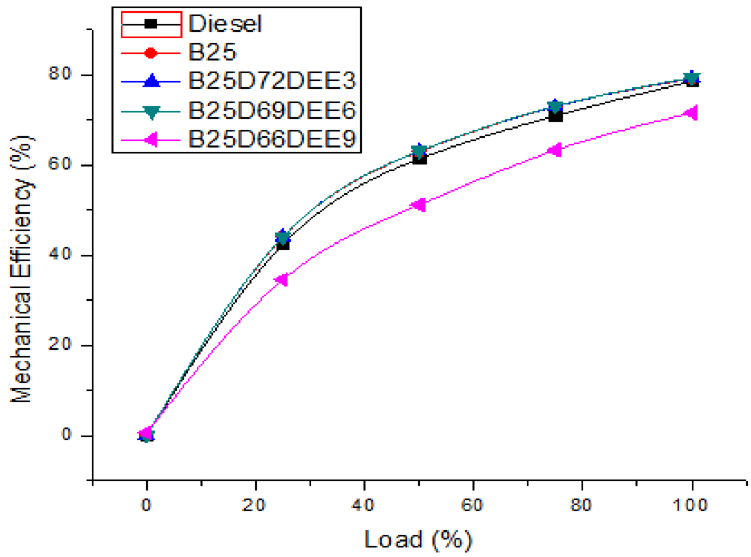

Fig.3. Variation of Mechanical Efficiency with load

C. *Brake Specific Fuel Consumption*

The variation in BSFC with load for different fuels is shown below. Brake-specific fuel consumption (BSFC) is the ratio between mass fuel consumption and brake effective power, and for a given fuel, it is inversely proportional to thermal efficiency. It can be observed that the BSFC of 0.20146kg/kW-hr were obtained for diesel and 0.19429 kg/kW-hr B25 at full load. It was observed that BSFC decreased with the increase in concentration of PSOME in diesel. The BSFC of Bio-diesel is decreases up to 3.69% as compared with diesel at full load condition. So the obtained blend added to the ignition improver Diethyl Ether 6% than decrease BSFC (0.179) compare to blend B25.

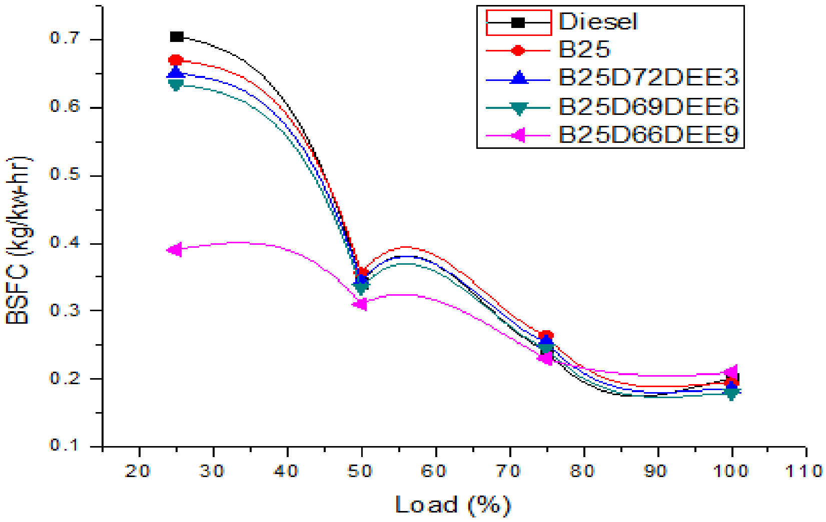

Fig.4. Variation of Brake specific fuel consumption with load

D. Volumetric Efficiency

The variation of volumetric efficiency with load is shown below. It has been observed that there is no change in volumetric efficiency with the increase in Break power in diesel fuel at all loads. However the volumetric efficiency decreases at high loads in the case, B05, B15, B25 and B35. It may be due to that the inner surface of engine cylinder is hot which makes the residual gases and fresh air to expand more thus reducing the flow rate of incoming air. It is observed diesel contains 69.45% at full load, in case of B25 at full load 69.09%.therfore the decrease in volumetric efficiency 0.52% while using B25. While using B25 and added to the ignition improver Diethyl Ether 6% it gives volumetric efficiency is 69.09% for B25D69DEE6% is equal to B25.

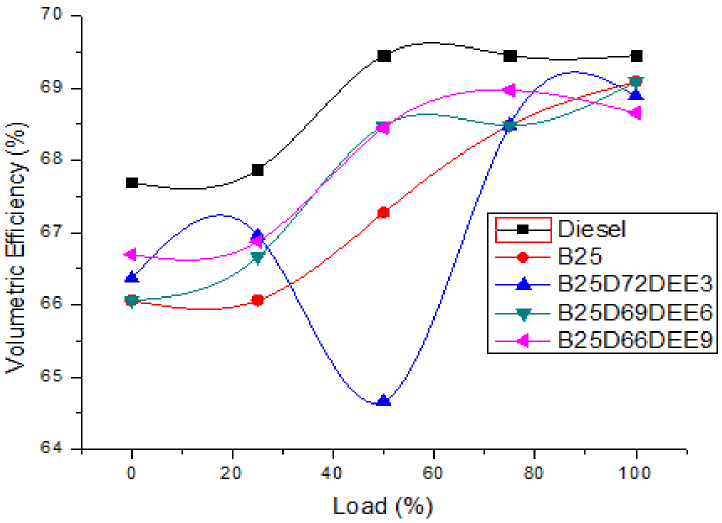

Fig.5. Variation of volumetric efficiency with load

E. Carbon Monoxide (CO)

The comparison of carbon monoxide for various biodiesel blends with respect to load is shown below. It was noticed that CO emission of 0.11% for diesel and the values for B05, B15, B25 and B35 are 0.1, 0.11, 0.10, 0.11.

The CO content is decreased for B25 blend at full load compared with diesel and added to the DEE6%. The B25D69DEE6 blend contains 0.092% of CO which is less than diesel and B25.This is because of pure combustion takes place while adding Diethyl Ether 6%.

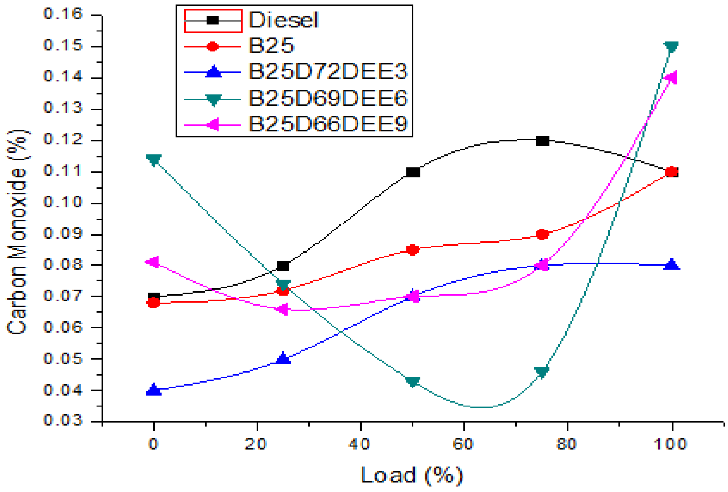

Fig.6. Variation of Carbon Monoxide with load

F. Carbon Dioxide (CO2)

The variation of carbon dioxide with load is shown in below. In case of PSOME, the CO_2 emission is greater. At full load diesel contains 6.01 % of CO_2 emissions where as in case of B25 it is 5.6 %.The decrease in CO_2 emissions is 7.14 %. The CO_2 emissions increased with load for all the fuel modes.

For the blend B25added with ignition improver DEE6% the value of carbon dioxide is 9.8 at full load. Then increased to combustion takes place increase the CO_2 compare to other blends.

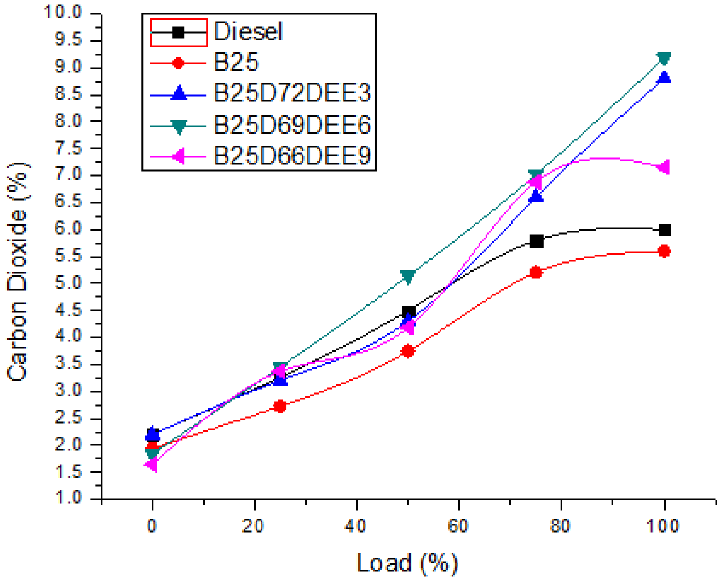

Fig.7. Variation of Carbon Dioxide with load

G. Oxides of Nitrogen (NO_X)

Variation of NOx with engine brake power for different fuels tested are shown below. The nitrogen oxides emissions formed in an engine are highly dependent on combustion temperature, along with the concentration of oxygen present in combustion products. The amount of NOx produced for B25 is 304 ppm, where as in case of diesel fuel is 438 ppm for diesel fuel. Then added to DEE6% for blend B25 then the NO_x emission for all the fuels tested followed an increasing trend with respect to load but compare to B25 the NO_x is reduced.

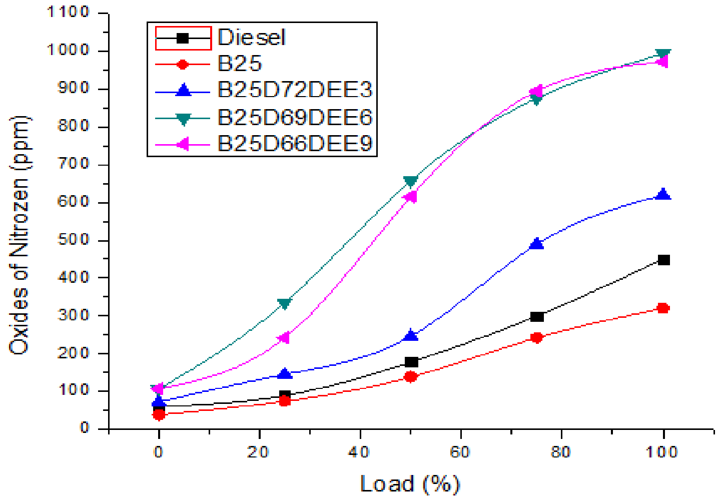

Fig.8. Variation of Oxides of Nitrogen with load

V. CONCLUSION

The investigations were carried out on the same engine with addition of DEE (ignition improver) 3%, 6 % and 9% volume ratios to optimum blend B25 (B25D72DEE3, B25D69DEE6 and B25D66DEE9) find out performance and emissions parameters and compared with optimum blend and diesel base line data. Out of this 6% volume addition of ignition improver (B25D69DEE6) shows best results in performance and emissions parameters.

The conclusions of this investigation are compared with optimum blend B25 and diesel base line data at full load as follows:

A. The maximum brake thermal efficiency for was (47.23%) was higher than that of B25 and diesel. The brake thermal efficiency increased in 7.96%, 10.98% compared with B25 and diesel.

B. Brake specific fuel consumption is decreases in blended fuels with added ignition improver. In B25D69DEE6 fuel the BSFC is lower than the diesel the decreased in BSFC.

C. Then ignition improver (DEE6) added to blend B25. The HC emission for B25D69DEE6 is 42ppm. The reduced amount of HC emissions up to 4ppm compared to B25.

REFERENCES

[1] BP statistical review of world energy. 64th edition June 2015.. https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bpstatistical-review-of-world-energy-2015-full-report.pdf.

[2] News article: 80 per cent of world's city dwellers breathing bad air: WHO. The Economic Times; May 12, 2016. http://articles.economictimes.indiatimes.com/2016-05-12/news/73039618_1_air-quality-maria-neira-air-pollution.

[3] News article: air pollution growing in India, China: NASA. The Economic Times; Dec 15, 2015. http://articles.economictimes.indiatimes.com/2015-12-15/news/69062104_1_air-quality-air-pollution-nitrogen-dioxide.

[4] Armas Octavio, Gomez Arantzazu, Ramos Angel. Comparative study of pollutant emissions from engine starting with animal fat biodiesel and GTL fuels. Fuel 2013;113:560e70. http://dx.doi.org/10.1016/j.fuel.2013.06.010.

[5] Barrios Carmen C, Domínguez-Saez Aida, Martín Carlos, Alvarez Paloma. Effects of animal fat based biodiesel on a TDI diesel engine performance, combustion characteristics and particle number and size distribution emissions. Fuel 2014;117:618e23. http://dx.doi.org/10.1016/j.fuel.2013.09.037.

[6] Alpteki Ertan, Canakci Mustafa, Ozsezen Ahmet Necati, Turkcan Ali, Sanli Huseyin. Using waste animal fat based biodiesels bio ethanol diesel fuel blends in a DI diesel engine. Fuel 2015;157:245e54. http://dx.doi.org/10.1016/j.fuel.2015.04.067.

[7] Awad Sary, Loubar Khaled, Tazerout Mohand. Experimental investigation on the combustion, performance and pollutant emissions of biodiesel from animal fat residues on a direct injection diesel engine. Energy 2014;69:826e36. http://dx.doi.org/10.1016/j.energy.2014.03.078.

[8] Wyatt Victor T, Hess Melissa A, Dunn Robert O, Foglia Thomas A, Haas Michael J, Marmer William N. Fuel properties and nitrogen oxide emission levels of biodiesel produced from animal fats. J Am Oil Chem Soc 2005;82(8):585e91.http://dx.doi.org/10.1007/s11746-005-1113-2.

[9] Attia Ali MA, Hassaneen Ahmad E. Influence of diesel fuel blended with biodiesel produced from waste cooking oil on diesel engine performance. Fuel 2016;167:316e28. http://dx.doi.org/10.1016/j.fuel.2015.11.064.

[10] Hwang Joonsik, Bae Choongsik, Gupta Tarun. Application of waste cooking oil (WCO) biodiesel in a compression ignition engine. Fuel 2016;176:20e31. http://dx.doi.org/10.1016/j.fuel.2016.02.058.

[11] Man XJ, Cheung CS, Ning Z, Wei L, Huang ZH. Influence of engine load and speed on regulated and unregulated emissions of a diesel engine fueled with diesel fuel blended with waste cooking oil biodiesel. Fuel 2016;180:41e9.http://dx.doi.org/10.1016/j.fuel.2016.04.007.

[12] Ch.Naveen Kumar et.al., “Experimental Investigation on 4-Stroke Single Cylinder Diesel Engine by Using Roselle Seed oil as Bio-Diesel”, IJETT, ISSN: 2231-5381, Volume-43 Number-3 -January 2017, Pages 173-178.