Using Bio-Diesel The Performance and Emission Characteristics of Diesel Engine Are Tested

Dr. R. RAMACHANDRA

Principal & Professor, Dept. of Mechanical Engineering, SKD Engineering College, Gooty. Anantapur, A.P

ABSTRACT: On the face of the upcoming energy crisis, vegetable oils have come up as a promising source of fuel. They are being studied widely because of their abundant availability, renewable nature and better performance when used in engines. Vegetable oils have high viscosity and poor volatility which lead to reduced Brake Thermal Efficiency and increased Hydrocarbon (HC), Carbon Monoxide (CO) and Oxides of Nitrogen (NO_X). Among all the available vegetable oils, Pongamia oil is one of the most suitable oil that can be used as an alternative fuel because of its compatibility with diesel and abundant availability. For the past few years a lot of research work has been done on evaluating the performance of a C.I Diesel engine by replacing diesel with Pongamia oil blends. Majority of the research works done were carried out with a maximum blending ratio of 1:1 (1 part of Pongamia oil and 1 part of diesel). Now taking a step forward blending ratio of 3:2 (3part of Pongamia oil and 2 part of diesel) is taken and the performance of CI diesel engine is evaluated by using new blend i.e. (B60). By using B60 directly as a fuel the combustion does not take place efficiently.

I.INTRODUCTION

The idea of using vegetable oil began in the year 1893 itself when Diesel engines came into existence. In the year 1911, Rudolf Diesel operated his first engine using straight vegetable oil (peanut oil). The physical and combustion properties of vegetable oils are closer to that of Diesel and in this context; vegetable oils can stand as an immediate candidate to substitute for fossil fuels. The greatest advantages of vegetable oils are that they are obtained from seeds of various plants. In view of this, researchers have started showing renewed interest towards vegetable oils because of its advantages as a potential alternate fuel. Vegetable oils are renewable and eco-friendly in nature and at the same time, it can be easily produced in rural areas. Sustainable development of a country depends on the extent that it is managing and generating its own resources. This also helps in conservation of depletion of non-renewable petro-products. However due to inherent high viscosity and low volatility, vegetable oils would pose problems such as fuel flow and poor atomization and constrain their direct use in engine without any modifications.

Vegetable oils are either edible or non-edible. Some of the edible oils are sunflower oil, palm oil, rice bran oil, and cottonseed oil. The non-edibleoils are mahua oil, Pongamia oil, rubber seedoil, etc. As rice bran and Pongamia are not very much in use for cooking purpose, these can be used as substitute for Diesel in CI engines. Pongamia oil has several properties closer to that of Diesel but certain properties such as high viscosity and low volatility pose problem when used as an alternate fuel for C.I engines. The potential of using vegetable oil for Diesel engines was studied by RecepAltinetal., Yoshomotoyetal. and Kensuke Nishietal.. The engine performance was very much similar to that for Diesel with little power loss and slight increase in the emission level. Karaosmanoglu. Fetal studied long-term utilization of vegetable oil and no significant increase or loss in power was noticed. Nwafor O.M.Ietal. Carried out combustion studies on both Diesel fuel and vegetable oil fuel with standard and advanced injection timings. Advanced injection timing compensates the effects of the longer delay period and slower burning rate that is exhibited by vegetable oils.

The problems related to low volatility and high viscosities are offset by subjecting the oil into the process of trans-esterification, and the high viscosity can be reduced. Methyl and ethyl esters of vegetable oil (called as bio-Diesel) have the physical and chemical properties closer to that of Diesel. The performance and emission characteristics of the Diesel engine using methyl ester are comparable with that of Diesel as per Dilip Kumar Boraetal. .BabuAketal. also has reported problems related to high viscosity. Blending vegetable oil with Diesel decreases the viscosity and improves the volatility. This improved properties results in better mixture formation and spray penetration. A number of investigators tried the vegetable oils in varying proportions with Diesel. Results obtained from experiments shows that vegetable oil and Diesel blends showed improvement in engine performance. Pre heating the vegetable oil reduces the viscosity and improves combustion characteristics.

It is necessary to introduce alternate fuel to replace the existing fossil fuels as it has been predicted by experts that the existing resources of the fossil fuels will be exhausted in another 50years. Now coming to the present situation too we have absolute scarcity hence we are popularizing the slogans such as “Save Oil”, introducing new fuel saving vehicles, etc. As the situation is deteriorating day-by-day especially in developing countries like India, we have to think of introducing alternate fuels. Apart from the scarcity, the cost also is increased at regular intervals. Depending on this, country’s economy is also affected. This is also another factor for finding the possibility of alternate fuels (the price of fossil fuels also depends on the fluctuation in the international market, imports and exports and their fiscal policies etc.)Continuous search for the alternate fuels has lead researchers to several areas. They are alcohols, H2, LPG, CNG, Biogas, Vegetable oils, etc. Out of these, as vegetable oils are renewable and they can be produced easily as the technology for extraction is well known, vegetable oils are becoming popular worldwide. Introduction of alternate fuels, which are extracted from vegetable oils, will positively reduce the usage of fossil fuels. There are various types of vegetable oils that can be used as alternate fuels.

II. PROPERTIES OF PONGAMIA OIL

Table 1 Properties of Pongamia oil

Properties	Diesel	Pongamia oil
Calorific Value(kj/kg)	42,700	36570
Density at 15^0C(kg/m^3)	831	956
Flash point (^{0}C)	45	235
Boiling point (^{0}C)	180-340	176-177
Cetane number	50	
Kinematic viscosity (cs)	0.745	48.83

III.SPECIFICATIONS OF DIESEL ENGINE

The engine is single cylinder vertical type four stroke, water-coo1ed, and compression ignition engine. The engine is self-governed type whose specifications are given in Table 2 is used in the present work.

Table 2 Engine specifications

Item	Specification
Engine	KIRLOSKAR ENGINE, 4 stroke-stationary.
Type	water-cooled
Injection	direct injection (DI)
Maximum speed	1500
Number of Cylinder	One
Bore	85 mm
Stroke	110 mm
Compression Ratio	16.5:1
Maximum HP	5 HP
Injection timing	25^0 before TDC
Injection pressure	200 bar

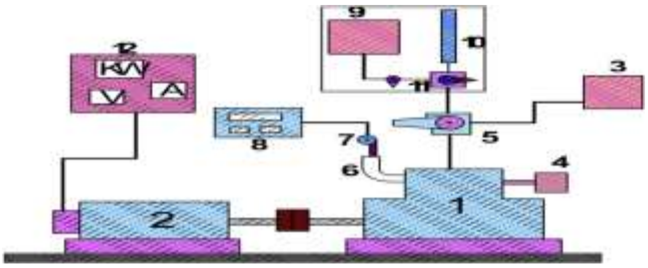

Fig 1Experimental set up

The experimental set up consists of engine, an alternator, top load system, fuel tank along with immersion heater, exhaust gas measuring digital device and manometer.

IV. EXPERIMENTAL PROCEDURE

The diesel engine alone is allowed to run for about 30 min, so that it gets warmed up and steady running conditions are attained. Before starting the engine, the lubricating oil level in the engine is checked and itis also ensured that all moving and rotating parts are lubricated.

The Experiments were carried out after installation of the engine. The injection pressure is set at 200 bar for the entire test.Precautions were taken, before starting the experiment. Always the engine was started with no load condition. The engine was started at no load condition and allowed to work for at least 10 minutes to stabilize. The readings such as fuel consumption, spring balance reading, cooling water flow rate, manometer reading etc., were taken as per the observation table. The load on the engine was increased by 20% of FULL Load using the engine controls and the readings were taken as shown in the tables. Step 3 was repeated for different loads from no load to full load. After completion of test, the load on the engine was completely relieved and then the engine was stopped.

V. RESULTS AND DISCUSSION

VARIATION OF (%) OF BRAKE THERMAL EFFICIENCY WITH BRAKE POWER

From Fig 5.1 it is observed that brake thermal efficiency for all blends increases with higher brake power. Whereas it had a higher rate of increase for the blend CPO40%:D60% than any other blends. Amongst of all CPO60%:D40% recorded for lower brake Power.

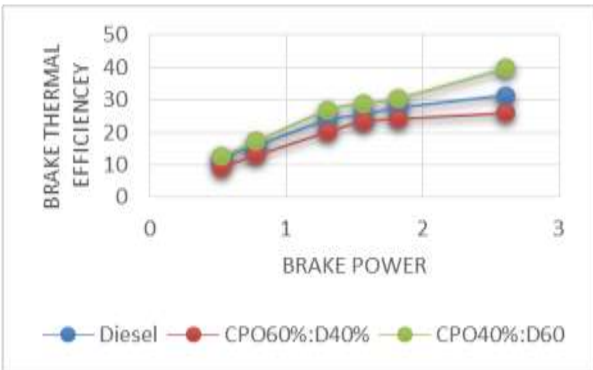

Fig: 5.1 Variation of (%) of Brake Thermal Efficiency with Brake Power (kW)

VARIATION OF BRAKE SPECIFIC FUEL CONSUMPTION (KG/KW-H) WITH BRAKE POWER (KW):

From Fig 5.2 It is clearly evident that brake fuel consumption for CPO60%:D40% has highest value than any other blends. Diesel followed the same trend as of above but will less values. CPO40%:D60%, followed the same trend but little lesser in value than that of Diesel.

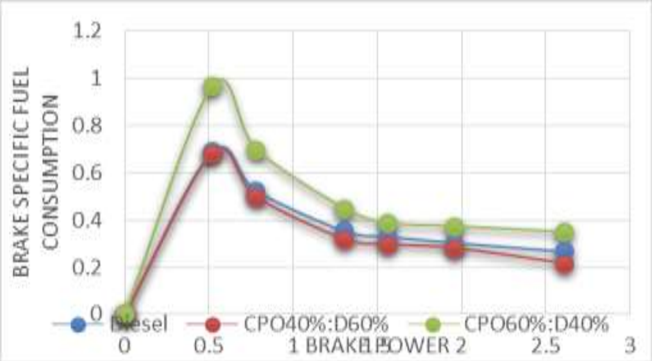

Fig: 5.2 Variation of Brake Power Vs Brake Specific Fuel Consumption

VARIATION OF HYDRO CARBONS (PPM) WITH BRAKE POWER (KW):

From the fig 5.3 it was found that Diesel recorded highest unburnt HC emissions than any other blend, which shows improper burning of fuel at higher brake powers. CPO40%:D60% initially followed similar trend and recorded lowest amongst all, whereas CPO60%:D40% recorded moderate values of unburnt hydrocarbons.

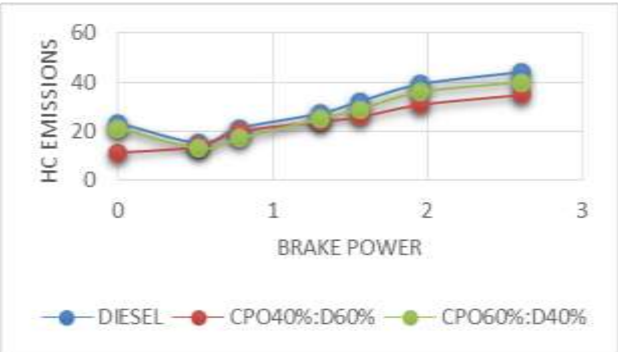

Fig: 5.3 Variation of (%) of Hydro Carbons with Brake Power (kW)

INDICATEDTHERMAL VARIATION OF CARBON DIOXIDE (% VOL) WITH BRAKE POWER (KW):

From the fig 5.4it can be observed that Diesel initially started with highest values of CO_2 but with increase of brake power it showed moderate values of emissions. CPO60%:D40% showed lowest CO_2 emissions than any other blend and Diesel. CPO40%:D60% recorded highest value of CO_2 emissions amongst all.

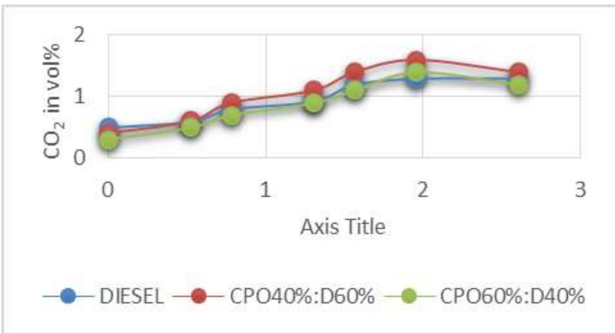

Fig: 5.4 Variation of (%) of Carbon Dioxide with Brake Power (kW)

VARIATION OF CARBON MONOXIDE (% VOL) WITH BRAKE POWER (KW):

From the fig 5.5 it is observed that CO emissions for Diesel are initially high, later it decreased with higher brake powers. Whereas CPO60%:D40% started almost with CPO40%:D60% later on it increase drastically with increase in brake power. CPO40%:D60% recorded for the lowest CO emissions which are harmful, and which are to be essentially less.

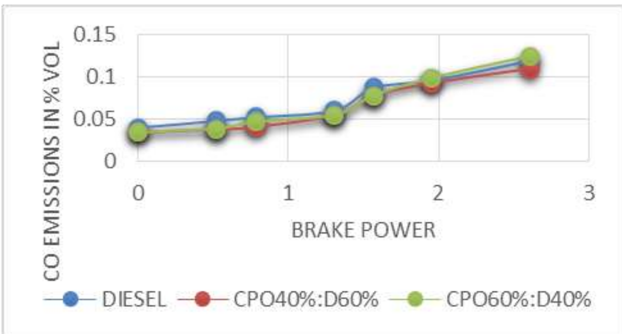

Fig: 5.5 Variation of (%) of Carbon Monoxide with Brake Power (kW)

VARIATION OF OXIDES OF NITROGEN (PPM) WITH BRAKE POWER (KW):

From the fig 5.6It can be seen that NOX for CPO40%:D60% initially started with low values, later on it increased with increase in the values of brake power, which shows that there is proper burning and higher temperatures are achieved in the engine, compared with any other blends. Diesel initially showed highest NOX emissions, but whereas it shifted to moderate at higher brake power. CPO60%:D40% initially had highest NOX emissions but at higher loads it shifted to all time low, showing improper combustion.

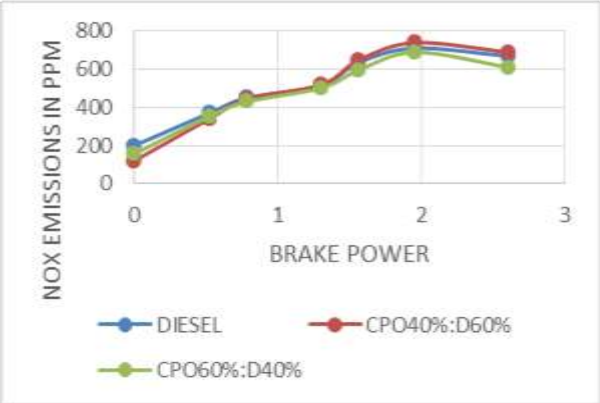

Fig: 5.6 Variation of (%) of Oxides of Nitrogen with Brake Power (kW)

VI. CONCLUSION

Following are the conclusions based on the experimental results obtained while operating single cylinder water cooled diesel engine fuelled with blends of Pongamia oil and diesel.

1. CPO40%:D60 Recorded highest brake thermal efficiency than other blends or diesel
2. The brake specific fuel consumption for CPO40%:D60% were very low showing less quantity of fuel is required for a specific output compared with the other two.
3. Unbornt HC emissions were low, which shows proper burning of fuel than Diesel or CPO60%:D40%
4. CO emissions for blend CPO40%:D60% are lower, which means reduction of harmful pollutants in atmosphere
5. CO_2 emissions for CPO40%:D60% were higher than any other blends.
6. NOX emissions were higher for CPO40%:D60: which suggests that elevated temperatures are attained in engine cylinder, which also indirectly says that it thermal efficiency has increased, since efficiency of the engine lies on the max and min temperature differences.

From the investigation it is evident that out of all blends CPO60:D40 has given the better performance and lower emissions at the same time NOx emission also decreased.

REFERENCES

[1] RecepAltin, SelimCetinkaya and HuseyinSardarYucesu, “The potential of using vegetable oil fuels as fuel for Diesel engines”, International Journal of Energy conversion and management Vol. 42, 2001, 529-538.

[2] Y. Yoshimoto, M. Onodera and H. Tamaki, “Performance and emission characteristics of Diesel engines fueled by vegetable oils”, SAE Technical Paper Series , Paper No. 2001-01-1807/4227.

[3] Kensuke Nishi, Koji Korematsu and Junya Tanaka, “Potential of rape seed oil as a Diesel engine fuel”, SAE Technical Paper Series, Paper No.2004-01-1858.

[4] F. Karaosmanoglu, G. Kurt and T. Ozaktas, “Long term C.I engine test of sunflower oil”, International journal of Renewable Energy, Vol. 19, 2000, 219-221.

[5] O. M. I. Nwafor and G. Rice, “Performance of rapessed oil methyl ester in Diesel engine”, International journal of Renewable Energy, 0960-1481 Vol. 95, 1995 00022-4.

[6] Dilip Kumar Bora, Milton Polly, VikasSandhuja and L. M. Das, “Performance evaluation and emission characteristics of a Diesel engine using mahua oil methyl ester (MOME)”, SAE Technical Paper Series, Paper No. 2004-28-0034.

[7] K. Babu and G. Devaradjane, “Vegetable oil and their derivatives of fuel for C.I engines: An Overview”, SAE Technical Paper Series, Paper No. 2003-01-0767

[8] O. M. I. Nwafor and G. Rice, “Performance of rapeseed oil blends in a Diesel engine”, International Journal of Applied Energy, Vol.54, No.4, 1996, 345-354.

[9] P. K. Devan and N. V. Mahalakshmi, “Performance, emission and combustion characteristics of poon oil and its Diesel blends in a DI Diesel engine”, Fuel, Vol. 88, 2009, 861-867.

[10] K. Pramanik, “Properties and use of Pongamiacurcas oil and Diesel fuel blends in compression ignition engine”, International Journal of Renewable Energy, Vol. 28, 2003, 239-248.

[11] Holman J P. “Experimental methods for engineers”, New York: McGraw-Hill**.**

[12]Nabi, M.N.; Minami, M.; Ogawa, H.; and Miyamoto, N. (2000). Impact of oxygenated fuel on Diesel engine performance and emissions. *Society of Automotive Engineers Technical Paper No.* 2000-01-0231.Society of Automotive Engineers.

[13]Neeft, J.P.A.; Makkee, M.; and Moulijn, J.A. (1996). Diesel particulate emission control. *Fuel Processing Technology*,47(1), 1-69.

[14] Elango, T.; and Senthilkumar, T. (2011). Performance and emission characteristics of CI engine fuelled with non-edible vegetable oil and Diesel blends. *Journal of Engineering Science and Technology* (*JESTEC*), 6(2), 240-250.

[15] Roy, M.M. (2008). Investigation of methyl tertiary butyl ether-Diesel combustion and odorous emissions in a direct-injection Diesel engine. *Journal of Automobile Engineering*, 222(2), 251-263.

[16] Sukumarpuhan, N.Vedaraman,Mahua (MadhucaIndica) seed oil: A source of renewable energy in India (Journal of scientific & Industrial research Vol. 64,November 2005, pp. 890 896).

[17] Padhi.S.K, Singh. R.K., Optimization of esterification and transesterification of mahua (Madhucaindica) oil for production of Biodiesel (J. Chem. Pharm. Res., 2010, 2(5):599 – 608).

[18] M.Pugazhvadivu and G.Sankaranarayan, Experimental studies on a Diesel engine using mahua oil is a fuel (Indian journal of science and technology Vol.3 no.7, july 2010).

[19] Samaga,B.S., Vegatable oils as alternative fuels for the C.I. engine (8 NCICEC 83, paper no.AF-2).

[20] V.Sajith, C.B.Sobhan, Experimental investigations on the effects of cerium oxide nanoparticles fuel additives on biodiesel (Hindawi publishing corporation,vol.2010, Article ID 581407).

[21] A.P.Subramanyam and C.G.Saravanan, Evaluation of combustion and emission characteristics of Diesel engine by addition various fuel additives.