Performance Analysis of 4-Stroke Twin Cylinder Pine Oil Methyl Esters

First A. P, Narendra[1], Second S. Venkateswara Rao[2], Third C. Dr. C. Naga Bhaskar
[1]*PG Student, NRI Institute of Technology, Agiripalli, Vijayawada, A.P, India.*
[2]*Assistant Professor, NRI Institute of Technology, Agiripalli, Vijayawada, A.P, India*
[3]*Professor, NRI Institute of Technology, Agiripalli, Vijayawada, A.P, India*

Abstract- **In a modern day world alternative source of energy are given importance due to gradual depletion of fossil fuels. Reserves vegetable oils can be used as an alternative to diesel in CI engines and the use of vegetable oils in CI engine results in low CO and HC emissions compared to conventional diesel fuel. In the initial stage the tests are conducted on the four stroke twin cylinder water cooled direct injection diesel engine with constant speed by using diesel and base line data is generated by varying loads with constant loads. In second stage, experimental investigation has been carried out on the same engine with same operating parameters by using the Pine oil Methyl esters in different proportions as B05, B15, B25 and B35 to find out the performance and emission. The performance and emission parameters obtained by the above are compared with the base line data obtained earlier by using diesel and optimum Pine oil blend is obtained.**

Index Terms- Pine Oil, Pine Bio Diesel, Alternate Fuels, Methyl Esters.

I. INTRODUCTION

Diesel engines are being used as one of the vital prime movers for generating power and electricity in many industrial and agricultural applications. Reports emanating from research studies on alternate or renewable fuels unanimously predict an unprecedented demand for petroleum fuels by 2030 and the repercussions of this have been already felt by the sudden surge in petroleum prices. In addition to this petroleum fuel demand, its use is also associated with increased environmental problems. Considering the future energy security, sustainability and environmental damage, the study on various alternate, clean and renewable sources of fuel has grabbed the interest and attention of many researchers. Among which, biodiesel is one of the most commonly used alternative fuel for diesel engine. Biodiesel is normally produced from vegetable oil or animal fats through trans-esterification in the presence of catalyst at elevated temperature, while higher fatty acid oil even demands double stage trans-esterification process.

The conversion of triglycerides into methyl or ethyl esters, through the trans-esterification process, reduces the molecular weight to one-third that of the triglyceride and also reduces the viscosity by a factor of about eight, with a marginal increase in volatility. Thus, after trans-esterification process, the properties of the biodiesel are so conducive for its use in diesel engine. Recent studies on engine performance using biodiesel have shown significant improvements when compared to that of diesel. Furthermore, emissions such as smoke, HC (hydrocarbon), CO (carbon monoxide) and CO_2 (carbon dioxide) were also found to be reduced at the expense of slight increase in NO_x (oxides of nitrogen).

Nevertheless, the use of biodiesel has also shown several apprehensions due to its higher viscosity, lower calorific value, and lower horse power output. Apart from biodiesel, researchers have conceived the idea of using alcohol and emulsion fuels in diesel engine as an alternative fuel. Experimental studies with micro emulsion fuel have reported a drastic reduction of NO_x emission in diesel engine. However, the use of emulsion fuels has also shown significant increase in CO and HC emission levels and drop in BTE (brake thermal efficiency) at lower loads. Therefore, in order to address these shortcomings of emulsion fuels, a recent research on novel emulsion fuel with the addition of nano particle additives has shown an increase in BTE and decrease in NO_x emission than diesel.

Furthermore, the application of ethanol in diesel engine has come to lime light in recent decades as it has the potential to reduce environmental emissions. Ethanol is an oxygen enriched fuel and when used in blends with diesel, the fuel viscosity is reduced, resulting in enhanced combustion. Though ethanol is less viscous, the heating value is very low and suffers limited miscibility with diesel. Besides emulsion fuel and ethanol, there have been reports about using turpentine oil derived from resin of tree in diesel engine.

The same report also suggests that there is an increase in BSFC (brake specific fuel consumption) and decrease in BTE for all the blends of turpentine with diesel. Similarly, another study pertaining to the use of turpentine in diesel engine claimed 60 to 65% replacement of diesel with turpentine while operating the engine in dual fuel mode. The reported experiment was performed by inducting turpentine as main fuel through induction manifold and diesel was admitted in to the engine through conventional fuel injector.

Globally, about 40% of worlds energy needs are being met from petroleum products as of today. The anticipated growth in demand was expected to be 7%. has been a significant and impressive growth in this sector which has surpassed and failed all the estimates, forecast and projections made in this regard. It is estimated that the world oil consumption will increase from 68 million barrel per day to 94 million barrel per day in next decade. India is hard pressed for this important modern resources and is making all possible efforts to explore the off and on shore crude and gas production besides having more than required refining capacity.

The successful exploration of crude and natural gas from desert area of the country and afterwards building infrastructure for its commercially production and setting facilities are given due importance. With the indigenous production of 32 MMT and import of 80 MMT now and 350 MT by 2025 AD (according to Hydro Carbon Vision 2025) the consumption is lightly to increase to 150 MMT by next 8 years, which will be difficult to meet with indigenous reserves, which are only 0.6% of world reserve. This will increase the import bill to an all time high during next decade.

The energy generation sources and capacity in India have some limitations. Starting from 1347 MW of installed power capacity in 1947 and limited food production, today we are generating about 1,22,000 MW, where as we need around 1,50,000 MW power to meet our requirements in all sectors, including intensive agriculture. The peak hour shortage is estimated 20%. The agriculture sector is worst effected from shortage of power. Despite of promise and our serious efforts we are unable to provide electricity even for 8 hours during standing crop irrigation period in rural areas. The demand for petroleum products in India has been increasing at a rate higher than the increase in domestic availability. At the same time there is continuous pressure on emission control through periodically tightened regulations particularly for metropolitan cities. In the wake of this situation there is urgent need to promote use of alternative fuels which must be technically feasible, economically competitive, environmentally acceptable and readily available.

In this study, oil derived from oleoresins of tree, widely grown for its bark, wood, tar and essential oil, has been decidedly chosen to be used as fuel for diesel engine. oil, stable under all conditions of use and storage, is unique in that the feedstock originates from the forest and can be blended with petro-based diesel fuel readily. For the current study, gum oil is being used and extracted from oleoresin, which is traditionally obtained from tree by the process of tapping. This essential oil, obtained from tree, is pale yellow in colour with fresh forest smell and is soluble in alcohols and other mineral oils. The estimated world production of oil was reported to be 30,000 tons per annum and the demand for oil by 2022 was predicted to be 853,894 tons. The constituents of oil are terol, which is a tertiary alcohol, dipentene (an isomer of ne), UN reacted ne and some minor quantities of other by-product and impurities. The ane, collected from tree, has been converted in to a terol (C10H18O) by acid-catalyzed hydration process. It could be comprehended from the molecular formula of oil that it contains inherent oxygen within the structure, which is obtained as the result of the hydration reaction, catalyzed by an acid. Similar to lower alcohols such as ethanol and methanol, oil has C, H and O atoms in its structure, emerging as a renewable feedstock in the realm of other alternate fuels. However, contrary to other alcohol type of fuels, oil has higher calorific values, which make it as one of the appropriate bio fuel to be used in diesel engine. Moreover, oil has lower viscosity and boiling point, which could increase the fuel atomization and its vaporization. All the other properties of oil, determined by ASTM methods, comply with the standards and it qualifies as a potential candidate for diesel engine.

R. Vallinayagamet al [1],A new type of bio fuel, pine oil, is introduced in this work for the purpose of fuelling diesel engine. The viscosity, boiling point and flash point of the reported oil are lower, when compared to that of diesel. Also, the calorific value of pine oil bio fuel is comparable to diesel.

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

Fig.1. 4-S Twin Cylinder Diesel Engine

The engine was first operated on diesel fuel with no load for few minutes at rated speed of 1500 rpm until the cooling water and lubricating oil temperatures comes to certain temperature. The same temperatures were maintained throughout the experiments with all the fuel modes. The baseline parameters were obtained at the rated speed by varying 0 to 100% of load on the engine.

The diesel fuel was replaced with the seed oil biodiesel, the test was conducted with the blend of 95% diesel and 05% biodiesel (B05).

After the seed oil biodiesel, the test was conducted with the blend of 85% diesel and 15% biodiesel (B15). After the seed oil biodiesel, the test was conducted with the blend of 75% diesel and 25% biodiesel (B25) and after the seed oil biodiesel, the test was conducted with the blend of 65% diesel and 35% biodiesel (B35). The directly blended fuel does not require any modifications to diesel engines.

Hence direct blending method was used in this test. The tests were conducted with these blends by varying the load on the engine.

IV. RESULTS AND DISCUSSIONS

A. Brake Thermal Efficiency

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.

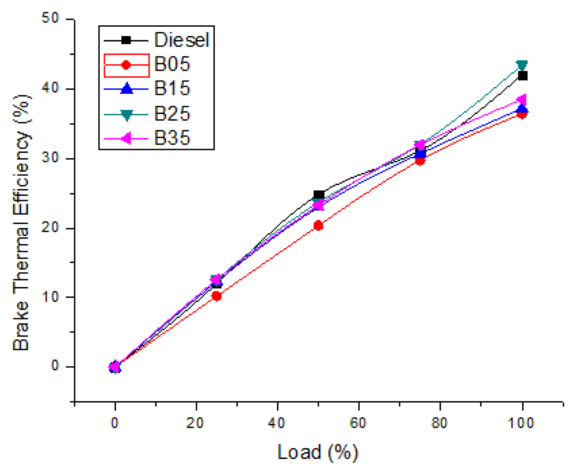

Fig.2. Variation of Brake Thermal Efficiency with load

B. Brake Specific Fuel Consumption

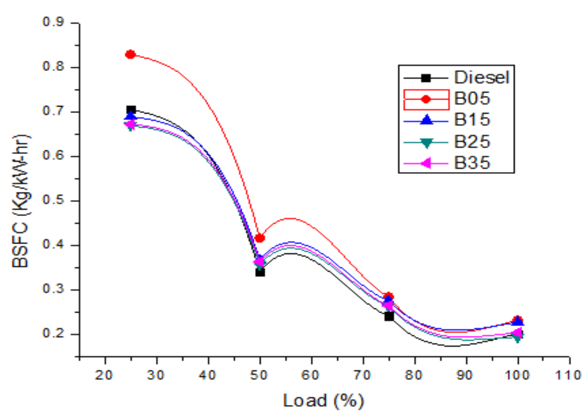

Fig.3. Variation of Brake specific fuel consumption with load

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.

C. Mechanical Efficiency

Considerable improvement in mechanical efficiency was observed by the blends B25 is 79.15% because of lowest frictional powers compared to diesel. Because of sufficient lubricating property of this blend frictional powers are reduced drastically and considerable improvement in mechanical efficiency has been observed and calorific value of this blend is more compared to other blends.

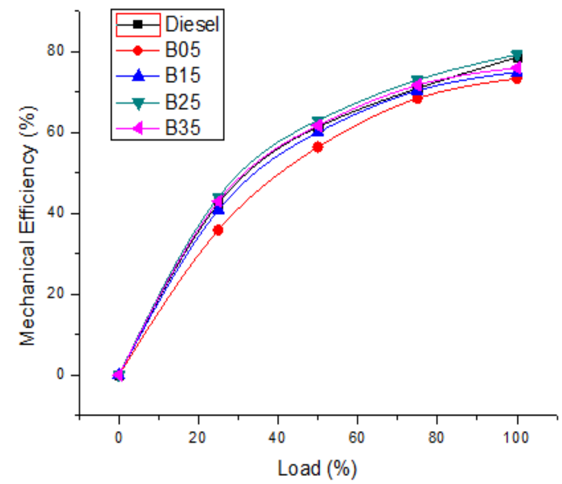

Fig.4. Variation of Mechanical Efficiency with load

D. Carbon Dioxide

The CO_2 emissions from a diesel engine indicate how efficiently the fuel is burnt inside the combustion chamber. 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 %.

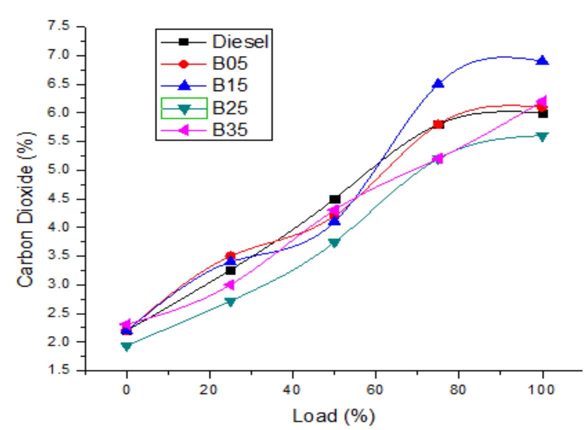

Fig.5. Variation of Carbon Dioxide with load

E. Carbon Monoxide (CO)

Carbon monoxide (CO) occurs only in engine exhaust, it is a product of incomplete combustion due to insufficient amount of air or insufficient time in the cycle to complete combustion. 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.

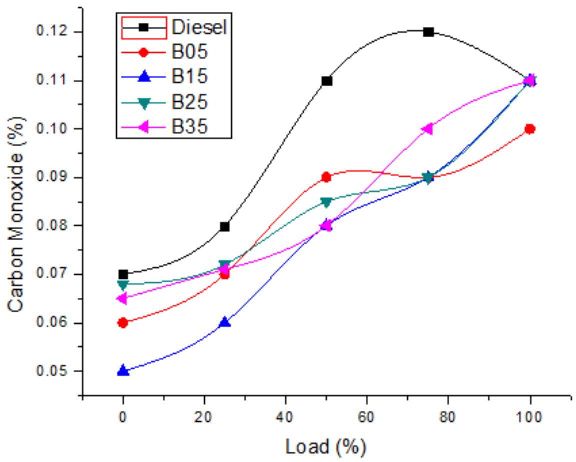

Fig.6. Variation of Carbon Monoxide with load

F. Hydrocarbons Emissions (HC)

the HC emissions decreased with increase in brake power for all biodiesel blends (B05, B15, B25 and B35) at all loads. In case of diesel fuel HC emissions are decreases with load, because of there is oxygen content present in diesel fuel. At full load diesel contains 54ppm where as in case of B25 it is 46ppm at same load. So there is a reduction from 54ppm to 46ppm at full load these reductions indicate a more complete combustion of the fuel. The presence of oxygen in the fuel was thought to promote complete combustion.

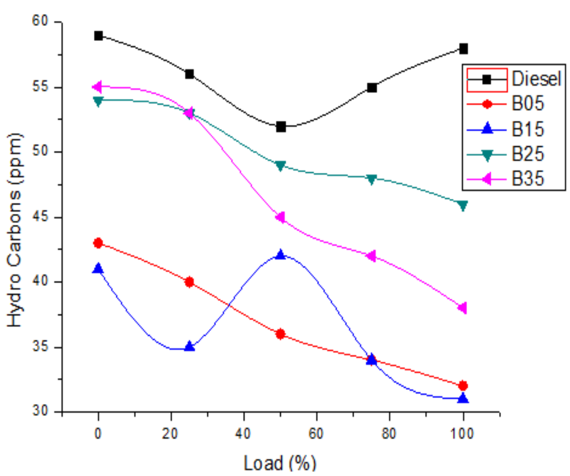

Fig.7. Variation of Hydro Carbons with load

V CONCLUSION

- The BTE of bio-diesel is increases up to 8.64% as compared with optimum blend at full load condition.
- Brake specific fuel consumption is decreases in blended fuels. In B25 fuel the BSFC is lower than the diesel in 0.1%.
- The CO content is decreased for B25 blend at full load compared with diesel.
- The decrease in CO2 emissions for B25 when compared to diesel is 7.14 %.
- At full load diesel contains 54ppm where as in case of B25 it is 46ppm at same load. So there is a reduction from 54ppm to 46ppm at full load these reductions indicate a more complete combustion of the fuel.

REFERENCES

[1] Vallinayagam and S. Vedharaj, W.M. Yang*, P.S. Lee, K.J.E. Chua, S.K. Chou "Combustion performance and emission characteristics study of pine oil in a diesel engine, Paper No: Energy 57 (2013) 344e351.

[2] 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.

[3] N.L. Panwar a,*, Hemant Y. Shrirame a, N.S. Rathore a, Sudhakar Jindal b, A.K. Kurchania, Performance evaluation of a diesel engine fueled with methyl ester of castor seed oil, Applied Thermal Engineering 30 (2010) ,pp245–249

[4] F. KaraosmanogÏ lu, G. Kurt, T. OÈ zaktas, Long term CI engine test of sunflower oil, Renewable Energy 19 (2000) ,pp219-221

[5] A.S. Ramadhas , S. Jay raj, C. Muraleedharan, Use of vegetable oils as I.C. engine fuels A review, Renewable Energy 29 (2004) ,pp727–742

[6] Murat Karabektas , Gokhan Ergen , Murat Hosoz ,The effects of preheated cottonseed oil methyl ester on the performance and exhaust emissions of a diesel engine, Applied Thermal Engineering 28 (2008) ,pp2136–2143

[7] M. Mani a,*, C. Subash b, G. Nagarajan b , Performance, emission and combustion characteristics of a DI diesel engine using waste plastic oil, Applied Thermal Engineering 29 (2009) 2738–2744.

[8] M.H. Mat Yasin a,⇑, Talal Yusaf b, R. Mamat a, A. Fitri Yusop a, Characterization of a diesel engine operating with a small proportion of methanol as a fuel additive in biodiesel blend, Applied Energy xxx (2013) xxx–xxx

[9] H. An, W.M. Yang ⇑, A. Maghbouli, J. Li, S.K. Chou, K.J. Chua, Performance, combustion and emission characteristics of biodiesel derived from waste cooking oils Applied Energy xxx (2013) xxx–xxx.

[10] Alireza Shirneshana , a , HC, CO, CO2 and NOx Emission evaluation of a diesel engine fueled with waste frying oil methyl ester, Procedia - Social and Behavioral Sciences 75 (2013) 292 – 297

[11] Ch.Naveen Kumar et al Experimental Investigation on 4-Stroke Single Cylinder Diesel Engine by Using Roselle Seed Oil as Bio-Diesel, International Journal of Engineering Trends and Technology (IJETT) – Volume-43 Number-3 - January 2017.

[12] G.Purna Chandra Rao et al, Performance & Evaluation of Diesel Engine (4-stroke 1-cylinder) using Jatropha Oil Blends with Super Charging Method, International Journal for Modern Trends in Science and Technology Volume: 03, Issue No: 07, July 2017.