Experimental Investigation of Eucalyptus Biodiesel and Its Blends on Performance of I.C. Engine

Vivek Ugare[1], Sachin Chavan[2]
[1, 2] Dept of Mechanical Engineering
[2]Asst. Professor, Dept of Mechanical Engineering
[1, 2] SIT, Lonavala.

Abstract- *Biodiesel is an alternative fuel similar to conventional or fossil fuel diesel. Biodiesel refers to a use of vegetable oil or animal fat based diesel fuel consisting of long chain alkyl esters. Biodiesels offer many benefits over conventional petroleum diesel. It burns with low net emissions and reduced particulates, hydrocarbons, and carbon monoxide. Biodiesels also possess a high cetane number and improves petroleum diesel cetane performance when blended. Since it is naturally low in sulfur content, it also lowers sulfur emissions when blended with petroleum diesel. Biodiesel blending also imparts improved lubricity to petroleum diesel. Since it is domestically produced, biodiesel shows great potential for reducing dependence on foreign energy supplies. It provides a "closed economic loop" in that the feedstock can be grown locally, the biodiesel can be produced locally, and the fuel can be used locally. Furthermore, it is evident that very minimal to no infrastructure change is necessary to implement wide spread biodiesel use. Biodiesel blends can be used in any diesel engine and can be transported and stored using existing infrastructure. Pure biodiesel is environmentally non-toxic and biodegradable. In this experimental work ,performance of diesel engine operating on certain load with Eucalyptus oil was evaluated and compared with diesel operation. The performance parameter considered for comparing is brake specific fuel consumption, volumetric efficiency. This study targets on investigating the effect of bio-diesel on performance and emission of diesel engine.*

Keywords*:* Biodiesel, Diesel, Emission, Engine performance Eucalyptus oil

I. INTRODUCTION

The main reason for the need of alternate fuels for IC engines is the emission problems. Combined with other air polluting factors, the large number of automobiles is a major contributor to the air quality problems of the world. Diesel engines are highly preferred for transportation since they are highly efficient and durable in the long run. However, because of lack of crude oil reserves, fuel cost and emission norms, alternative fuels are of high interest to replace the diesel fuel in diesel engines. Many alternative liquid fuels for diesel engines such as bio-diesel, alcohol have been introduced in the recent past. Today Most of the alternative fuels are biomass derived and easily available. Many alternative fuels blends has been introduce in past and they gave very satisfying results. Therefore, in this work the eucalyptus oil which is high octane biomass derived fuel is blended with diesel in different proportions by volume and used as fuel in four stroke single cylinder diesel engine. The performance and emission characteristics of the engine were studied. The results show the reduction in consumption of fuel as the brake specific fuel consumption was found to decrease. The improvement in brake thermal efficiency is also observed. While the emission parameters were also improved, emissions were significantly reduces as the load was increasing compared to the other bio diesels.

Eucalyptus oil can be extracted from eucalyptus leaves, abundantly available throughout the year. Currently the eucalyptus oil uses are limited just for few traditional applications such as medicine or traditional pharmacopoeia. After the extraction of pure Eucalyptus oil it was transformed into biodiesel by the method of trans esterification the extracted biodiesel properties were compared and studied with those of petroleum diesel to learn its adaptability for use in compression ignition engine the eucalyptus oil was blended with diesel in following ratios E5, E10, E15, E20, E30 (5% ,10%, 15%, 20%, 30% by proportion).

Fig.1. Eucalyptus seeds

Cetane number of Eucalyptus oil prevents the complete replacement of diesel fuel from the diesel engine. When eucalyptus oil which has high volatility and low viscosity is blended it results in a fuel with reduced viscosity and increased volatility. The reduction in viscosity and increase in heating value would result in better engine performance. The volatility of the blend also increased which results in fine atomization and better spray formation. The properties of blend like lower calorific value, flash point and viscosity are comparable with those of diesel oil, Eucalyptus oil.

Properties ofDiesel	Diesel	Eucalyptus biodiesel
Density(150C)	0.875	0.911
Viscosity(400C)cSt	1.67	1.94
Calorific	44.2	43.2
Flash point (0C)	58	34
Firepoint (0C)	67	43
CetaneIndex	51	49.5

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At present the amount of biodiesel available is less than that of diesel. The biodiesel blended with diesel by volume as B5 (5% biodiesel & 95% diesel fuel), B10 (10% biodiesel & 90% diesel fuel), B15 (15% biodiesel & 85% diesel fuel), B20 (20% oil biodiesel & 80% diesel fuel), B30 (30% biodiesel & 70% diesel fuel). Then the samples were proceed for their property testing's.

TestDescription	B00	B5	B10	B15	B20	B30
Density (Gm/cc)	0.832	0.833	0.833	0.834	0.836	0.839
CV MJ/kg	42.50	42.39	42.28	42.11	41.90	41.55
Flashpoint	64	68	72	79	85	105

II. VARIABLE COMPRESSION RATIO ENGINE (VCR)

Variable compression ratio is a technology to adjust the compression ratio of an internal combustion engine while the engine is in operation. This is done to increase fuel efficiency while under varying loads. Higher loads require lower ratios to be more efficient and vice versa. Variable compression engines allow for the volume above the piston at 'Top dead centre' to be changed. For automotive use this needs to be done dynamically in response to the load and driving demands.

Variable compression engines have existed for decades but only in laboratories for the purposes of studying combustion processes. These designs usually have a second adjustable piston set in the head opposing the working piston. (Very much like model aircraft 'Diesel' engines). Earlier variable compression engines have been highly desirable but technically unobtainable for production vehicles due to the mechanical complexity and difficulty of controlling all of the parameters. However, new solutions like Waulis approach does not use a second piston and is implemented to existing 4-cylinder engine with minor modifications. This is a promising sign towards full commercial production readiness and cost-efficient innovative solution which will change the future of VCR engines.

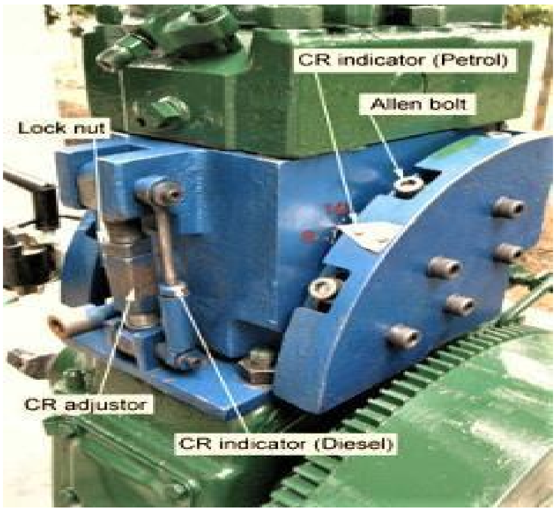


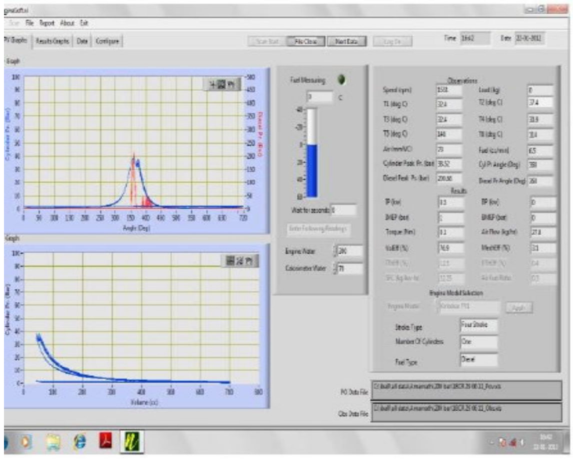
Fig.2. Adjustment of compression ratio diagram

Engine Specifications	• Singlecylinder. • 4strike,watercooled. • Stroke110mm. • Bore87.5mm. • Diesel3.5kW. 1500RPM. • CRrange12to18. • Injectionvariation0to250. • Constantspeed
Dynamometer	• Typeeddycurrent • Watercooled • Withloadingunit

Two separate fuel tanks with a fuel switching system are used, one for diesel (D100) and the other for biodiesel (B100). Fuel consumption is measured using optical sensor. A differential pressure transducer is used to measure airflow rate. Engine is coupled with an eddy current dynamometer to control engine torque through computer. Engine speed and load are controlled by varying excitation current to eddy current dynamometer using dynamo meter controller. A piezoelectric pressure transducer is installed in engine cylinder head to measure combustion pressure. Signals from pressure transducer are fed to charge amplifier. A high precision crank angle encoder is used to give signals for top dead centre and crank angle. The signals from charge amplifier and crank angle encoder are supplied to data acquisition system. An AVL exhaust gas analyser and AVL smoke meter are used to measure emission parameters and smoke intensity respectively. Thermocouples are used to measure exhaust temperature, coolant temperature, and inlet air temperature.

III. ENGINE SOFT SOFTWARE

Lab view based Engine Performance Analysis software package Engine soft LVI is used for the on line performance evaluation figure gives an image of a typical menu during interface with Engine soft LV. Engine Soft LV can serve most of the engine testing application needs including monitoring, reporting, data entry, data logging. The software evaluates power, efficiencies, fuel consumption and heat release. It is configurable as per engine set up. Various graphs are obtained at different operating conditions. While on line testing of the engine is in RUN mode necessary signals are scanned, stored and presented in the form of graphs. Stored data file is accessed to view the data graphical and tabular formats. The results and graphs can be printed. The data in excel format can be used for further analysis.

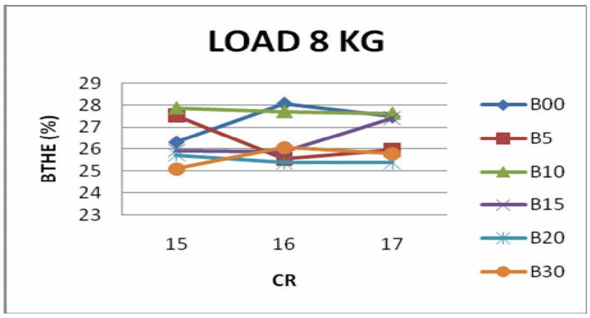


The Experiments were performed on two basic independent parameters like Load and Compression ratio for various blends of Bio-Diesel and Diesel fuel on CI Engine.

IV. RESULTS

From the experiments performed and the observation table obtained, following results were concluded.

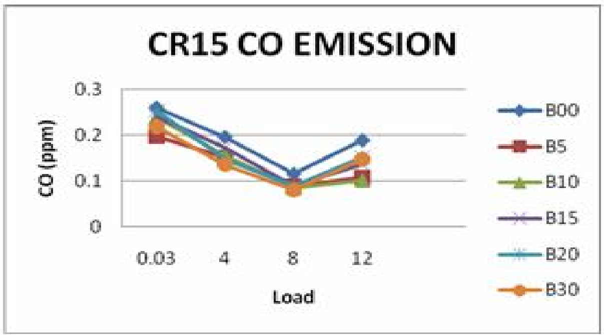
It can be seen that Brake power increases with increasing load and compression ratio. The above graph shows BP varying with CR and Blends. The highest Brake Power can be seen at Blend B10 for CR 16 at load 12 Kg.

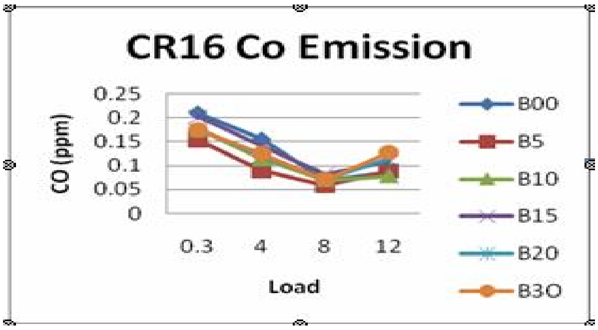


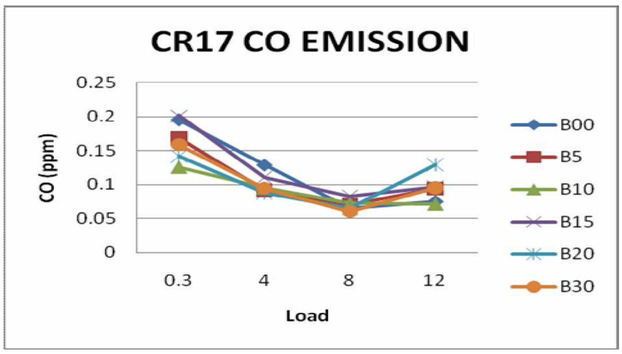
The brake thermal efficiency increases with increase in brake power and decreases with increase in calorific value.

Hence we have found that maximum BTHE is for blend B10 at CR 16 and CR 15 at Load 12 Kg.

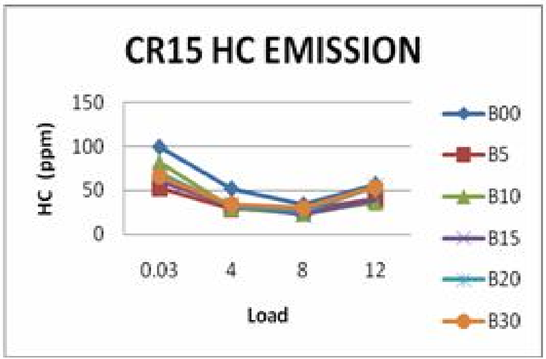
Mechanical efficiency increases with increasing Brake power and decreases with increasing Indicated power. Maximum mechanical efficiency can be seen for Blend B30 at CR 15 & CR17 for load of 12 Kg.

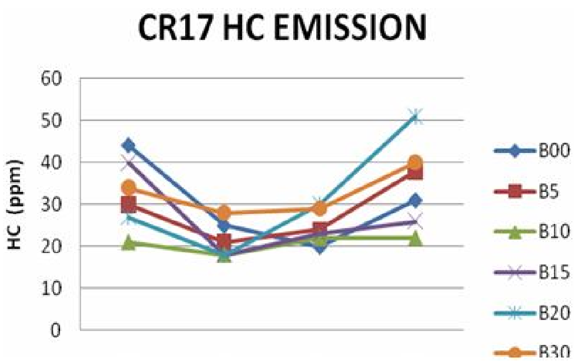


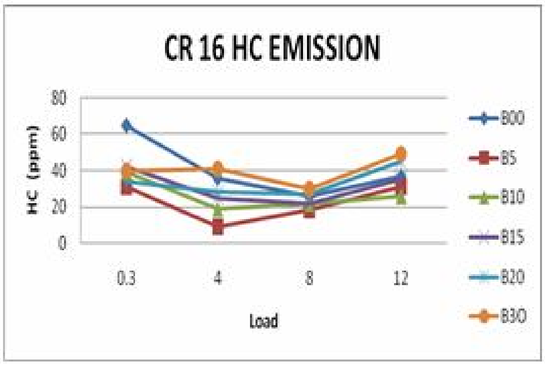




There is a decrease in CO emissions with increasing load from 0.3 kg to 8 kg. After 8 kg, CO emissions increase with increasing load. This is because after 8 kg, frictional losses increase which decreases cylinder temperature. Hence, CO emissions are lowest for blend B30 at load 8 kg at CR 17. Other factors such as oxygen content and viscosity also affect the CO emissions.







From the graph, it can be seen that HC emissions for all blends first decrease and after 4 kg of load it increases. This is because at 4 kg load, there are less frictional losses which increase the cylinder liner temperature, hence decreasing the HC emissions. It can also be seen that B10 blend has approximately near values to pure diesel. Similarly CO emissions increase with increase in load and blends. The lower percentage of biodiesel blends emits very low amount of CO_2 in comparision with diesel. As the biodiesel blend percentage increase in blended fuel, the combustion is improved with high oxygen content. Hence CO2 emission increases with high combustion temperature and oxygen content.

V. CONCLUSION

It can be observed that the calorific value of eucalyptus oil is comparable to that of diesel. Also its density is within the acceptable range as per the ASTM norms. The viscosity is the factor which signifies whether the engine parts needs to be modified or not. Since, it is also in the acceptable range, there is no such issue. This makes the eucalyptus biodiesel to be experimentally fit without any modifications in parts of the engine. As per the study concluded, it is feasible to work over the eucalyptus biodiesel in a variable compression ratio engine. Though, the experimentation would show the results including relatively less performance as compared to diesel, it would definitely produce similar brake power with slightly higher fuel consumption .It is better to use the trans esterified biodiesel with or without blending in the diesel engine as it would add an advantage of fuel flexibility without making changes in existing parts along with assurance for extended engine life. The range of blending that should be considered during experimentation is 10-50%, as it can be seen from literature survey to obtain satisfactory results. The emissions using the biodiesel could be satisfactorily reduced; the CO, CO2, and HC reduce while the NOx emissions should increase because of higher oxygen content and higher exhaust gas temperature as compared to that with diesel. Performance parameters of eucalyptus oil biodiesel are better than diesel.

After studying all the above graphs and results, we came to a conclusion that the blend B10 (10% biodiesel and 90% diesel) shows better performance characteristics and low emissions at CR 16 and partial load (4 kg and 8 kg).

REFERENCES

[1] PuneetVerma ,Mahendra Pal Sharma, GauravDwivedi, “Potential use of eucalyptus biodiesel in compressedignition engine’’11 March 2015.

[2] N. S Senthur, T. S Ravikumar, Cijil. B. John “Eucalyptus Biodiesel; an Environmental friendly fuel for Compression Ignition Engines’’ American Journal of Engineering Research (AJER) 2014.

[3] J. Allen Jeffrey, D. Nandhakumar, L.Martin, M. Mansoor, Ali khan and V. Mukeshkumar, “Eucalyptus Oil Biodiesel A Promising Fuel For The Near Future” Research Journal of applied science, (IJSETR) 2016.

[4] Atul.G. Londhekar, S.C. Kongre, “Effects of Different Additives on Performance and Emission of Biodiesel Fuelled Compression Ignition Engine” International Journal of Science and Research (IJSR) 2017.

[5] P.SrinivasaRao and K. Srinivas, “Experimental Analysis Of Single Cylinder Diesel Engine Fuelled With Methyl Ester Of Palm Kernel Oil Blending With Eucalyptus Oil” International Journal of Engineering Research and Applications (IJERA) 2012.

[6] D.D Nagdeote and M.M. Deshmukh, “Experimental Study of Diethyl Ether and Ethanol additives with Biodiesel-Diesel Blended Fuel Engine” International Journal of Emerging Technology and Advanced Engineering, March-2016.

[7] Santosh Kumar, RohitChandel and Rakesh Kumar, “Performance and emission characteristics of eucalyptus oil and diesel blend in four stroke single cylinder diesel engine” International journal of renewable energu research, February 2016

[8] Prabu, A., Anand, R. B “Production and Application of Biodiesel – A Case Study’’July 2012

[9] AlirezaValipour,“A Review on Effect of Fuel Additives on Combustion, Performance and emission Characteristics of Diesel and Biodiesel Fuelled Engine” International Journal of Application or Innovation in Engineering & Management, (IJAIEM)January 2014.

[10] M. Krishnamoorthi, R. Malayalamurthi, “A Comparison of Performance and Emission Characteristics of Three Alcohol Biofuels: Ethanol, n-butanol and Isopropyl,(IJPSRR) October 2016.