Study of LPG and Eucalyptus Oil Biodiesel in a Dual Fuel Engine

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Abstract— **These instructions give you guidelines for preparing papers for International Journal of Science, Engineering and Technology Research. Use this document as a template if you are using Microsoft Office Word 6.0 or later. Otherwise, use this document as an instruction set. The electronic file of your paper will be formatted further at International Journal of Computer Theory and Engineering. Define all symbols used in the abstract. Do not cite references in the abstract. Do not delete the blank line immediately above the abstract; it sets the footnote at the bottom of this colum Elevated environmental awareness and lack of availability in fossil fuels is encouraging commercials to develop viable alternative fuels like hydrogen, Liquid petroleum gas, biodiesel from vegetable oils, compressed natural gas and biogas to provide stand in to diesel fuel for diesel engine. This present work deals with using LPG and eucalyptus oil biodiesel in dual fuel mode in a four stroke single cylinder diesel engine. The biodiesel is blended with diesel and stored in the fuel tank and LPG gas is sent through the intake manifold and made to mix with intake air .Analysis were carried out for performance and emission characteristics. It was found that lesser Hydrocarbon and carbon monoxide emission for biodiesel blend and LPG-bio diesel blend when compared with diesel and higher Nitrogen oxide emission for biodiesel blend and LPG- bio diesel blend. In terms of Performance lower Brake thermal efficiency and higher Specific fuel consumption for biodiesel blend and LPG-bio diesel blend.**

Index Terms— **Liquid petroleum gas, Biodiesel, Dual fuel and Diesel engine.**

1) INTRODUCTION

One of the most successful inventions in day to day life is use of diesel in diesel engine. Using vegetable oil in diesel engine was started way back in 1900. The plant oil fuels were not accepted much at that time. It was found that all the properties of plant oils were close to diesel except viscosity and volatility Diesel could be re placed by the plant oil with satisfactory engine performance [1] Compression ignition engine generally uses diesel as the fuel for combustion which expels more power and better efficiency. But it ultimately leads to environmental hazards like HC, CO and NOx emission. As an opportunity to reduce the level of pollution, various alternate fuels like producer gas, biogas, alcohols, vegetable oils, microbial oil and many more find its application as a whole or mixed under various proportions along with diesel are used. [2] Compression ignition engines are preferred prime movers due to their excellent drivability and higher thermal efficiency. In order to meet the norms and Also the fast depletion of oil reserves have necessitated a search for alternate fuels for diesel engines. On the other hand, due to the rapid growth of automotive vehicles in transportation sector, the consumption of oil keeps increasing [3]. For substituting petroleum fuels used in IC engines, fuel of bio-origin provides a feasible solution to the twin crisis of fossil fuel depletion and environmental degradation. The importance on controlling emissions from automobiles while improving fuel economy has increased a substantial research and development effort in pollution control. As result, control technology and the understanding of pollutant formation mechanisms have been developed rapidly during the past decade. [4]

Recently in this mundane world dual fuel technology is widely adopted and nominated method with gaseous and blended fuel in four stroke engines. In this present work eucalyptus oil biodiesel and liquefied petroleum gas is used in single cylinder compression ignition engine in dual fuel mode to increase the performance characteristics and reduce emission from the exhaust. LPG ensembles as a effective gaseous fuel due to lesser content of carbon, clean combustion and availability of the fuel. It also reduces the wear inside cylinder and overall improves engines life to a greater extent. Eucalyptus oil was used as biodiesel. The bio diesel was prepared by transesterification process with the help of methanol and NaOH and the derived oil was analyzed using gas chromatography spectrometry analysis. Firstly the effect of diesel fuel were studied secondly biodiesel blended with diesel were studied finally liquefied petroleum gas with biodiesel blends were analyzed briefly in compression ignition engine from low load to full load and the corresponding performance and emission characteristics were examined.

2) MATERIALS AND METHOD

A. Transesterification

Biodiesel, can also be called as fatty acid methyl ester (FAME), is produced from transesterification of vegetable oils or animal fats with the addition of methanol and NaOH . Eucalyptus oil is extracted from eucalyptus leaves and it is abundantly available throughout the year. The various fatty acids present in eucalyptus oil are Palmitic acid, Oleic acid, Octadecenoic acid and Hexanoic acid. Transesterification process was used to convert raw eucalyptus oil into eucalyptus oil biodiesel. The procedure involved in this method is as follows 1000 ml of eucalyptus oil is taken in a round flask and is heated and maintained at a temperature of 60^0C for one hour. Then 10 grams of sodium hydroxide

(NaOH) and 200 ml of methanol (CH_3OH) were taken in a separate beaker. The sodium hydroxide (NaOH) and the alcohol (methanol) are thoroughly mixed until it is properly dissolved to form sodium methoxide solution . The solution obtained is mixed with eucalyptus oil in the flask and it is stirred properly. The Methoxide solution with eucalyptus oil is heated to 60^{o}C and it is continuously stirred at constant rate for 1 hour by a rotating stirrer. The solution is poured down to the separating beaker and is allowed to settle for 24 hours. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Methyl ester is separated from the glycerin. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated methanol. Certain impurities like sodium hydroxide (NaOH) etc. are still dissolved in the obtained biodiesel. These impurities are cleaned up by washing with 250 ml of water for 1000 ml of biodiesel

Figure (1) Ricebran oil

Figure (2) Glycerol separation

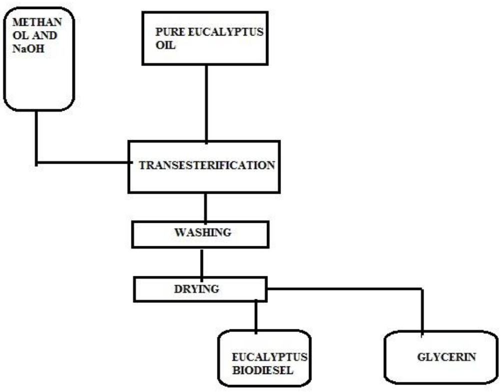

Figure (3) Transesterification Process

Table (1) Properties of Eucalyptus biodiesel

Property	**Conventional diesel**	**Eucalyptus biodiesel**
Density (15^0 C)	0.879	0.917
Viscosity (40^0 C) cSt	1.679	1.99
Calorific Value	44.3 MJ/Kg	42.1 MJ/Kg
Flash point (^{0}C)	59	37
Fire point (^{0}C)	69	41
Cetane Index	54	48.7

B. GC/MS Analysis

This analysis was carried out with the help of JOEL GC MATE 2 GC MS system. The system identified five major fatty acid ester namely Palmitic acid, Oleic acid, Octadecenoic acid and Hexanoic acid present in Eucalyptus

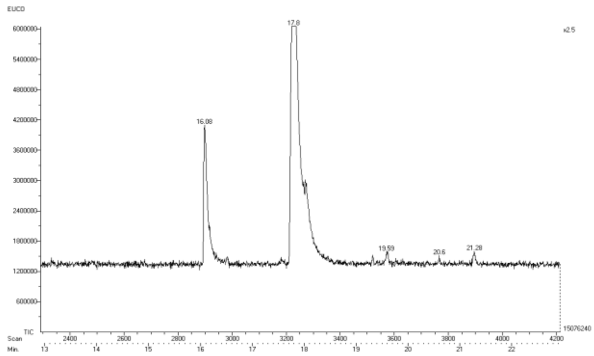

Figure (3) GC/MS Mass Spectrum for Eucalyptus Oil Methyl Ester

Biodiesel as shown in table (2). The base peak of the chromatogram was found at RT 17.8.Various minor and major peaks were also identified at RT 16.08, RT 19.59, RT 20.6 and RT 21.8.

Table (2) Fatty A cid Methyl Ester in Eucalyptus oil

Rete ntion time	**Name of ester**	**Name of fatty acid**	**No of Ions**	**Scan**
16.0 8	Hexadec anoic acid methyl ester	Palmitic acid	614	2898
17.8	Octadece noic acid methyl ester	Oleic acid	358	3228
19.5 9	Octadece noic-acid,2-(hex adecyloxy)e thyl ester	Octadecen oic acid	818	3571
20.6	Cholest-5 -en -3 –ol-6- nitro acetate ester	Hexanoic a cid	756	3766
21.2 6	18-Norch olest dien-21- oic acid		811	3896

3) EXPERIMENTAL SETUP

The performance and emission tests were performed on a constant speed, single cylinder four stroke, and vertical air cooled compression ignition engine. The specifications of the engine are mentioned in table (3). The performance and emission tests were conducted at a constant speed of 1500 rpm and a varying load from no load to full load. The engine was modified in the dual fuel mode by connecting LPG cylinder lines to the intake manifold with a flame trap to avoid back fire and a mixing unit. A crypton five gas analyzer was used to measure the HC, CO,NO_X in the exhaust and Bosch smoke metre was used to find the intensity of the smoke from the exhaust The pilot flow rate of Eucalyptus biodiesel was varied using the fuel injection pump and the LPG flow rate was adjusted with the help of flow control valves and flow metre .

Figure (4) Experimental Setup

Table (3) Specification of Test Engine

Engine Make	**Greaves**
Model No	5520
Engine Type	Single cylinder four stroke vertical air cooled
Injection timing	260 BTDC
Bore	78mm
Stroke	68mm
No Of Cylinders	1
BP	5 hp
Compression Ratio	18:1
Speed	3000-3600 rpm

4) RESULTS AND DISCUSSIONS

A. Performance Characteristics

Brake Thermal Efficiency

The variation of brake thermal efficiency with Biodiesel blend and LPG along with biodiesel at various loads is shown in figure (5). It is evident that at low loading condition all variants of fuel reflect less efficiency. It is evident in each case except at low loads, there is an optimum combination of inducted to injected fuel, at which maximum efficiency is found. At lesser flow rates of LPG, the thermal efficiency is lower throughout the low load spectrum than that of neat diesel operation. The lean LPG-air mixture does not encourage flame propagation resulting in incomplete combustion. The brake thermal efficiency of biodiesel blends and LPG- biodiesel were lower when compared with straight diesel. This may be due lesser calorific value of biodiesel

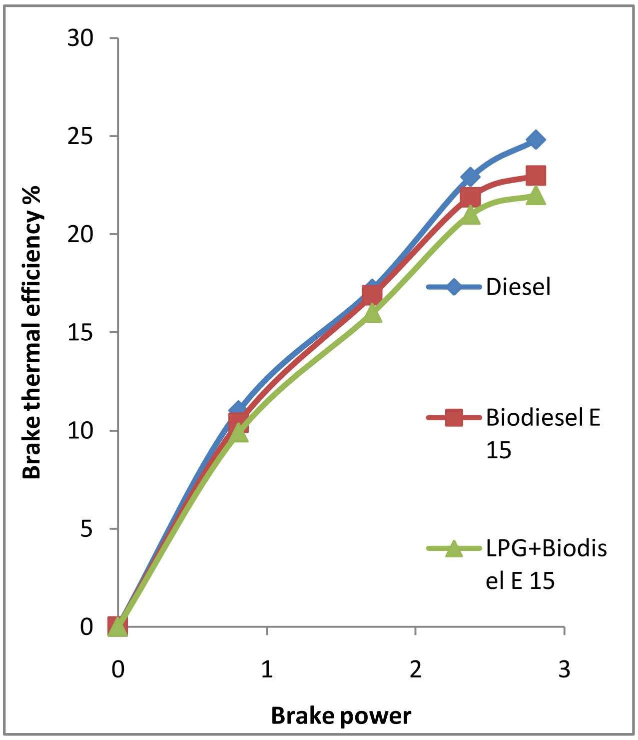

Figure (5) Variation of Brake thermal efficiency with output power

Brake Specific Fuel Consumption

Figure (6) shows the variation of specific fuel consumption and brake power with straight diesel, biodiesel blends and biodiesel-LPG in a dual fuel mode. Specific fuel consumption is one of the important parameters which project the fuel efficiency of an engine. The graph shows that specific fuel consumption is higher for all fuel variant at low loading condition the specific fuel consumption for straight diesel is lesser when compared with other fuel variants this may be due to incomplete combustion and atomization of biodiesel blends and LPG- biodiesel blends.

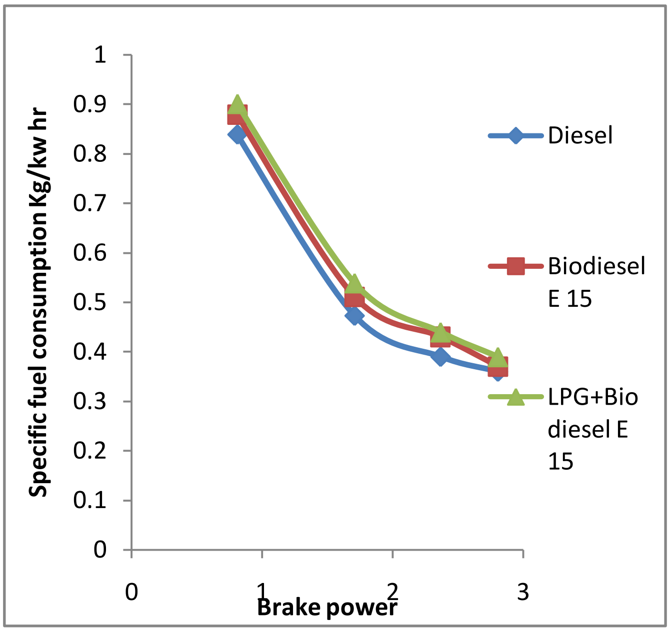

Figure (6) Variation of Specific Fuel Consumption with output power

B. Emission Characteristics

Carbon Monoxide Emission

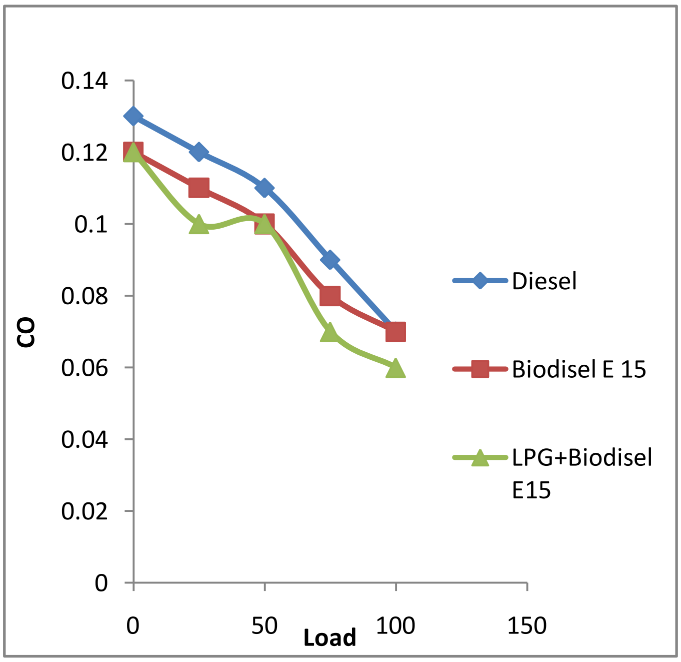

Figure (7) Variation of Carbon monoxide emission

The variation in carbon monoxide between diesel, biodiesel blends and LPG- biodiesel blends is shown in figure (7).Carbon Monoxide emissions are formed due to incomplete combustion, insufficient air and improper ignition delay [2].The carbon monoxide emission were higher at loads when diesel was used as fuel but there were reduction in carbon monoxide emission when biodiesel was used as fuel and there was further reduction when LPG and biodiesel was used as fuel.

Hydrocarbon Emission

The variation of hydrocarbon emissions for straight diesel, biodiesel blend and LPG- biodiesel in dual fuel mode is shown in figure (8). Hydrocarbon emission was found to be lower for Biodiesel blend. Secondly the lower hydrocarbon was in LPG –Biodiesel blends for complete range of operating condition when compared with diesel this is due to additional ignition sources.

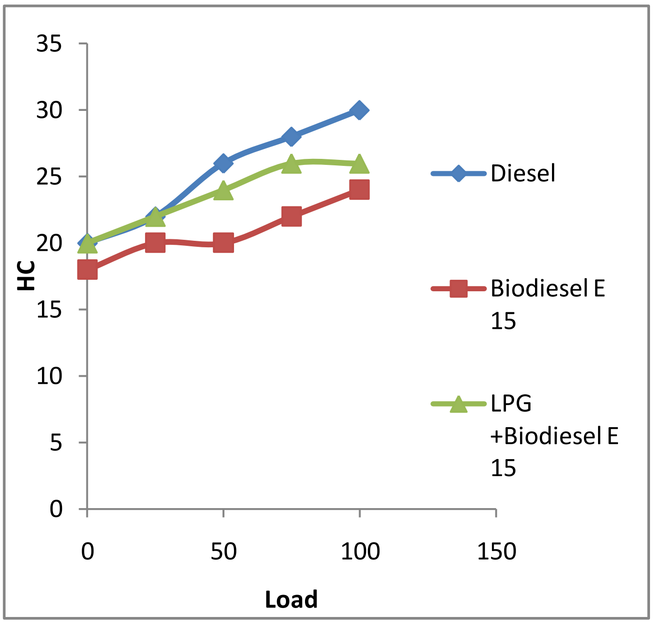

Figure (8) Variation of Hydro carbon emission

Nitrogen oxide emission

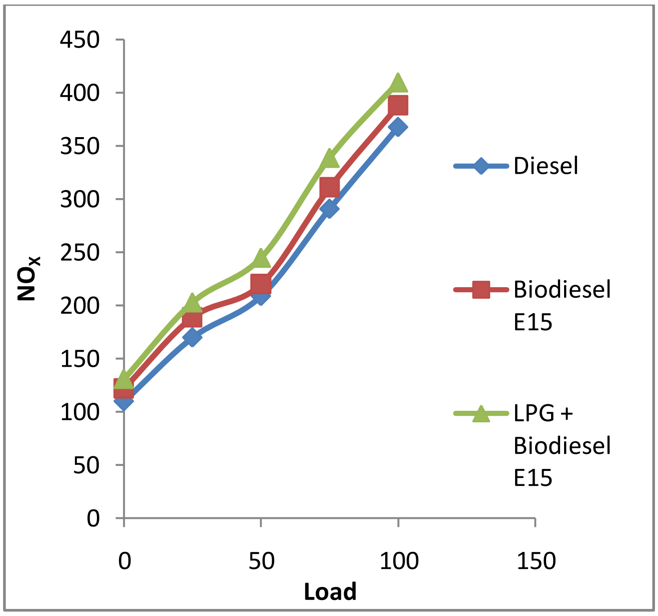

Figure (9) Variation of Nitrogen oxide emission

The variation of nitrogen oxide emission with load for straight diesel, biodiesel and LPG-biodiesel in dual fuel mode is shown in figure (9).The NOx emission consists of nitric oxide, nitrous oxide and nitrogen dioxide in different percentages which are formed due to rise in cylinder temperature during combustion. The NOx emission was found to be higher when LPG–Biodiesel blends were used as fuel when compared with diesel this is due to rise in operating temperature the rise in temperature is due to traces of oxygen in biodiesel and usage of LPG along with biodiesel.

5) CONCLUSION

From the Experimental investigation the following conditions were spotted.

- Biodiesel was prepared through Transesterification method using methanol and sodium hydroxide and nearly 78% of eucalyptus methyl ester were extracted. GC/MS analysis revealed the presence of namely palmitic acid ,oleic acid,octadecenoic acid and hexanoic acid in strong proportions.
- The brake thermal efficiency were slightly lower for biodiesel blends and LPG- biodiesel blends when compared with diesel
- The specific fuel consumption were slightly higher for biodiesel blends and LPG- biodiesel blends when compared with diesel
- The carbon monoxide emission were slightly lower for biodiesel blends and LPG- biodiesel blends
- The hydrocarbon emission were lower for biodiesel blends and LPG- biodiesel blends when compared with diesel
- The nitrogen oxide emission increased when biodiesel blends and LPG- biodiesel blends were used as fuel
- The smooth function of the engine was seen at 2.7-7.7 mg/cycle of eucalyptus oil biodiesel and reminder of LPG with injector pressure of nearly 120 bars.

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