Eucalyptus Oil Biodiesel A Promising Fuel For The Near Future

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***Abstract*— Conventional fuels such as petrol diesel are very important energy sources for this current era but the emission from conventional fuels and depletion of conventional fuels is propelling researchers to shift on biodiesel. In the current study pure eucalyptus oil is derived and transformed into biodiesel by transesterification process and blended with diesel the blends ratios were (15%, 25% and 30% by volume) and the blended fuel is made to run in an single cylinder four stroke air cooled compression ignition engine. The performance characteristics like SFC, BP and BTH and for emission CO, HC and NO_X in the exhaust gases was analysed and studied. After analyzing all the fuel blends for all the loading conditions of the engine the result showed that there was a significant reduction in HC and CO emission and increased NO_X emission when biodiesel blends were increased. This can be rectified by small modifications in the engine. The performance characteristics of biodiesel blends was not equal to conventional diesel at all loads**

***Index Terms* — Biodiesel, Compression ignition engine, Eucalyptus oil and Transesterification**

I. INTRODUCTION

Alternative fuels have gained more essence in the recent era and numerous researches have been carried out to supersede conventional fuels. Fuel energy extremity and shoot up in need of Petrol and diesel fuels have opened doors for application of bio fuels. Increased exhaust emissions from conventional fuels has lead to environmental contamination and global warming. The fact that the fossil fuel reserves are getting expend everyday is leaving the world pathetic. It is the best time for every human to pay serious attention in finding an alternative other than petroleum and diesel fuel sources which could be used as unorthodox fuels to the conventional fuels such as petrol and diesel. The main reaction needed for converting oil to biodiesel is called as transesterification Transesterification is the process of reacting a triglyceride molecule with an excess of alcohol in the presence of a strong base catalyst such as KOH, NaOH, NaOCH3 etc. To produce fatty ester and glycerol [1] Even though several other techniques are available for biodiesel preparation, transesterification is the best method as the physical characteristics of the ethyl esters produced closely resemble those of petro-diesel and the production process is relatively simple [2] In recent decade, the main focus it to prepare biodiesel from edible oils like cottonseed oil, sunflower oil, coconut oil. Producing biodiesel from edible oils may leave negative effect on agriculture in terms of scarcity of food crops so non-edible oils are preferred for production of biodiesel.[3] Numerous biodiesels, which are extracted from different vegetable oil sources, have been tried as alternative to diesel fuel for several years. Previous researches in this field showed that the use of biodiesels resulted in a performance comparable to diesel fuel with added benefit of lower emissions. Biodiesels are also expected to reduce the engine wear in diesel engines as they are found to have better lubrication properties than petro-diesel [4].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 [5].After the extraction of pure Eucalyptus oil it was transformed into biodiesel by the method of transesterification 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 E15,E25,E30 (15% ,25%,30% by proportion) the experiment were carried out on a kriloskar TAF 1 Four stroke single cylinder vertical air cooled diesel engine at varying load (from no load to full load) and constant rpm the outcome of the engine performance and emission were thus observed and studied

II MATERIALS AND METHOD

Vegetable oils are triglycerides of fatty acids and alcohol esters of fatty acids have been prepared by the transesterification of the glycerides, wherein linear, monohydroxy alcohols reacts with the vegetable oils in the presence of catalyst to produce alcohol esters of vegetable oil. [6] .Transesterification is the process of cutting down heavier molecules into lighter ones In this process of preparing eucalyptus biodiesel ethyl ester was employed ethanol was used as alcohol in this process. First pure eucalyptus oil was taken in a beaker the quantity was 500ml pure eucalyptus oil 100 ml ethanol and 5 grams of NaOH Flakes. The eucalyptus oil in the beaker was heated around 50^0C-60^0C in a burner the oil was stirred thoroughly as shown in the Figure(1). While the oil is heated at one side on the other hand simultaneously the NaOH flakes is made to dissolve completely and mixed with ethanol to form sodium ethoxide solution shown in the Figure (2). After heating the oil for an hour the sodium ethoxide is poured into the heated oil and stirred for an another hour maintain the temperature for around 50^0C-60^0C while stirring the colour transformation took place from yellow to light red in colour after that the entire

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solution from the beaker is now poured into a separation flask for allowing the glycerol to separate from biodiesel it took nearly 24 hrs for the glycerol to get separated as shown in Figure (3) .After separating the glycerol which looked in black colour was segregated from the biodiesel the extracted biodiesel is heated for around one hour to remove any untreated ethanol and the biodiesel was washed with 15% ethanol to eliminate impurities. The cleaned biodiesel thus obtained was the ethyl ester of Eucalyptus oil, which is known as Eucalyptus biodiesel.

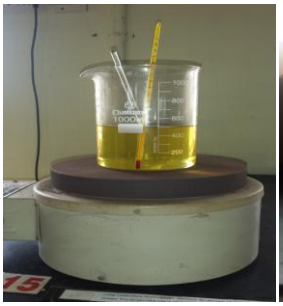

Figure (1) Heated oil

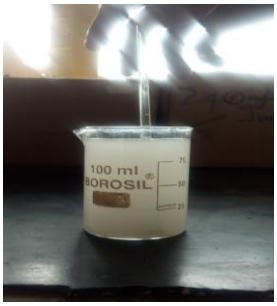

Figure (2) Sodium Ethoxide

Figure (3) Glycerol separation

Table I Properties of Diesel and Eucalyptus biodiesel

Property	Conventional diesel	Eucalyptus biodiesel
Density (15^0 C)	0.875	0.911
Viscosity (40^0 C) cSt	1.67	1.94
Calorific Value	44.2 MJ/Kg	43.2 MJ/Kg
Flash point (^{0}C)	58	34
Fire point (^{0}C)	67	43
Cetane Index	51	49.5

After comparing the results the eucalyptus oil biodiesel shows almost identical properties hence it can used as bio fuel in an diesel engine

III EXPERIMENTAL SETUP

The performance and emission tests were performed on a constant speed, single cylinder vertical air cooled diesel engine. The specifications of the engine used for the test are given below. All the performance and emission tests were conducted at a constant speed of 1500 rpm and a varying load.

Table II Engine specification

Engine	Kriloskar TAF 1
Type	Four stroke air cooled engine
Compression ratio	17:5:1
Injection timing	23^0
Injection pressure	200 bar
Rated power	4.4 KW
Rated speed	1500 rpm
No of cylinder	Single cylinder
Bore dia	87.5mm
Stroke	110 mm

The engine was integrated to a load bank with electrical loading. A DC generator with electrical load bank was used for loading purposes. The rheostat connected in series to controls the load on the engine by controlling the voltage. oxygen content Unburned Hydrocarbons Carbon monoxide, and Nitrogen oxide emissions was measured by using AVL DI 444 Five gas analyzer and the smoke was measured using the AVL 415 smoke meter the figure(4).Shows the experimental setup of the engine

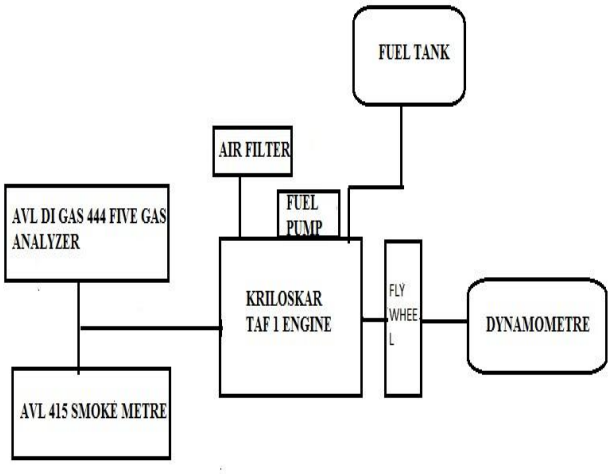

Figure (4) Experimental setup

In the beginning the engine is made to start and run with conventional diesel after warm up phase the performance and emission characteristics of conventional diesel is noted and plotted and the same is followed for eucalyptus biodiesel the blends which was employed was E15 (15%biodesel and 85%

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diesel) ,E25(25%biodesel and 75% diesel) and E30 (30 %biodiesel and 70 % diesel) once the procedure was completed all the values are noted for further reference and the values are calculated. With the calculated values the graphs are plotted.

IV RESULTS AND DISCUSSIONS

The experiments was conducted in a Kriloskar TAF engine at an injection pressure of 200 bar, compression ratio 17.5:1 and a standard injection timing 23°.

A) Performance characteristics

Brake thermal efficiency

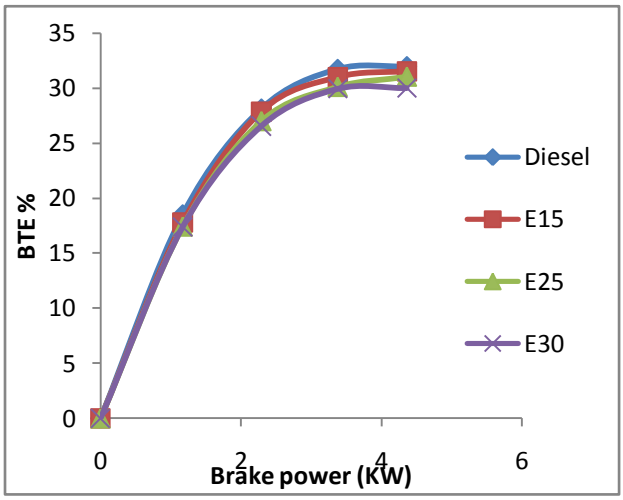

Figure (5) Variation of BTE with output power

Brake thermal efficiency projects the engine efficiency and it is one of the significant factor to measure the efficiency of the engine The variation in Brake thermal efficiency with respect to power output at various loads for conventional diesel and eucalyptus biodiesel blends is shown in the figure(5). It is evident that there is an rise in brake thermal efficiency as the load is increased the maximum Brake thermal efficiency was found with conventional diesel at full load (32.3 %) at the rated output the eucalyptus fuel blends resulted in reduction of brake thermal efficiency approximately by (3%). It is quite natural that when increase in biodiesel blends resulted in decrease in brake thermal efficiency this may be due to the inferior heating values guiding to a slower burning process when compared to conventional diesel.

Specific fuel consumption

The specific fuel consumption of an engine can be defined in terms of specific fuel consumption in kilogram per kilowatt hour. It is an important parameter that a display how capable is the engine performance it is inversely proportional to the brake thermal efficiency. The figure (6) represents the specific fuel consumptions for conventional diesel and biodiesel blends at varying loading conditions in the previous graph we could see brake thermal efficiency is greater when compared to biodiesel blends hence the lowest SFC is recorded by conventional diesel when comparing it with eucalyptus biodiesel blends. The main criteria for rise in SFC is the heating value reduces when blend is increased

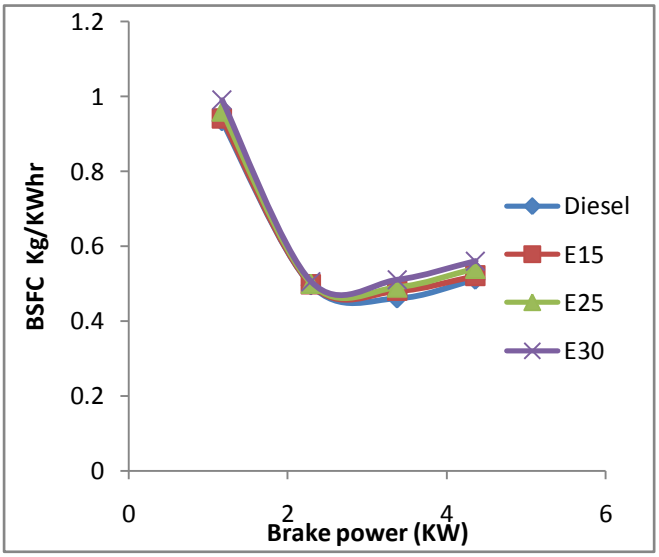

Figure (6) Variation of SFC with output power

B) Emission characteristics

CO Emission

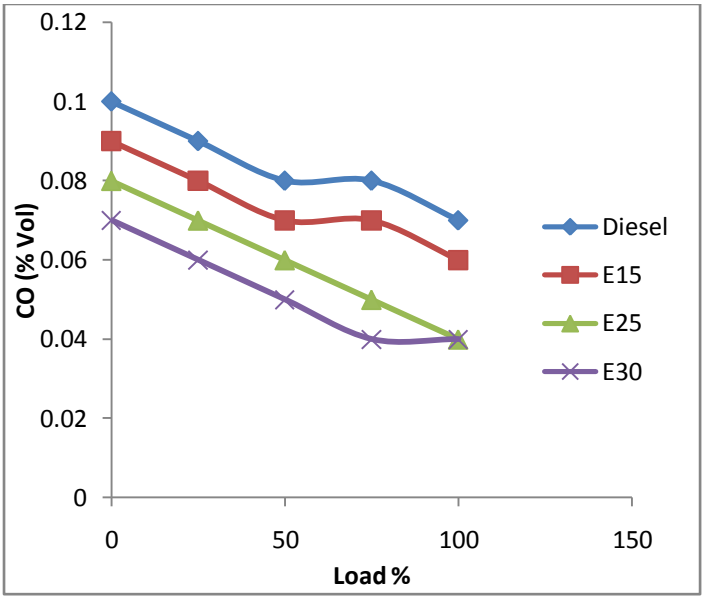

Figure (7) Variation of Carbon monoxide emission

The variation in CO emission for diesel and eucalyptus oil biodiesel at various loads of the engine is shown in figure (7). It is evident that there is a drastic reduction in CO emissions while using biodiesel blends when comparing it with conventional diesel. The cause for the reduction in CO emissions is because of more effective and complete combustion taking place due to the more number of oxygen content in the biodiesel. The availability of sufficient oxygen content causes most of the CO to be oxidized and converted to CO_2 but the entire conversion of CO to CO_2 is never attainable

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HC Emission

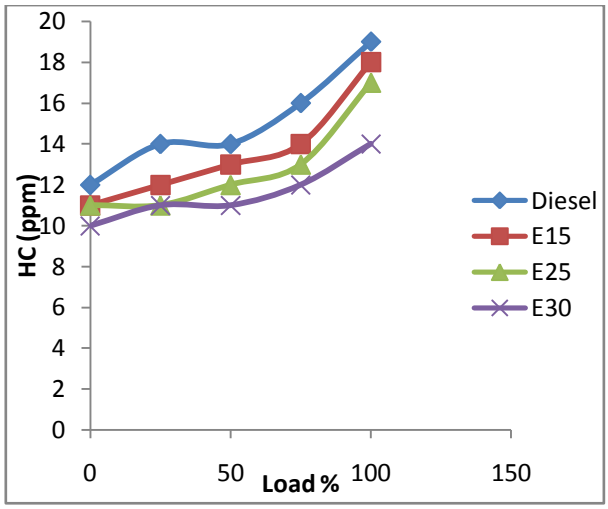

Figure (8) Variation of Hydro carbon emission

The HC emission is because of rich fuel mixture and insufficient combustion. Almost Similar to CO emissions, HC emission also occurs when the fuel fails to ignite completely inside the combustion chamber. The variations in HC emission for conventional diesel fuel and eucalyptus biodiesel for various load is shown in figure (8) The HC emission was observed to be comparatively more in diesel than biodiesel blends the reduction in HC emission in biodiesel is because of oxygen content in biodiesel which improves the quality of combustion almost there is an reduction of 18% when biodiesel blends is used as fuel

NO_X Emission

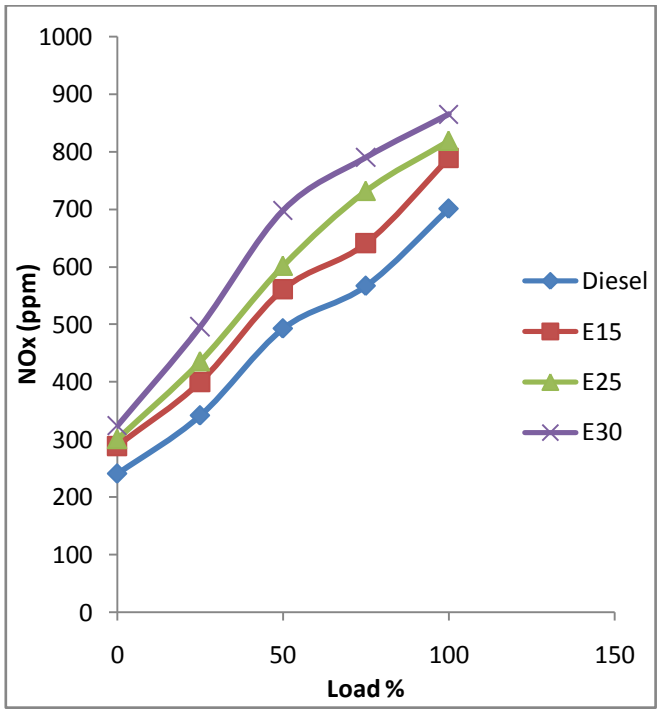

Figure (9) Variation of Nitrogen oxide emission

The NO_X Emission is caused mainly because of nitrogen parameter in air and the operating temperature of the engine. The NOx emission from an engine leans upon the maximum combustion temperature and the availability of oxygen. When the combustion temperature inside the engine rises a particular limit, nitrogen unite with oxygen to create nitrogen oxide NOx. It is evident that the combustion temperature is higher and the oxygen content is greater for eucalyptus biodiesel, it can be seen that the NOx emissions of biodiesel and its blends are higher than those of conventional diesel at all loads on the engine. The Figure (9) shows that there was a rise in NOx emission when biodiesel is used as fuel

Oxygen content

The variation of Oxygen content in the exhaust gases is shown in Figure (10) As discussed earlier the oxygen content in biodiesel is more when compared to conventional diesel this is because more oxygen content in the biodiesel. The oxygen content in biodiesel at no load was nearly 18% But in diesel it was 16% and at full load it was 15% in biodiesel and 12.5% in diesel

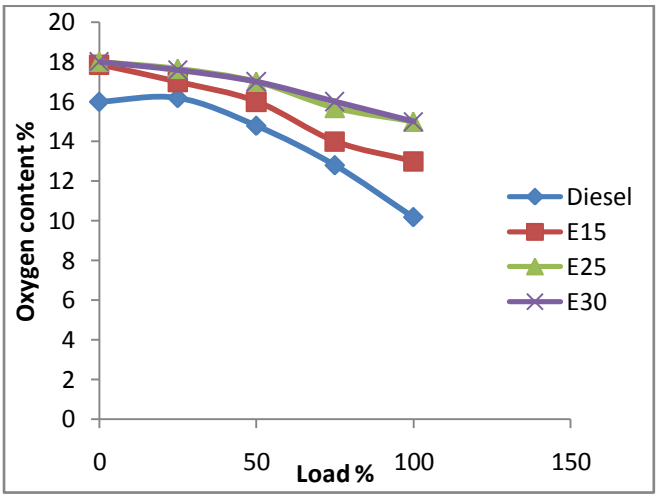

Figure (10) Variation of oxygen content

V CONCLUSION

This project aims at determining the adaptability of Eucalyptus biodiesel as an alternative fuel for use in single cylinder air cooled Compression Ignition Engines. In this analysis, biodiesel was made from pure eucalyptus oil by the process of transesterification. The prepared biodiesel was then blended with diesel in the following proportions (15%, 25% and 30%) and then tested in a single cylinder direct injection diesel engine to obtain the performance and emission characteristics. The similarities of various chemical properties of eucalyptus biodiesel with diesel display its adaptability for use as an alternative fuel. These are following conclusions drawn from this investigation

- The brake thermal efficiency was slightly lower in biodiesel blends when compared with diesel fuel
- The SFC increases with increase in biodiesel content in the fuel blend due to lesser calorific value in the blend
- But in terms of emission HC and co emission was found

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to be less in biodiesel blends when compared with diesel due to its oxygen content

- The NOx emission was found to be higher in biodiesel blends when compared with diesel due to rise in operating temperature of the engine when biodiesel was used as fuel

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