EXPERIMENTAL ANALYSIS ON 4 – STROKE SINGLE CYLINDER DIESEL ENGINE BLENDED WITH EUCALYPTUS AND METHYL ESTER OF PALM KERNEL OIL

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Abstract:

Ever increasing fuel price, continuous addition of on road vehicles, fast depleting petroleum resources and continuing accumulation greenhouse gases are the main reasons for the development of alternative fuels. Many alternative fuels are identified and tested successfully in the existing engine with and without engine modification. However, research is still continuing in this field to find the best alternative fuel for the existing petro fuel.

Most of the alternative fuels identified today are bio-fuels and are having one or few undesirable fuel characteristics which are not permitting them to replace the existing petro fuel completely. However, the various admission techniques experimented by the researchers are giving good solution to apply larger fraction of replacing fuel in the existing engine.

The present investigation used two bio-oils called Eucalyptus oil; distilled oil from leaf of eucalyptus and methyl ester of palm kernel oil, a distilled oil from palm seed oil in a DI diesel engine, as an alternate fuel for diesel oil. But, the insufficient Cetane number of Eucalyptus oil prevents the complete replacement of diesel fuel from the diesel engine. However, the blended form of methyl ester of palm kernel oil and Eucalyptus oil displace diesel fuelto large extent and does not require any engine modification. Hence, this investigation mainly focused on the complete replacement of diesel fuel using Eucalyptus oil and methyl ester of palm kernel oil.

In this work, bio mass derived eucalyptus oil was chosen as the major constituent and the methyl ester of palm kernel oil was used as an ignition improver to enhance the performance of the blends. The performance, emission and combustion characteristics of bio fuel blends were evaluated using a naturally aspirated direct injection diesel engine

Key Words: Diesel engine, Eucalyptus oil, methyl ester, blending, performance

I. INTRODUCTION:

Feasibility studies on the use of different renewable liquid and gaseous fuels have been studied throughout the world. Attempts have been made in many developed countries of the world on the use of vegetable oils as diesel engine fuel. In most of the research work vegetable oil has been tried as pure, esterified or blended with diesel. Many researchers, engine manufacturers and users in different countries of the world have performed tests that demonstrated the potential and problems of this fuel source. However, there are several real problems that restrict the introduction of this source in to energy pool. This chapter reviews the feasibility of this fuel source and some of the results obtained from investigations on the use of vegetable oils and their esters as fuel in compression ignition engines. This chapter starts with basic approach for the process of trans esterification and fuel characterization. It is followed by extensive literature survey on engine performance and emission. Later in this chapter literature on economic assessment is reviewed. The objective of this chapter is to review all the literature related to the subject extensively. Consequently, limitations of literature review are explored and problem is formulated.

Ramadhas and et al. [1] have analyzed the suitability of rubber seed oil as an alternative for the diesel fuel in C.I. engine. Significant reduction in viscosity of rubber seed oil is achieved by simply diluting with diesel in varying proportions. Engine performance and emission tests were conducted with rubber seed oil-diesel blends in a C.I. engine. From the experimental results obtained, rubber seed oil is found to be a promising alternative fuel and does not need any major modification in the structure of the engine.

Purushotham and et al. [2] have evaluated the performance, emission and combustion characteristics of a single cylinder, constant speed, direct injection diesel engine using orange oil as an alternative fuel. The results are compared with the standard diesel fuel operation. The results indicated that the brake thermal efficiency was higher compared to diesel. CO and HC emissions were lower and oxides of nitrogen were higher compared to diesel operation. The smoke emissions are reduced marginally for orange oil than the diesel fuel.

Hasan Serin and Neslihan Yucel Akar[3]. The study presents the results of investigations carried out on a four-cylinder, four-stroke, direct injection diesel engine operated with tea seed (Camellia sinensis) oil biodiesel. The oil from tea seeds was extracted from grounded seeds using the Soxhlet extraction apparatus. The biodiesel was produced by transesterification of tea seed oil with methanol in the presence of a catalyst (NaOH). After being blended with regular diesel fuel (D), the fuel properties of tea seed biodiesel (B) was determined according to ASTM and EN standards. The fuel mixtures (biodiesel content at the volumetric ratios of 10%B–90%D (B10), 20%B-80%D (B20), and 100%B (B100)) were tested in a direct injection diesel engine at full load condition.

Mohamed Saied Shehata[4]. Experimental studies have been carried out to investigate effects of biodiesel fuels on diesel engine performance, Carbon monoxide (CO) and nitric oxide (NOx) emissions, exhaust gas temperature (TExhaust), oil temperature (TOil), wall temperature (TWall), and cylinder pressure with/without exhaust gas recirculation(EGR). Biodiesel fuels are prepared from cotton seed oil, palm oil and flax oil. All the measured parameters for biodiesel fuels are compared with the base diesel fuel with/without EGR for different engine speeds.Fuel inlet temperature of 120°C gives minimum viscosity different between diesel and biodiesel fuels.Biodiesel fuels give slightly less brake power (BP), brake thermal efficiency (gBth) and slightly high brake specific fuel consumption (BSFC) and high fuel mass flow rate per cycle. Diesel fuel gives CO higher than biodiesel fuels due to less O atoms in fuel molecules.

II. Transesterification Process:

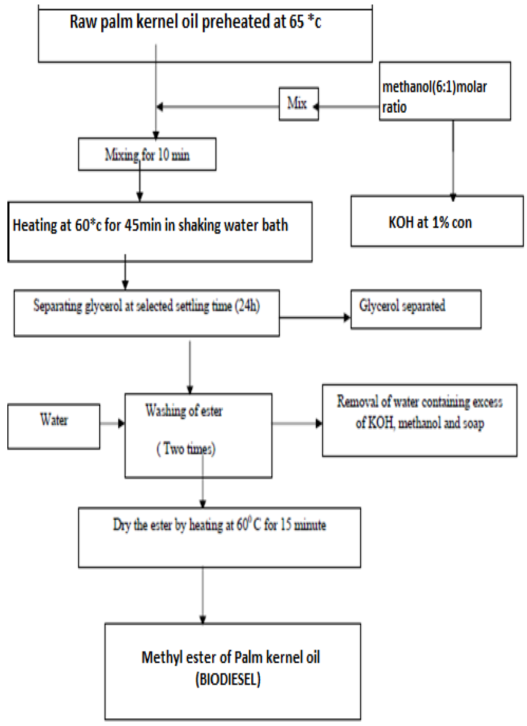
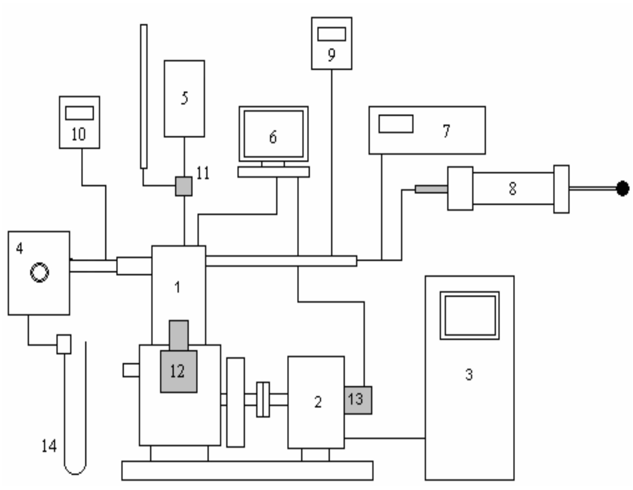


Fig 3.1 Schematic Diagram Of Simple Procedure For Production Of Methl ester of Palm kernel oil

III. Experimental Setup.



1-Diesel Engine; 2- Eddy current Dynamometer; 3- Dynamometer Control; 4- Anti pulsating Drum; 5- EU blends; 6- P-IV computer with DAQ; 7- Gas Analyzer Fumigator; 8- Smoke sampling pump; 9- Exhaust temperature indicator; 10- Air inlet temperature indicator; 11- Two way valve; 12-Fuel Injection Pump; 13- Crank angle encoder;
14- Manometer.

IV. DIESEL ENGINE:

Fig 1. Overview of an Engine

Table: 1. Engine Specifications:

Engine Type	**4 stroke, single cylinder, water cooled diesel engine**
Make	Kirloskar
Rated Power	3.75 Kw
Stroke Length	110 mm
Bore Diameter	80 mm
Compression Ratio	16.5:1
Dynamometer	Eddy current dynamometer

V. PROPERTIES OF FUEL:

A. Viscosity:

The viscosity of different fuel blends are found by using Red Wood viscometer-I

Fig 2. Red Wood viscometer

B. Flash point and Fire Point:

The flash points and fire points of different blended oils can be found out by using pen sky marten's flash and fire point apparatus.

Fig 3. Penskymarten's apparatus

C. Calorific Value:

The calorific values of different blended oils are obtained by using Bomb Calorimeter.

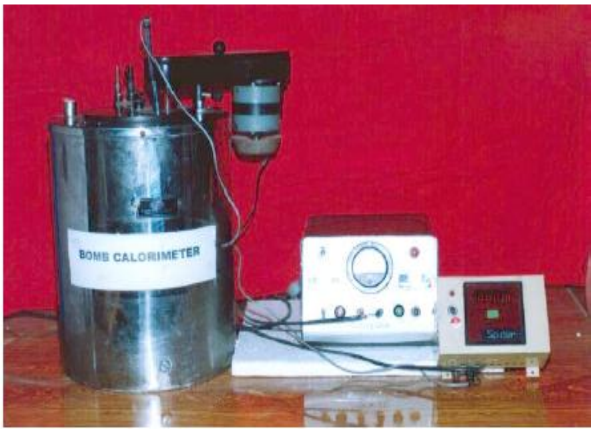


Fig 4 Bomb Calorimeter

Fig 5: Cloud point appparatus

Table 2: Different properties of fuel

Properties	Diesel	Palm kernel oil	Eucalyptus oil
Kinematic viscosity at 40^{0}C (mm^2/sec)	2-4	4.839	1.6-2.1
Calorific value KJ/kg	42,700	37,250	43270
Pour	-17	2	
Flash	76	167	5
Density(kg/m^3) at 15^{0}C	84	883	913

WORKING:

The four stroke diesel (CI) engine operates on diesel cycle. The piston reciprocates inside the cylinder, which is connected to the crankshaft by connecting rod. The valves operated by means of cams and push rods. Water is circulated through the provision made around the cylinder called engine cooling water jackets for cooling purpose. The four strokes taking place are mainly suction, compression, expansion (power stroke) and exhaust strokes.

The dynamometer is fixed to the engine flywheel and are mounted on a M.S channel frame and further mounted on vibro mounts. Panel board is used to fix burette with a three way lock, digital temperature indicator with selector switch, digital RPM indicator and U-tube manometer.

1. Digital temperature indicator to measure different temperatures sensed by respective thermocouples.
2. Digital RPM indicator to measure the speed of the engine.
3. A manifold burette is provided to measure the rate of fuel consumed while running the engine.
4. Hart ridge smoke meter is provided to measure the smoke density at different loading conditions.
5. Exhaust gas or multi gas analyzer is provided to measure the exhaust emissions.

Fig 6: Smoke meter

Fig 7: Exhaust gas Analyzer

VI. PERFORMANCE CURVES:

The performance and emission characteristics of a high speed diesel engine at various loads from no load to full load fueled with palm kernel oil discussed below as per the results obtained.

A. Brake Thermal Efficiency:

Engine is made to run at constant speed 1500 r.p.m. By using different oil blends the load on the engine is gradually increased manually .At every load and for every blend time taken for fuel consumption is noted. The indicated power is obtained by drawing a graph between load and Brke Thermal efficiency. With this the $\eta_{bth}$is obtained. The below graph is drawn by taking loadon X-axis and η_{bth} on Y-axis

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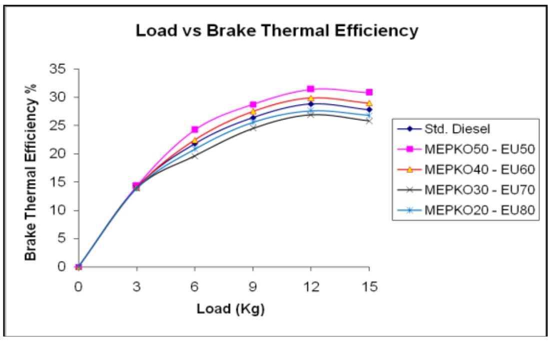


Fig.8; Load vs Brke Thermal efficiency

B. Brake specific fuel consumption

Here the Volume of air actually entering at different loads and at different blends are noted by making the engine to rotate at constant speed.fuel consumption remains constant as the engine is at constant speed.The below graph is drawn for comparing the amount the amount of specific fuel consumption at different loads.

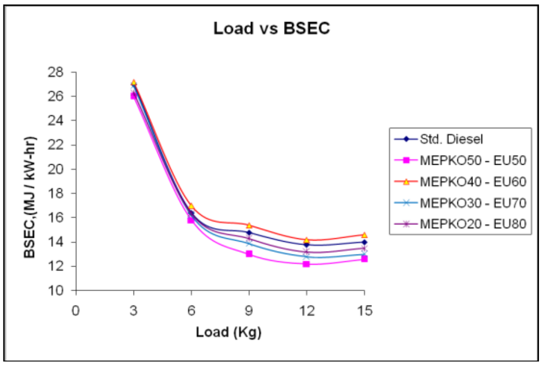
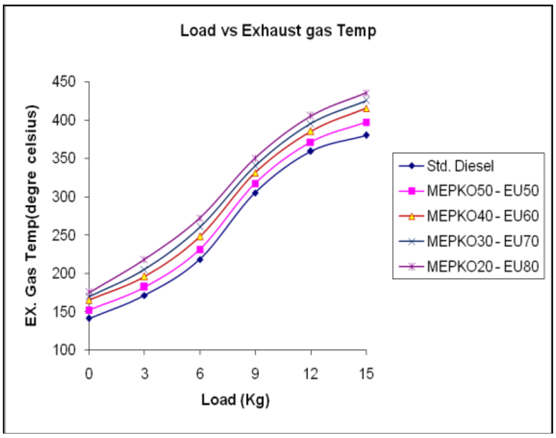


Fig.9:load vs Brake specific fuel consumption

C. Exhaust gas temperature

Here the engine exhaust system system is connected to smoke meter for obtaining the temperature at exhaust gases at different loads and at different blends.A graph is drawn by taking load on X-axis andexhaust temperature on Y-axis.With this graph we can get the Max. exhust gas temperature.



A. Fig.10. load vs Exhaust gas temperature

D. Hydrocarbons

Here the engine exhaust system system is connected to Exhaust Gas Analyser for obtaining the hydrocarbons in exhaust gases at different loads and at different blends.A graph is drawn by taking load on X-axis and hydrocarbonson Y-axis.With this graph we can get the information on hydrocarbonsons .

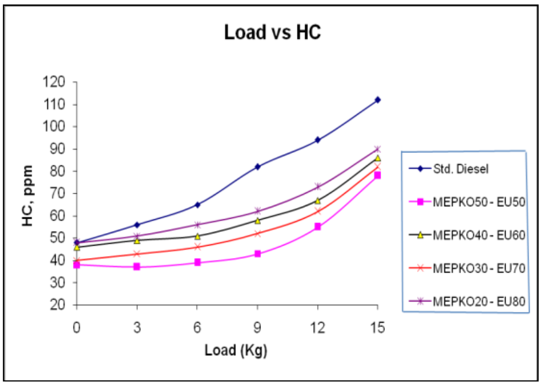


Fig.11: load vs Hydro carbons

E. Nitrous Oxide:

Here the engine exhaust system system is connected to Exhaust Gas Analyser for obtaining the NO_x in exhaust gases at different loads and at different blends.A graph is drawn by taking load on X-axis and NO_x on Y-axis.With this graph we can get the information on NO_x.

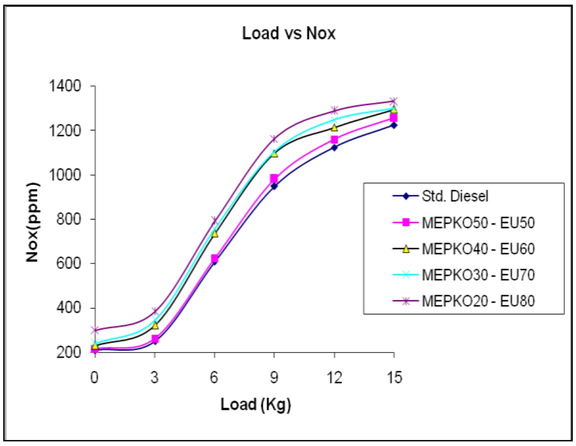


Fig.12:. load vs NO_X

F. Carbon Monoxide:

Here the engine exhaust system system is connected to Exhaust Gas Analyser for obtaining the % of CO in exhaust gases at different loads and at different blends.A graph is drawn by taking load on X-axis and CO on Y-axis.With this graph we can get the information on CO.

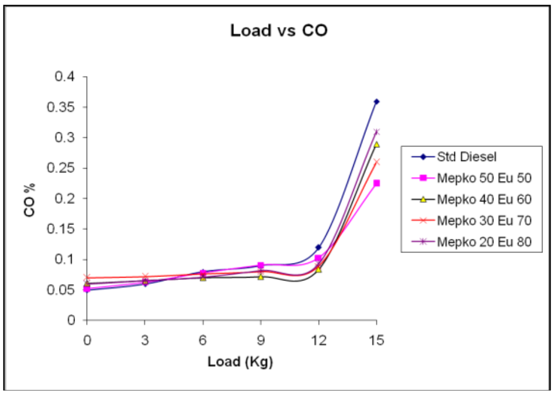


Fig.13. load vs Carbon monoxide

VII. CONCLUSIONS:

Based on the experimental investigation conducted on a single cylinder DI Diesel engine using methyl ester Palm kernel oil-eucalyptus oil blends. The following major conclusions are arrived.

1. The results showed that the mixing of high cetane fuel of methyl ester of palm kernel oil with low cetane fuel of eucalyptus oil up to 50% increases brake thermal efficiency by 2.6 percentage from the std.diesel fuel.
2. Increased volatility and reduced viscosity are the benefits of these blends, which led to fine atomization and better spray formation.
3. Approximately 50% smoke reduction was achieved with MePKo50-Eu50 operation.
4. The result shows a 34% reduction in HC emission and 37.5% reduction in CO emissions for MePKo50-Eu50 blend.
5. Comparatively a slighter increment in NOx emission was found while working with MePko50-Eu50 blend at all loads.
6. The added advantage of this eucalyptus oil is that, it can be blended with any oil without any modification.

The results also proved that the blending of methyl ester Palm Kernel oil with eucalyptus oil up to 50% increases the engine performance without much deteriorating its emission. So the MePKo50-Eu50 blend can be used as an alternative fuel in DI diesel engine.

VIII. REFERENCES:

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