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PERFORMANCE ANALYSIS OF CI ENGINE USING ALTERNATIVE FULES

Faraaz Khan, Vipin Mehta

Student, Professor

Mechanical Department, All Saints college of Engineering and Technology Bhopal 462001

Abstract: The depletion of oil resource as well as the environmental regulation has led to the development of alternate energy sources. In present work the performance characteristics of a computerized single cylinder diesel engine when fuelled with blends of mustard, kerosene and diesel were evaluated. Experiments were performed with different blends namely MK5, MK10 and MK15and the performance of these blends was compared with diesel oil. The various fuel properties such as Calorific value, viscosity, flash point, fire point, carbon residue and cetane number were calculated in Anacon Laboratories Pvt. Ltd, New Delhi for different blends. For analysing the performance of C.I. engine using these blends- brake power, mechanical efficiency, brake mean effective pressure, brake thermal efficiency, specific fuel consumption, torque and volumetric efficiency were found at different load. Variations of cylinder pressure with crank angle were observed at loads of 15kg, 9kg and in no load condition. Brake thermal efficiency for MK5 blend was greater as compared to diesel fuel and other blends and was least for MK15 blend. The specific fuel consumption was found minimum for MK5 blend as compared to diesel fuel and the other blends. And specific fuel consumption was maximum for MK10 blend. The volumetric efficiency reduces with increase in load and was greater for MK5 blends as compared to other blends, although it was quite less than that of diesel oil. It was found that the blends of Mustard, kerosene and diesel oil could be successfully used with acceptable performance up to certain extents in C.I. engine.

Index Terms - Renewable Energy, Conventional Fuels, Biodiesel, Combustion, Efficiency

1 INTRODUCTION

1.1 Fossil fuel Reserves

Under the depleting condition of petroleum products, a search for a substitute fuel for CI engines is in progress. Vegetable oils are good alternatives to diesel oil as they are renewable and can be produced in rural areas where there is critical need for modern forms of energy. For developing countries, fuels of bio-origin, such as alcohol, vegetable oils, biomass, biogas, Synthetic fuels, etc. are becoming important. Such fuels can be used directly, or with some modification as substitutes of diesel fuels. The known world-wide reserves of petroleum are 100 billion barrels and these petroleum reserves are predicted to be consumed in about 40 years. So, the availability of petroleum is uncertain in the future. From the very beginning, the IC engines are being fueled mostly by petroleum products like petrol and diesel. IC engines use only a small fraction of distillation products of crude oils. These crude oils have limited reserves. Any shortfall of petroleum fuels in the world market will, therefore, have a great impact on the economy of non-oil third world countries. Vegetable oils from crops such as mustard, soybeans, peanut, sunflower, rape, coconut, Karanja, neem, cotton, mustard jatropha, linseed and coster have been evaluated in many parts of the world in comparison with other non-edible oils. Different countries are looking for different vegetable oils depending on their climate and soil condition. As for example Soyabean oil in USA, rapeseed oil and sunflower in Europe, Olive oil in Spain, palm oil in south east Asia, mainly in Malaysia and Indonesia, coconut oil in Philippines are considered to substitute diesel fuel. Different researchers result show that vegetables oils are promising alternative fuels for CI engine. In view of growing energy demand of our country, it is thus reasonable to examine the use of Mustard Oil and Kerosene oil blends as a substitute fuel for IC engine. Renewable energy is the energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). In 2008, about 19% of global final energy consumption came from renewable, with 13% coming from traditional biomass, which is mainly used for heating, and 3.2% from hydroelectricity. New renewable (small hydro, modern biomass, wind, solar, geothermal, and bio-fuels) accounted for another 2.7% and are growing very rapidly. The share of renewable in electricity generation is around 18%, with 15% of global electricity coming from hydroelectricity and 3% from new renewable [11]. Climate change concerns, coupled with high oil prices, peak oil, and increasing government support, are driving increasing renewable energy legislation, incentives and commercialization.

1.2 Conventional Fuels and Their Prospects

Petroleum products mostly use as conventional fuels of IC engines. These are produced by fractional distillation of crude oils. Crude Petroleum is generally found as underground deposit in porous rocks or sands or lime stones derived from plants and trees buried thousands of years back. Southern Russia, the United States and the Arabian countries have the major reserves of this petroleum. Petroleum products consist of various hydrocarbons like paraffin 's (CnH2n+2), naphthene's (CnH2n), aromatics (CnH2n-6) and olefins (CnH2n) having different molecular structures. Fractional distillation enables thermal separation of crude oils into a range of products such as gasoline, kerosene, gas oil, and the various grades of residual fuel oils. Diesel engine consumes diesel as its fuel which is darkish brown liquid blended from kerosene and gas oil. Diesel engines are widely used in transport vehicle, in irrigation and water pumping in rural areas, in power generating plants and in various industries. This energy source is nonrenewable in nature and has limited reserve and it will be exhausted in near future if the consumption pattern continues at the present rate. As a result, the whole world will have to face tremendous oil crisis due to burning of these oils due to the availability constraint. Again, due to burning of these oils, CO2 content of the atmosphere rises as an absolute deposit thereby polluting the environment. [13].

1.3 Energy Scenario in India

Before Conventional commercial sources of energy in the country include fossil fuels, such as coal, oil, natural gas and hydropower. A brief accounting of these commercial sources of energy in India has been provided below:
Coal: Coal has also become a precious source of production of chemical of industrial importance coal is and will continue to be the mainstay of power generation in India. It constitutes about 70% of total commercial energy consumed India. In India, coal occurs in rock sequences mainly of two geological ages, namely, Gondwana, little over 200 million years ago and in Tertiary deposits which were found at a much later geological epoch (about 55 million years) ago. The major resources are located in central and eastern parts of the country. In India, the major coal fields are Raniganj, Jharia, Bokaro, Singrauli, PanchKanham (Tawa valley), Talchar, Chanda-Wardha and Godavari valley in states of Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. The proven coal reserves of the country as on January 1, 2005 is 247,847 million tones, the highest proven amount being 35417 million tons in Jharkhand. About 65 % of coal produced in India is used to produce electricity and rest in industries and for other purposes.

2. Objective of the Present Paper

- To prepare various blends of diesel, mustard and kerosene oil in required proportions.
- To determine the physical and thermal properties of mustard blending with Kerosene.
- To compare the suitability of mustard blending with kerosene and diesel.
- To know about the variation of cylinder pressure at different load for diesel oil, MK5, MK10 and MK15 blend.
- To find and compare the performance characteristic of C.I. engine using MK5, MK10 and MK15 blends prepared by diesel fuel.

3. LITERATURE REVIEW

R. Vinoth Kumar [1] 2018 studied the feasibility of using two edible plant oils mustard (Brassica nigra, Family: Cruciferae) and neem (Azadirachtaindica , Family: Meliaceae) as diesel substitute a comparative study on their combustion characteristics on a C.I. engine were made. Oils were esterifying (butyl esters) before blending with pure diesel in the ratio of 10:90, 15:85, 20:80, and 25:75 by volume. Pure diesel was used as control. His Studies revealed that on blending vegetable oils with diesel a remarkable improvement in their physical and chemical properties was observed. Cetane number came to be very close to pure diesel. Engine (C.I.) was run at different loads (0, 4, 8, 12, 16, and 20 kg) at a constant speed (1500 rpm) separately on each blend and also on pure diesel. Results have indicated that engine run at 20% blend of oils showed a closer performance to pure diesel. However, mustard oil at 20% blend with diesel gave best performance as compared to neem oil blends in terms of low smoke intensity, emission of HC and NOx. All the parameters tested viz., total fuel consumption, specific energy consumption; specific fuel consumption, brake thermal efficiency and cylindrical peak pressure were improved. These studies have revealed that both the oils at 20% blend with diesel can be used as a diesel substitute.

Dragos Tutunea, Ilie Dumitru [2] 2017 in this paper analyzed the sunflower methyl ester (SFME) and its blends as an alternate source of fuel for diesel engines. Biodiesel was prepared from sunflower oil in laboratory in a small biodiesel installation (30L) by base Transesterification. A 4-cylinder Deutz F4L912 diesel engine was used to perform the tests on various blends of sunflower biodiesel. The emissions of CO, HC were lower than diesel fuel for all blends tested. The NOx emissions were higher due to the high volatility and high viscosity of biodiesel.

Shiv Kumar Sharma, D.D. Shukla [3] 2017 In this research, Biodiesel was prepared by the process of trans-etherification, from waste cooking refined soyabean oil. Thereafter, an experimental investigation was carried out on a 4 – stroke Compression ignition engine, with single cylinder which is fueled with blends of Biodiesel and petro diesel. 6 blends of biodiesel were taken for investigating performance characteristics of engine, under different conditions of load. Blend B20 of biodiesel was found most suitable among all blends of biodiesel and petro diesel

B. V. Krishnaiah, Dr. B. Balu Naik [4] 2017 investigated the performance characteristics of a diesel engine with sunflower oil and its diesel blends investigates in this paper. The sunflower oil- diesel blends SF5 (5%Sunflower oil and 95% diesel), SF10 (10%Sunflower oil and 90% diesel),SF15 (15%Sunflower oil and 85% diesel), and SF20 (20% Sunflower oil and 80% diesel) was prepared to test in diesel engines. The performance and the emissions of CO, HC and NOx in diesel engine were obtained based on the present experimental results. . Comparison of sunflower blends (SF5, SF10, SF15 and SF20) with engine diesel was done. The brake thermal efficiency was decreased with increasing of its blend and the brake specific fuel consumption was slightly more than the diesel fuel in this results showed .The emissions of CO and HC are slightly higher than pure diesel. However as blended ratio increased, the NOx emissions of the blends were found to be decreased significantly compared to diesel.

M. PRABHAHAR [18] 2016 Investigates the performance and emission characteristics of a diesel engine with mustard oil and its diesel blends. The mustard oil-diesel blends M5 (5% Mustard oil and 95% diesel), M10 (10% Mustard oil and 90% diesel), M15 (15% Mustard oil and 85% diesel), and M20 (20% Mustard oil and 80% diesel) was prepared to test in diesel engines. Experimental results were obtained on the performance and the emissions of CO, HC and NOx in diesel engine. Comparison of mustard blends (M5, M10, M15 and M20) with engine diesel was done. The results showed that the brake thermal efficiency was decreased as the blend increased, and the brake specific fuel consumption was slightly higher than the diesel fuel. The CO and HC emissions are higher than diesel. However, NOx emissions of the blends were found to be decreased significantly compared to diesel as blend ratio increased. Smoke emission was found to be increased slightly when compared to diesel.

Ayhan Demirbas [5] discussed progress and recent trends in biodiesel fuels. Fossil fuel resources are decreasing daily. Biodiesel fuels are attracting increasing attention worldwide as blending components or direct replacements for diesel fuel in vehicle engines. Biodiesel fuel typically comprises lower alkyl fatty acid (chain length (C14–C22)), esters of short-chain alcohols, primarily, methanol or ethanol. Methanol is the commonly used alcohol in this process, due in part to its low cost. Methyl esters of vegetable oils have several outstanding advantages over other new-renewable and clean engine fuel alternatives. Biodiesel fuel is a renewable substitute fuel for petroleum diesel or petrodiesel fuel made from vegetable or animal fats; it can be used in any mixture with petrodiesel fuel, as it has very similar characteristics, but it has lower exhaust emissions. Biodiesel fuel has better properties than petrodiesel fuel; it is renewable, biodegradable, non-toxic, and essentially free of sulphur and aromatics. Biodiesel seems to be a realistic fuel for future; it has become more attractive recently because of its environmental benefits. Biodiesel is an environmentally friendly fuel that can be used in any diesel engine without modification.

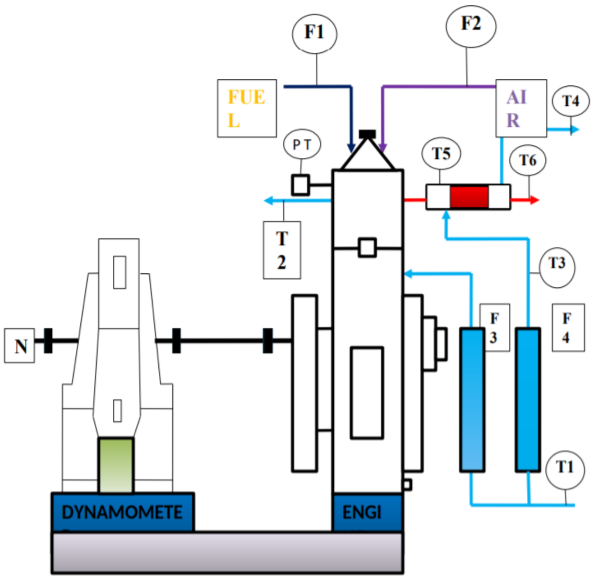
S.Jaichandar and K. Annamalai [6] discussed the status of biodiesel as an alternative fuel for diesel engine. To meet increasing energy requirements, there has been growing interest in alternative fuels like biodiesel to provide a suitable diesel oil substitute for internal combustion engines. Biodiesels offer a very promising alternative to diesel oil since they are renewable and have similar properties. Biodiesel is defined as a trans esterified renewable fuel derived from vegetable oils or animal fats with properties similar or better than diesel fuel. Extensive research and demonstration projects have shown it can be used pure or in blends with conventional diesel fuel in unmodified diesel engines. This paper reviews the history of biodiesel development and production practices. Fuel-related properties are reviewed and compared with those of conventional diesel fuel. The effect of use of biodiesel fuel on engine power, fuel consumption and thermal efficiency are collected and analyzed with that of conventional diesel fuel. In the subsequent section, the engine emissions from biodiesel and diesel fuels are compared, paying special attention to the most significant emissions such as nitric oxides and particulate matter. The problems with substituting vegetable oil for diesel fuels are mostly associated with their high viscosities, and low volatilities. The viscosity of vegetable oils can be reduced by transesterification. Transesterification is the most common method and leads to mono alkyl esters of vegetable oils and fats, known as bio-diesel. The production of biodiesel from vegetable oil is very simple. In the production of biodiesel it is observed that the base catalyst performs better than acid catalysts and enzymes. The biodiesel and their blends have similar fuel properties as that of diesel. It is also observed that biodiesel has similar combustion characteristics as diesel. Biodiesel engines offer acceptable engine performance compared to conventional diesel fuelled engines. The objectives of acceptable thermal efficiency, fuel economy and reduced emissions using biodiesel in CI engines are attainable, but more investigations under proper operating constraints with improved engine design are required to explore the full potential of biodiesel engines.

4 EXPERIMENTAL SETUP & METHODOLOGY

4.1 EXPERIMENTAL SETUP: -

A Computerized Single Cylinder 4 Stroke Diesel Test rig set-up for measuring the different engine performance parameters was available in I.C. Engine Laboratory of ASCT BHOPAL and all the observations were calculated on the same. The setup consists of single cylinder, four stroke, Diesel engine connected to eddy current type dynamometer for loading. It is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ−PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand-alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement. The Specification of Experimental setup is shown below in table 3.2.

Fig. 4.1- Experiment test rig of C.I. Engine



5. METHODOLOGY
5.1 EXPERIMENTAL PROCEDURE: -

Following procedure were adopted to obtain the performance of various blends.
- Fill lubrication oil in the engine and fuel in the fuel tank.
- Provide electric supply to panel box
- Adjust crank angle sensor for TDC matching.
- Confirm load signal displayed on process indicator
- Fill water in the manometer up to "0" mark level.
- Ensure water circulation through engine, calorimeter and dynamometer.
- After this we run the engine set up at different load and store the observation in a data file or use previously stored data file in "EnginesoftLV" for indicated power calculation.
- Then we export the data file in ms excel worksheet. The pressure crank angle and volume data is available in excel.
- Worksheet was saved as "Engine.xls". The worksheet shows pressure crank angle plot, pressure volume plot and indicated power calculation. The worksheet is for single cylinder four stroke engine with 180 observations per revolution.
- Copy the pressure readings from exported data file in to the IP_cal worksheet at the respective crank angle.

• Observe the Pressure crank angle diagram, pressure volume diagram and indicated power value. The above procedure were adopted and the observations were found using MK5, MK10, MK15 and Diesel oil. The following engine performances were determined:-

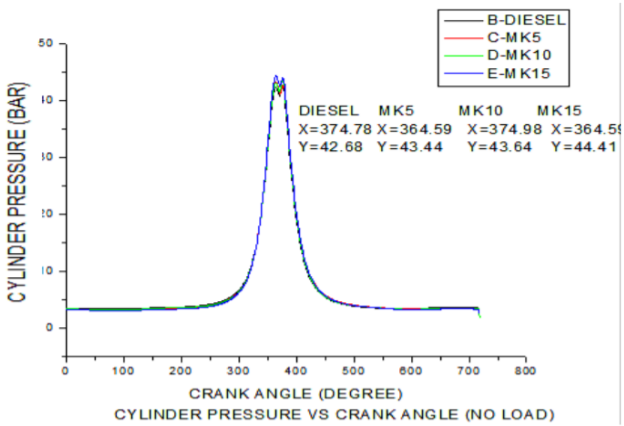
i) Brake Power (BP)
ii) Mechanical Efficiency
iii) Brake mean effective pressure (BMEP)
iv) Brake thermal efficiency (BTE)
v) Specific fuel consumption (BSFC)
vi) Torque at different load
vii) Volumetric efficiency at different load Above Performance parameters were found experimentally for MK5, MK10, MK15 and Diesel oil their graphs were plotted at different load.

6 . RESULT

6.1:- VARIATION OF PRESSURE AT DIFFERENT CRANK ANGLE (NO LOAD):-

Graph 4.1 shows the variation of cylinder pressure at different crank angle in no load condition In no load condition the value of cylinder pressure was less as compared to loading condition. The maximum cylinder pressure observed was 44.41Bar at crank angle 364.59 0 for MK15 blend. Due to burning of fuel during power stroke the cylinder pressure increases drastically to optimum value and after this stroke the cylinder pressure reduces below 5 bar.

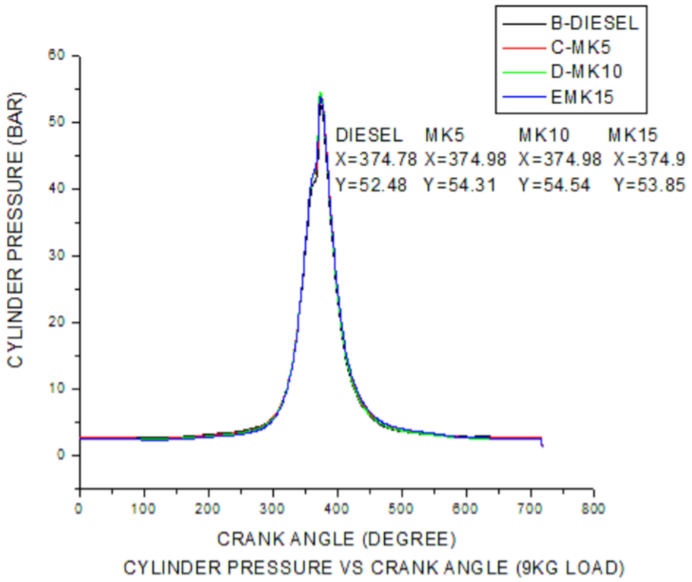
Graph 6.1 Variation of Pressure at Different Crank Angle (No Load)



6.2:- VARIATION OF PRESSURE AT DIFFERENT CRANK ANGLE (9kg LOAD):-

From the Graph 4.2 it was observed that the cylinder pressure increases considerably more as compared No load condition. Here also the Pressure created inside the cylinder was increased drastically during power stroke. The maximum cylinder pressure observed was 54.54 Bar at crank angle 374.98 0 for MK10 blend. The value of cylinder pressure was a little bit less for diesel fuel than the other blends that were used. It is also observed that all the blends follow the same curve as diesel fuel.

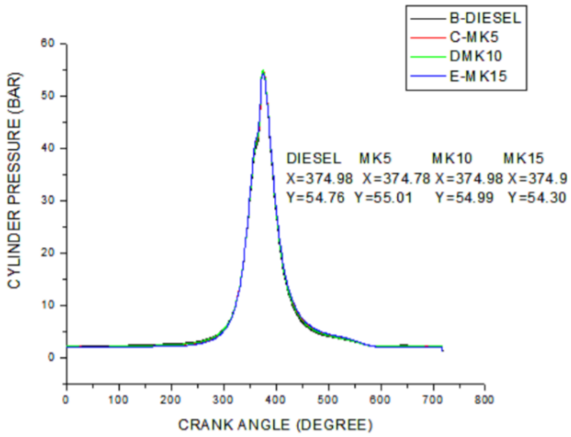
Graph 6.2 shows the variation of cylinder pressure with different crank angle at load of 9kg.



6.3:- VARIATION OF PRESSURE AT DIFFERENT CRANK ANGLE (15kg LOAD):-

In this case also the values of cylinder pressure were greater as compared to No load condition. The maximum cylinder pressure observed was 55.01Bar at crank angle of 374.78 0 for MK5 blend. The value of maximum pressure for MK5 blend was 0.5% more than the optimum pressure for diesel fuel. This increase in pressure was because of superior burning characteristic of MK5 blend as compared to diesel, MK10 and MK15blend.

Graph 6.3 shows the variation of cylinder pressure with different crank angle at load of 15kg

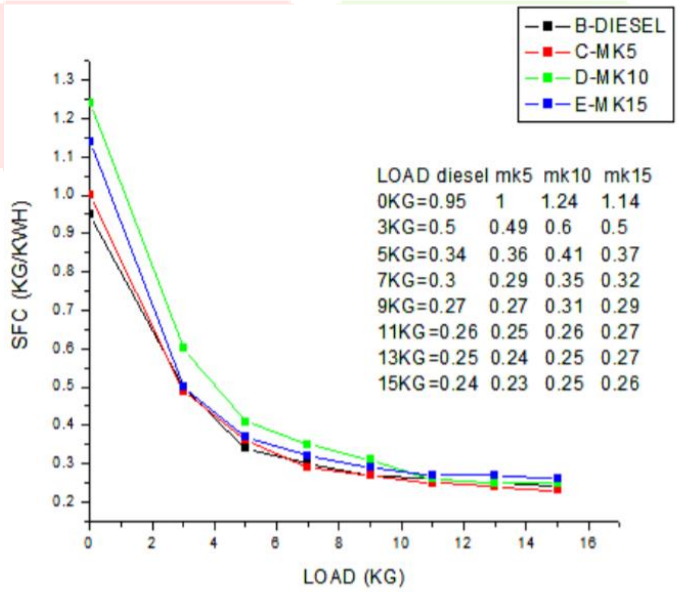


CYLINDER PRESSURE VS CRANK ANGLE (15KG LOAD)

6.4 SPECIFIC FUEL CONSUMPTION:-

Graph 4.8 compares the variation of specific fuel consumption at different load for MK5, MK10, MK15 and diesel oil. It was clear from the Graph 4.8 that Specific fuel consumption was reduced with increase in load. The specific fuel consumption at loading condition of 15kg was 0.24 Kg/KWh for diesel oil, 0.23 Kg/KWh for MK5 blend, 0.25 Kg/KWh for MK10 blend and 0.26 Kg/KWh for MK15 blend. From Graph it was clear that specific fuel consumption was more for MK10 blend. The Specific fuel consumption was maximum for MK10 blend as compared to other blends that were used. This is caused due to effect of delay in ignition pressure, higher viscosity and lower calorific value of the fuel.

Graph 6.8:- Specific fuel consumption at different load



SFC VS LOAD

7. CONCLUSION & FUTURE SCOPE

7.1 CONCLUSION:-

From experimental analysis it was found that the blends of Mustard, kerosene and diesel oil could be successfully used with acceptable performance up to certain extents. Based on the study it was clear that kerosene and mustard oil cannot be used directly as CI engine fuel due higher viscosity, density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion chamber. The following points were concluded from the experimental test- • Brake horse power obtained for MK5 blend was found little greater than the MK10, MK15 and Diesel fuel at different load except at 15kg load. • The mechanical efficiency was maximum for diesel as compared to other blends. It was also observed that among the three blends, the mechanical efficiency was greater for MK10 blend. • The value of brake mean effective pressure was a little bit more for MK5 blend than the MK10 and MK 15 blend • The Brake thermal efficiency was also greater for MK5 blend as compared to the other blends used. • The Specific fuel consumption was quite near as of the diesel fuel and was less for MK5 blend. • The volumetric efficiency was greater for MK5 blends as compared to other blends, although it was quite less than that of diesel oil. Above results are favorable and shows that the blends of Mustard, kerosene and diesel fuels can be used as a alternate fuel for diesel engine, which is cheap and can be produced easily by mixing these oils in required proportions. From the above used blends MK 5 blend will be better form performance point of view.

8 FUTURE SCOPE:-

1. Emission study can also be performed using these blends of mustard, kerosene and diesel.
2. Performance can be measured after with preheating fuels and /or mixing additives in them.
3. Performance of the engine can be compared for various other blends of these fuels.
4. Design changes can be studied and can be proposed after studying the problems encountered after prolonged service of engines with these alternatives fuels.
5. Analysis of composition of exhaust emission can be done with prolonged service with these blends.

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