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An Experimental Investigation on a Diesel Engine using Blends of Methanol with Rapeseed Oil as a Dual Fuel

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ABSTRACT: Man's transporting needs have always been dependant on derivatives of fossil fuels, chiefly petrol and diesel. These needs have greatly pressurized the scarcely available natural resources and are to become a luxury for the future generations. This project aims at finding an alternative for diesel and reducing the pressure on its existing demand.

Vegetable oils are renewable by nature and the non-edible category of these oils can be used as an alternate fuel to C.I. engines. In our project we have tried Rapeseed oil its ethyl ester and various blends of ethyl ester of rapeseed oil with methanol as the alternate fuel. The oil was procured and its properties was esterified by transesterification process in laboratory private limited, Hyderabad to minimize the problems of volatility, viscosity and polyunsaturated characters which are unfavourable to engine operation. The engine was tested for its performance using rapeseed oil with various blends of the esterified oil with Methanol. Also, the emission characteristics of these blends were determined using an exhaust gas analyser. Finally, its performance and emission characteristics were evaluated and compared with that of pure diesel and it was found to be an effective alternate fuel with better emission characteristics.

KEYWORDS: Engine test for its performance using rapeseed oil with various blends of the esterified oil with Methanol.

1. INTRODUCTION

1.1 CURRENT TRENDS

In the modern and fast moving world, petroleum based fuels have become important for a country's development. Products derived from crude oil continue to be the major and critical sources of energy for fuelling vehicles all over the world. However, petroleum reserves are limited and are non renewable. At the current and projected rates of consumption of crude, it is estimated that these reserves will be badly depleted in due course and it may become impossible to meet requirements. Oil availability from sources within India increased from 0.25 million tonne in 1947 to about 34.56 million tonne in 1989-90. This met 66% of the total demand in 1989-90. The demand for petroleum products in 1990-91 was estimated as 58.87 million tones and it was approximately 100 million tonne in 2000. It is expected to reach 175 million tonne in 2006-2007. Diesel is mainly consumed in the transport, industrial and agricultural sectors. The cost of transportation affects the economics of all other consumables that reach common people in a developing country like India. A country's development is strongly linked to availability of fuels for transportation and power generation. Thus, India faces the major challenge of meeting the high demand of oil to meet the growing energy needs. It is therefore, important to have a long-term plan for development of alternative energy sources in a balanced manner by making optimal use of available land and manpower resources. It is important to explore the feasibility of substitution of diesel with an alternative fuel, which can be produced with in the country on a massive scale for commercial utilization. At present the potential alternative fuels are: 1. Alcohols (Methanol and Ethanol), 2. Liquefied Petroleum Gas (LPG) 3. Hydrogen and 4. Vegetable oils.

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Liquid fuels because of their high energy content per unit volume and ease of handling and distribution are better suited as compared to solid and gaseous fuels. The prime liquid alternative fuels are alcohols and vegetable oils. Both vegetable oils and alcohols are derived from biomass i.e. from renewable sources. Alcohols due to their low cetane number are not suitable for direct use in diesel engines. The poor volatility and low octane number make vegetable oils unsuitable for spark ignition engines. Vegetable oils are considered as good alternatives to diesel as their properties are close to diesel. Thus, they offer the advantage of being able to be readily used in existing diesel engines without out modifications. They have a reasonably high cetane number. The flash point of vegetable oils is high and hence it is safe to use them.

Vegetable oils typically have large molecules, with carbon, hydrogen and oxygen being present. They have a structure similar to diesel fuel, but differ in the type of linkage of the chains and have a higher molecular mass and viscosity. The presence of oxygen in vegetable oils raises the stoichiometric fuel air ratio. Contrary to fossil fuels, vegetable oils are free from sulfur and heavy metals. The heating value is also only slightly lower than diesel. It is approximately 90% of that of diesel fuel.

This increases the work necessary to spray vegetable oils in diesel engines and also makes it difficult to break them up into fine droplets. The carbon residue of vegetable oils is higher than that of diesel. This leads to a smoky exhaust in a diesel engine. Table 1.1 compares some of the important properties of different non-edible vegetable oils, which are used as fuels in diesel engines.

1.2 RAPESEED OIL

Rapeseed oil is environmentally safe and not browsed by animals. As a compression ignition engine fuel, Rapeseed oil has a high cetane number, which is very close to diesel. This makes it an ideal alternative fuel as compared to other vegetable oils. The flash point of Rapeseed oil is 275 °C as compared to 750 °C for diesel.

Due to its higher flash point, rapeseed oil has certain advantages over petroleum crude like greater safety during storage, handling and transport. However, the higher flash point may create problems in engine starting. The viscosity of rapeseed oil is nearer as compared with other vegetable oils. The higher viscosity of rapeseed oil could pose problems related to flow of oil in the fuel supply pipes and nozzle. The main problem associated with the use of vegetable oils as indicated earlier is their high viscosity and poor volatility. Different methods can be adopted to use vegetable oils efficiently.

Some of them are:

1. Preheating
2. Transesterification with alcohols,
3. Blending with diesel/alcohol,

1.3 METHANOL

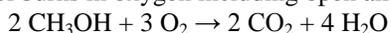
Methanol, also known as **methyl alcohol**, **wood alcohol**, **wood naphtha** or **wood spirits**, is a chemical with the formula CH₃OH (often abbreviated MeOH). Methanol acquired the name "wood alcohol" because it was once produced chiefly as a byproduct of the destructive distillation of wood. Modern methanol is produced in a catalytic industrial process directly from carbon monoxide, carbon dioxide, and hydrogen.

Methanol is the simplest alcohol, and is a light, volatile, colorless, flammable liquid with a distinctive odor very similar to, but slightly sweeter than, that of ethanol (drinking alcohol) At room temperature, it is a polar liquid, and is used as an antifreeze, solvent, fuel, and as a denaturant for ethanol. It is also used for producing biodiesel via transesterification reaction.

Methanol is produced naturally in the anaerobic metabolism of many varieties of bacteria, and is ubiquitous in small amounts in the environment. As a result, there is a small fraction of methanol vapor in the atmosphere.

Over the course of several days, atmospheric methanol is oxidized with the help of sunlight to carbon dioxide and water.

Methanol burns in oxygen including open air, forming carbon dioxide and water:



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Methanol ingested in large quantities is metabolized to formic acid or formate salts, which is poisonous to the central nervous system, and may cause blindness, coma, and death. Because of these toxic properties, methanol is frequently used as a denaturant additive for ethanol manufactured for industrial uses. This addition of methanol exempts industrial ethanol (commonly known as "denatured alcohol" or "methylated spirit") from liquor excise taxation in the USA and some other nations.

1.4 DUAL FUEL OPERATION

The dual fuelling is a well-established technique to use different types of fuels in diesel engines. A conventional diesel engine can be easily modified to operate in this mode. This engine can accept a wide range of liquid and gaseous fuels. The dual fuel engine can result in good thermal efficiency and extremely low smoke emissions particularly at high power outputs. In a dual fuel engine, a volatile liquid or gaseous fuel with a high octane number is inducted along with air through the intake manifold. The resulting homogeneous mixture is compressed to a temperature below its self-ignition point. A pilot fuel (with a high cetane number) is injected through the standard injection system. This self-ignites and initiates the combustion in the primary fuel air mixture. Alcohols have been widely used as inducted fuels in the dual fuel engine. However, dual fuel operation with alcohol induction results in higher hydrocarbon and carbon monoxide emissions.

Use of hydrogen, due to its high flame velocity can enhance the combustion rate of vegetable oils and reduce emissions. Dual fuel operation normally poses problems of low efficiency when the concentration of the inducted fuel is low. This is because the lean mixture of the inducted fuel with air does not burn well.

Use of fuels with wide flammability limits and high flame velocity can overcome such problems in the dual fuel engine. Since vegetable oils produce high smoke emissions, dual fuel approach can be a viable option for improving their performance. Vegetable oils can be used the pilot fuel and alcohol can be the inducted fuel. The high flame velocity of alcohols and hydrogen can improve the overall combustion process.

1.5 Present Work

In this work different blends of Rapeseed oil and Methanol as a fuel in a Diesel engine were studied experimentally. Rapeseed oil was converted into its methyl ester by the transesterification process.

Subsequently Rapeseed oil was blended with methanol in different proportions and tested. Performance and emission characteristics were obtained. Graphs were plotted based upon the results obtained

1.6 METHODOLOGY

The methodology adopted is outlined below in a step-by-step manner, Selection of a suitable vegetable oil (rapeseed oil). Choosing an experimental setup with necessary instrumentation to Study performance and emission characteristics of the diesel engine fuelled with rapeseed oil and Methanol

Preparing the ethyl ester of rapeseed oil by the transesterification process. Conducting experiments with blends of vegetable oil (rapeseed oil) and Alcohol (methanol) to study performance, emission characteristics. Comparing the performance with diesel at various load conditions

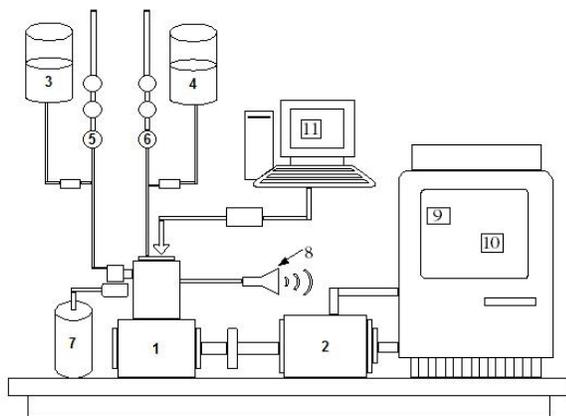
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II. EXPERIMENTAL METHODS

2.1 EXPERIMENTAL SETUP



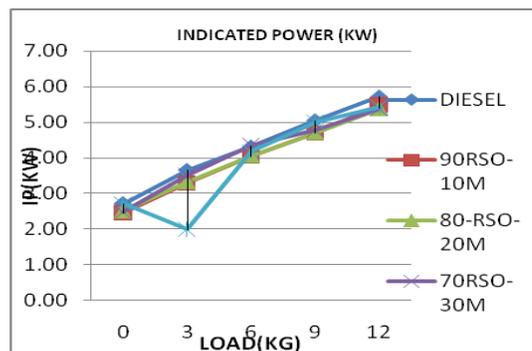
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|------------------------------|-----------------------------|
| 1. Engine | 7. Air filter |
| 2. Dynamometer | 8. Silencer |
| 3. Methanol tank | 9. RPM meter |
| 4. Rapeseed- tank | 10. Load indicator |
| 5. Diesel burette | 11. Data acquisition system |
| 6. Rapeseed-Methanol burette | |

III. COMPARISON OF DIESEL AND RAPESEED OIL BLENDS WITH METHANOL ON ENGINE PERFORMANCE AND EMISSIONS

The performance, emission and combustion characters of the engine under various load conditions were compared for diesel and blends of Rapeseed oil and methanol.

3.1 Ip(Kw) Vs Load

Indicated power is the power obtained from burning of the fuel. The Indicated power of diesel is found to be higher when compared with the other blends. This is because Diesel has higher calorific value than all other blends used. Higher the calorific value more the Indicated power obtained from burning of the fuel.



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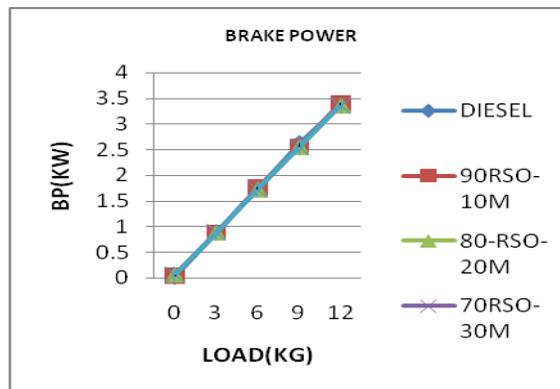
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3.2 Brake power vs Load

Brake power is the power obtained at the crankshaft of the engine.

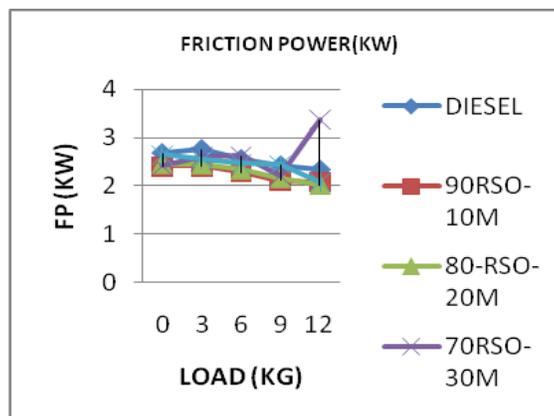
Brake power = Indicated power –frictional power.

It is found that the Brake power of all the blends is similar to Diesel.



3.3 Load Vs Friction Power

Frictional power is the power absorbed due to relative motion of different bearing Surfaces such as piston rings, main bearings, cam shaft bearing etc. The frictional power of Diesel is the highest when compared to all other blends.

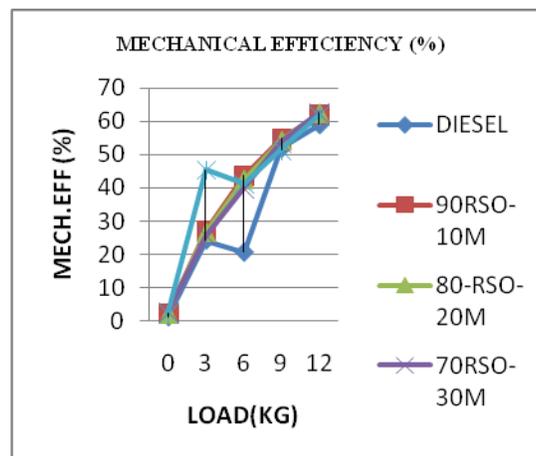


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3.4 Load Vs Mechanical Efficiency



Mechanical efficiency is the ratio of Brake power to the Indicated power. Mechanical efficiency of 60Rso-40M blend is high while it is low in Diesel. This is because brake power of 60Rso-40M blend is high and its indicated power is low.

IV. CONCLUSION

This experiment was aimed at studying the performance of diesel engine using rapeseed oil. Experiments were conducted at a constant speed of 1500 rpm under variable load conditions. Subsequently, rapeseed oil was blended with methanol and tested under variable load conditions. Blends of Rapeseed oil and methanol resulted in better performance with reduced Smoke emissions as compared to that of neat diesel. This is due to the improved Properties like Cetane number, viscosity, volatility, density etc

The brake thermal efficiency of blends of Rapeseed oil and Methanol was better

When compared to diesel. Thus on observing the readings and values of volumetric efficiency, NO_x and CO emissions, for various concentrations of blends of Rapeseed oil and methanol it is concluded that 60 RSO-40M mixture results in the best performance.

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