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COMBUSTION PERFORMANCE ANALYSIS OF A DIESEL ENGINE USING SCRAP PLASTIC OIL, ETHANOL, JATROPHA METHYL ESTER AND DIESEL OIL BLEND

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ABSTRACT

Diesel engines are the main sources of rapidly growing energy consumption worldwide which is the main reason for the pollution as well. This research work is done to analyze the performance analysis of diesel engine when blended with Ethanol, Scrap plastic oil (SPO), Jatropha methyl ester (JME) and diesel fuel. For this experiment I used four stroke single cylinder water cooled diesel engine. Further I prepared four different blends of Ethanol, SPO, JME and diesel with 10% to 50% at a difference of 10% with also 5% Ethanol mixed. Afterwards the performance parameters were evaluated at different blend ratios and further they were compared with the diesel. The mixture of 20% blending with equal racial volume of Ethanol, SPO and JME in diesel showed almost the same results when compared with diesel.

Keywords: Ethanol, Scrap Plastic Oil (SPO), Jatropha Methyl Ester (JME) And Diesel.

I. INTRODUCTION

Increasing modernization and industrialization has lead to a significant rise in demand of petroleum products which especially includes the Diesel fuel. As all these are the nonrenewable resources of energy production, it is difficult to estimate the availability of these resources in future, which might result in the uncertainty of its supply. This is because fossil fuel reserves are depleting at a very faster rate, which is thereby causing the continuous increase in price of petroleum products all over the globe. [1] The high price of petroleum products is a big concern for Indian economy, therefore an alternative cheaper fuel is required to fulfill the needs. [2] Many researchers have worked on alternate fuels like vegetable oil, biodiesel (transesterified vegetable oil), alcohol [3], natural gas, biogas and pyrolysis oil, neem oil etc. Some of the vegetable oils are Sunflower, Soybean, Jatropha [4], Cottonseed, Canola and Peanut oils. Biodiesel fuels are considered to be the potential replacement for diesel fuel, and have large number of advantages than as compared to other sources of fuel. Some of the advantages which cannot be avoided are such as anti knock qualities, higher cetane number and lower emissions of carbon mono oxides and Oxides of Nitrogen. They are also

renewable, biodegradable, non-toxic and eco friendly. Jatropha oil is basically extracted from the Jatropha seeds which inculcate the very similar properties as that of the diesel. Some properties such as kinematic viscosity, solidifying point, flash point, pour point and ignition point is very high in Jatropha oil for which to avoid problems, is further improved by Transesterification process where it gets converted to biodiesel. [5] Another source of the alternative fuel is the Plastic which we all know that today in globe how much of the waste plastic is available which can be recycled. Despite dumping the waste plastic we can use it as an alternative source of fuel for generating the energy and this indeed will save the environment from hazardous effect because the properties of SPO is again very similar to that of Jatropha biodiesel. [6] Although studies have been done over JME and SPO as a fuel which gives considerable reduction in the emission of Carbon mono oxide, Hydro carbons and Oxides of Nitrogen, but my study will give very positive inferences when used JME, Ethanol and SPO with Diesel [7] as a blend.

II. NOMENCLATURE

Some of the nomenclatures which would be used frequently in throughout the research are mentioned in the following table 1.

Table 1: Nomenclature of Blends

NAME	MIXTURE RATIO / NAME
M10	5% Ethanol + 5% SPO + 5% JME + 85% Diesel
M20	5% Ethanol + 10% SPO+ 10% JME + 75% Diesel
M30	5% Ethanol + 15% SPO + 15% JME + 65% Diesel
M40	5% Ethanol + 20% SPO + 20% JME + 55% Diesel
M50	5% Ethanol + 25% SPO + 25% JME + 45% Diesel
CO	Carbon monoxide
HC	Hydrocarbon
NO_x	Oxides of Nitrogen

2.1 Jatropha Methyl Ester (JME)

Among the available non edible seeds produced in India, Jatropha oil is the most preferred as fuel because of its high biodiesel yield; [8] Its Oiling content is also around 40%. As we know that direct use of vegetable oil is not applicable to most of diesel engines due to their high viscosity and pour point content, as it would prevent atomization and might damage the engine, so to decrease the viscosity and pour point and to make it useable in diesel engine, there is a process known as Transesterification is done. Transesterification is the most common method for biodiesel production which is used to convert vegetable oil into biodiesel. Here the displacement of alcohol from an ester by another alcohol is done for which Methanol is most commonly used for the purpose since it is the cheapest alcohol available. As here I have used methanol as alcohol, so I get Jatropha methyl ester and if would have did that with ethanol, I would have get Jatropha ethyl ester. Here triglycerides of fatty acids (vegetable oil) with alcohol in the presence of a

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catalyst are made to react to produce glycerol and fatty acid esters which eventually are known as biodiesel. Various properties of JME is shown in table 2.

Table 2: Properties of JME

PROPERTIES	RATING
Density(Kg/m3)	880
Kinematic viscosity(cSt)	5.65
Calorific value(KJ/Kg)	38450
Flash point(oc)	160
Cetane no.	50-55

2.2 Scrap Plastic Oil (SPO)

Scrap Plastic Oil which is known as SPO is produced by Pyrolysis process in which thermal degradation of wastes in an oxygen-free environment, in which the oxygen content is kept low for gasification to take place [9]. Pyrolysis liquefaction is a non-combustion heat treatment that chemically decomposes waste material by applying the heat directly or indirectly over the waste material. This is an endothermic reaction which requires an input of energy which is mainly applied indirectly through the walls of the reactor in which the waste material is fed into. Pyrolysis liquefaction process occurs under extensive pressure and at an operating temperature of more than 430oc which leads to the production of Pyrolysis oil, Charcoal and some gases [10]. The pyrolysis process for the plastic substances makes the long chain polymer molecules and breaks them into the shorter chains through heat and pressure otherwise if the process goes under the natural process of the earth to break down carbon into oil than it would take million of years. On the other hand the pyrolysis process accomplishes this with the intense heat in a closed system which consumes less time.

Pyrolysis process is usually the unique chemical reaction that aids in the burning of many solid organic fuels, like wood, cloth, and paper, and also of some kinds of plastic. Properties of SPO are shown in table 3.

Table 3: Properties of SPO

PROPERTIES	RATING
Density(Kg/m3)	793
Kinematic viscosity(cSt)	2.149
Calorific value(KJ/Kg)	44200
Flash point(oc)	40
Cetane no.	50

2.3 Ethanol

Ethanol which is also called alcohol, ethyl alcohol, and drinking alcohol, is a chemical compound, a simple alcohol with the chemical formula C2H5OH and is often abbreviated as EtOH. Ethanol is a volatile, flammable, colorless liquid with a slight characteristic odor and is naturally produced by the fermentation of sugars by yeasts or via petrochemical processes. The largest single use of ethanol is as an engine fuel and fuel additive. It reduces harmful

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tailpipe emissions of carbon monoxide, particulate matter, oxides of nitrogen, and other ozone-forming pollutants [11]. Ethanol combustion in an internal combustion engine yields many of the products of incomplete combustion produced by gasoline and significantly larger amounts of formaldehyde and related species such as acetaldehyde [12] which leads to a significantly larger photochemical reactivity and more ground level ozone [13].

III. EXPERIMENTAL SETUP

The experimental setup consists of a diesel engine with dynamometer to impart loads. The engine I used for the experimentation is a constant speed four stroke single cylinder vertical diesel Kirloskar engine which is water cooled and is mounted on a cemented bed with suitable supply for cooling system. The load applied on the engine is by means of mechanical loading device. The outlet temperature of the cooling medium is maintained to 50^{o}C by constantly maintaining the coolant supply.

Initially the setup was made to run on Diesel fuel so as to maintain the temperature and aid with all warm up conditions. Further when the engine was in its running situation I switched the fuel supply from Diesel to Ethanol-SPO and later Ethanol-JME-SPO. The schematic arrangement of experimental setup is shown in figure 1 along with the photograph of actual experimental setup in figure 2.

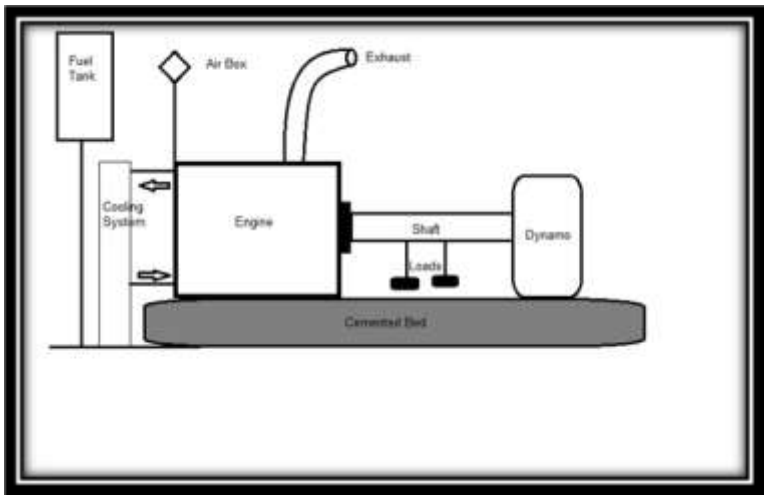

Fig.1 : Schematic arrangement of experimental setup

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Fig2 : Photograph of actual experimental setup

Engine specifications are given in table 4

Table 4 : Engine Specifications

ILLUSTRATION	RATING/NAME
Model/ Manfacturer	Kirloskar
Brake power(hp)	5
Rated speed(rpm)	1500
Compression ratio	17
Kilo watt (kW)	3.7
Type of cooling	Water cooled
Injection type	Direct injection
Stroke length(mm)	110
Bore(mm)	80
Specific Fuel Consumption	245g/kW-h
Lube Oil	SAE 40

IV. RESULT AND DISCUSSIONS

The comparison of performance parameters of Diesel engine using diesel, Scrap Plastic Oil, Ethanol and jatropha methyl ester are mentioned underneath.

- Load Vs brake thermal efficiency
- Load Vs Brake Specific Fuel Consumption
- Load Vs Exhaust gas temperature

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4.1 Brake Thermal Efficiency Vs Load

Variation of Brake thermal efficiency with various load conditions is shown in fig 3. The brake thermal efficiency for that of diesel is 28.24% at full load. At full load for ethanol mixed blends, M10, M20, M30, M40 and M50, it is 28.13%, 28.26%, 25.71%, 23.28% and 22.59 respectively. Data shows that M20 values are very close to that of Diesel.

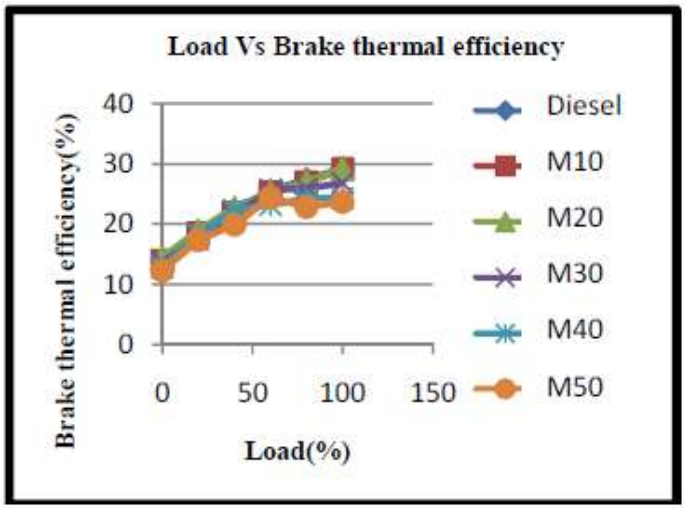

Fig 3: Variation of BTE with Load

4.2 Brake Specific Fuel Consumption Vs Load

Variation of Brake specific fuel consumption with various load conditions is shown in Fig 4. The observed brake specific fuel consumption values for diesel fuel and ethanol mixed blend - M10, M20, M30, M40 and M50 at full loading conditions respectively are 0.28, 0.31, 0.30, 0.34, 0.37, 0.46. Data shows that the value of the blend M20 are very near to that of Diesel.

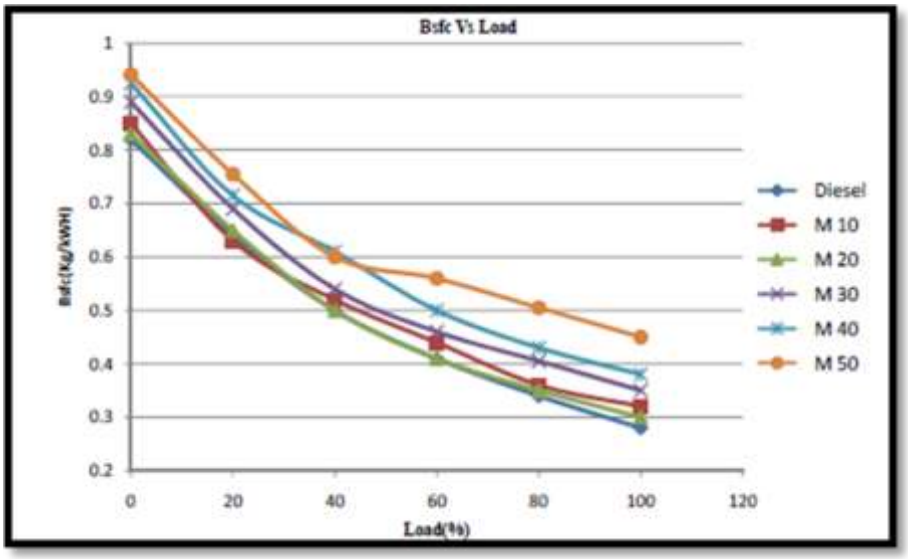

Fig 4 : Variation of BSFC with Load

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4.3 Exhaust Gas Temperature Vs Load

Variation of exhaust gas temperature with various load conditions is as shown in Fig 5. As load increases, the temperature also increases gradually. Temperature values for diesel and ethanol mixed blends- M10, M20, M30, M40 and M50 at full load are 2910C, 2970C, 3090C, 3270C, 3460C and 3600C respectively.

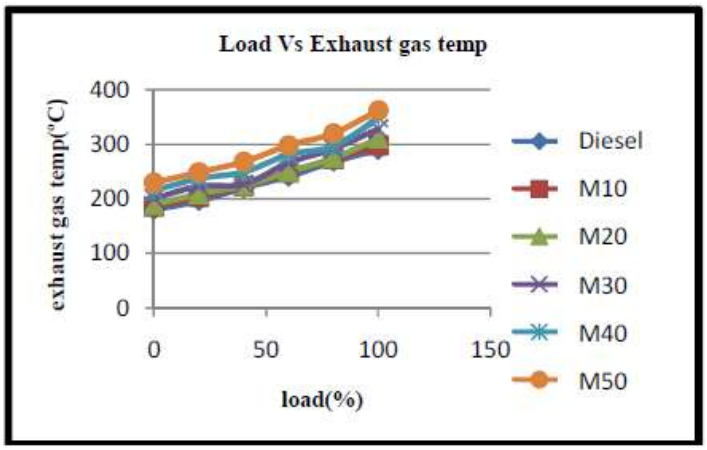

Fig 5 : Variation of EGT with Load

V. CONCLUSION

In this aforesaid study, experiments were carried out using ethanol mixed diesel, SPO and JME blends which brings to a very important conclusion that Blend M20 gives supreme results than as compared to the other blends. At full load the Brake thermal efficiency of M20 is 28.26 and that of diesel is 28.24, which is almost same. Brake thermal efficiency decreases as blend ratio is increased after 20%. Brake Specific Fuel Consumption decreases with increase in load and increases with increase in blend ratio of JME Ethanol and SPO.

It is concluded that JME, Ethanol and SPO blends are good alternative fuels for diesel engine in which the use of Ethanol makes this fuel good by imparting the Anti Knock Quality and at the same time provides the stable properties to the fuel.

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