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EXPERIMENTAL INVESTIGATION ON DIESEL ENGINE USING MAHUA ETHYL ESTERS

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Abstract:-

Diesel engines are used for automotive application because they have lower specific fuel consumption and superior efficiency compared to S.I engines. However in spite of these advantages NOx and smoke emissions from the diesel engines cause serious environmental problems. In the present work, biodiesel was produced from mahua oil. In this present work, investigations were carried out to study the performance, emission and combustion characteristics of mahua oil. The results were compared with diesel fuel, and the selected oil fuel blends. For this experiment a single cylinder, four stroke, water cooled diesel engine was used. Tests were carried out over entire range of engine operation at varying conditions of load. To increase the engine performance parameters and to decrease the exhaust gas emissions with increase biodiesel concentration. Additive to added the Ethanol. The blending percentage in the steps of 10%, 20%, 30% & 40%.

Keywords: - mahua oil, ic engines, bio diesel, ethyl esters,emissions

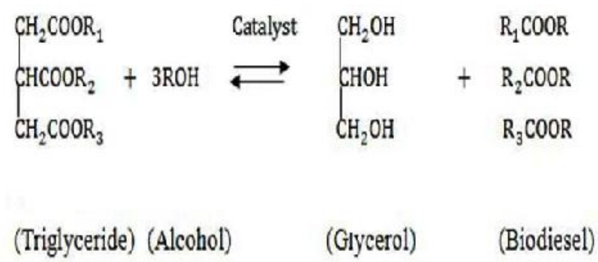
1. INTRODUCTION

The Energy comes in a variety of renewable forms like wood energy, wind energy, solar energy, ocean water power, geothermal energy; bio energy generated by bio fuels is viewed as a strong source of energy in the coming years. The Energy is also available in the nonrenewable form of fossil fuels that is oil, natural gas and coal, which provide almost 80% of the world's supply of primary energy. Use of these fossil fuels is a major source to cause pollution of land, sea and the entire atmosphere. For the last two centuries it is coming to know that all the unprecedented industrialization, power productions and transportation are mainly driven by fossil fuels and they have changed the face of this planet. India is the fourth largest consumer of energy in the world after USA, China and Russia, but it is not endowed with abundant energy resources. Despite the recent global economic slowdown, India's economy is expected to continue to grow at 6 to 8 percent per year in the near term, the strong economic growth and a rising population, growing infrastructural and socioeconomic development will stimulate an increase in consumption across all major sectors of the Indian economy. India imports about 80% of its crude oil requirement for domestic production of oil is inadequate to keep pace with the rising consumption of petroleum products [1-3]. The indiscriminate extraction and consumption of fossil fuels results in a reduction of petroleum reserves and also the emissions from the fossil fuels are considered as a major source to the environment pollution. Hence there is a need to find some alternate fuel, which can provide compensation for the depletion of the conventional petroleum resources and which can be produced from the available local resources. Such alternative fuels are alcohol, ethanol, biodiesel, vegetable oils etc. The present experimental work is carried out using mahua oil (madhuaca indica) as raw fuel or raw material as biodiesel production. The India is a large importer of vegetable oils so the edible oils cannot be used for the production of the biodiesel. The India also has a wide range of potential to become a leading biodiesel producer in the world since biodiesel can be harvested and sourced from non edible oils such as Mahua, Jatropha, Pongamia Pinnata, Neem, Castor, flaxseed etc [4-5]. Mahua oil is a non edible vegetable oil and is considered as a potential alternative fuel for the CI engines. Mahua India is popular for its quality and it is also exported to the foreign countries. After Canada, China and Russia the India is the fourth largest country in the production of large quantities of Mahua oil.

Figure 1: Mahua, Its seeds and Plant

2. BIODIESEL PRODUCTION

Biodiesel is oxygenated compounds, defined as the mono alkyl esters of long chain fatty acids are also called ethyl esters derived from lipid feedstock for example vegetable oils, animal fats or even waste cooking oil. Pure oils are not suitable for diesel engines because they can cause the carbon deposits and pour point problems and they can also cause the problems like engine deposits, injector plugging, or lube oil gelling [8]. So to use the oils in the diesel engines, they are chemically treated and that chemical process is known as transesterification. The transesterification which is also known as alcoholysis is the reaction of fat or vegetable oil with an alcohol to form esters and glycerol. Mostly a catalyst is also used to improve the rate and yield of the reaction. Since the reaction is reversible in nature, excess alcohol is used to shift the equilibrium towards the product. Hence, for this purpose primary and secondary monohydric aliphatic alcohols having 1-8 carbon atoms are used. The chemical reaction of transesterification processes is shown below in fig.2 where R represents a mixture of various fatty acid chains depending on the specific oil in use. Subscript 3 represents the number of moles needed to satisfy the formation of ethyl esters.



A. Properties of Mahua Oil

The different properties of mahua oil are tabulated in the Table I [1, 4]. It can be seen in the table that the properties of themahua oil is very closer to the diesel.

3. EXPERIMENTAL SETUP

The experimental test rig is a VCR engine that is a Variable Compression Ratio engine. It is a vertical, single cylinder, water cooled engine connect to eddy current type dynamometer for loading. The test rig engine consists of the fuel supply system for both diesel and biodiesel, lubricating system, water cooling system and various sensors attached and integrated with the computerized data acquisition system for the measurement of load, cylinder pressure, injection timing, position of crank angle etc. The fig. 3 below shows the complete test rig of VCR engine.

5. RESULTS AND DISCUSSION

A) BRAKE THERMAL EFFICIENCY

The variation of brake thermal efficiency with brake power for different fuels is presented in Fig..1. In all cases, it increased with increase with brake power. This was due to reduction in heat loss and increase in power with increase in load. The maximum thermal efficiency for B30 at full load 33.46% was nearer to diesel (32.74%).

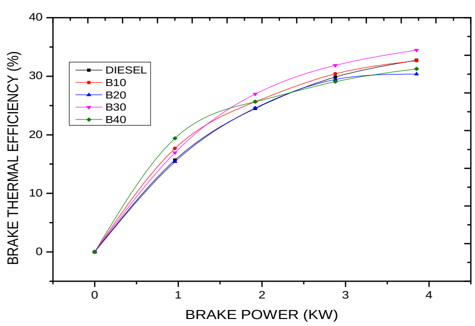


Figure2: Variation of Brake Themral Efficiency with Brake power

B) MECHANICAL EFFICIENCY

The comparison of Mechanical efficiency for various biodiesel blends with respect to brake power shown the Fig..2. From the plot it is observed diesel and its blends at full load conditions. But considerable improvement in mechanical efficiency was observed by the blend B30.

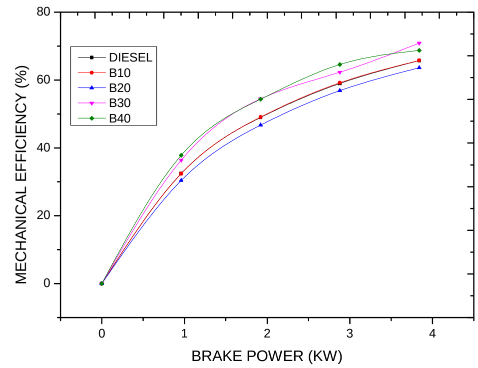


Figure 3: Variation of Mechanical Efficiency with Brake power

C) BRAKE SPECIFIC FUEL CONSUMPTION

The variation in BSFC with brake power for different fuels is presented in Fig.3. Brake-specific fuel consumption (BSFC) is the ratio between mass fuel consumption and brake effective power, and for a given fuel, it is inversely proportional to thermal efficiency. It can be observed that the BSFC of 0.263kg/kW-hr were obtained for diesel and 0.251 kg/kW-hr B30 at full load. It was observed that BSFC decreased with the increase in concentration of mahua oil in diesel.

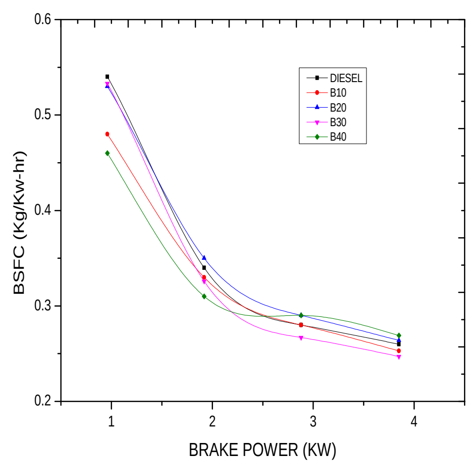


Figure 4: Variationof Brake Specific Fuel Consumption with Brake power

D) INDICATED SPECIFIC FUEL CONSUMPTION

The variation of Indicated Specific Fuel Consumption with brake power is shown in Fig..4. It is observed that from the graphs B30 line varies similar with the diesel. At full load ISFC of diesel is 0.167 kg/kW-hr and for B30 are 0.171 kg/kW-hr. The ISFC of bio-diesel is increases up to 2.39% as compared with diesel at full load condition.

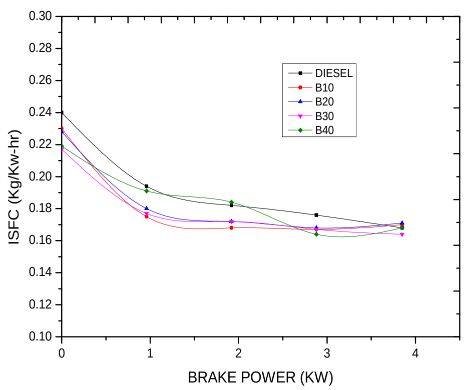


Figure 5: Variation of Indicated Specific Fuel Consumption with Brake power

E) VOLUMETRIC EFFICIENCY

The variation of volumetric efficiency with Brake Power is shown in Fig..5. The actual volume of air which is inducted for the combustion of B30 is less with respect to stoichiometric A/F ratio and therefore the volumetric efficiency of the engine is slightly increased when B30 is used as fuel.

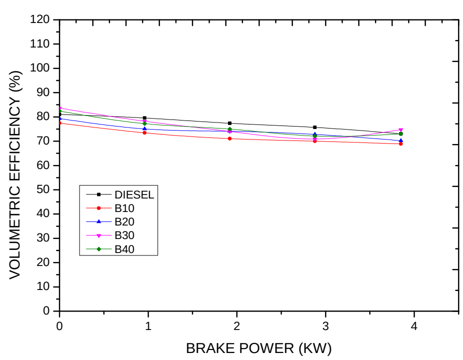


Figure6: Variation of Volumetric Efficiency with Brake power

Properties	Diesel	Mahua seed oil
Density (gm/cc)	0.83	0.91
Viscosity (cst)	3.22	38.5
Flash point (^{o}c)	50	128
Fire point (^{o}c)	66	192
Calorific value (kJ/kg)	42500	39600
Specific gravity	0.83	0.91

EMISSION ANALYSYS

F) CARBON MONOXIDE (CO)

The comparison of carbon monoxide for various biodiesel blends with respect to brake power shows in Fig.6. Carbon monoxide (CO) occurs only in engine exhaust, it is a product of incomplete combustion due to insufficient amount of air or insufficient time in the cycle complete combustion. For B30 carbon monoxide emission level is lower than that of diesel, in order to gives 10% to 20% extra oxygen. Due to the presence of extra oxygen, additional oxidation reaction takes place between O_2 and CO .The decreased CO emissions is 40% than diesel fuel for B30.

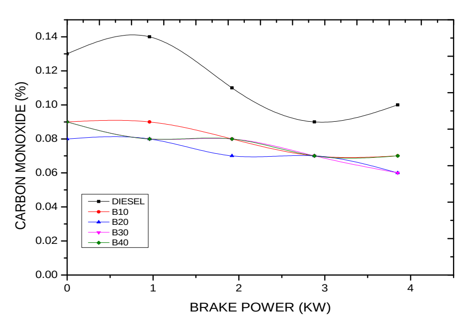


Figure 7: Variation of Carbon monoxide with Load

G) CARBON DIOXIDE (CO2)

The variation of carbon dioxide with brake power is shown in Fig..7. The CO_2 emissions from a diesel engine indicate how efficiently the fuel is burnt inside the combustion chamber. The ester-based fuel burns more efficiently than diesel. Therefore, in case of B30 the CO_2 emission is greater. At full load diesel contains 6.0 % of CO_2 emissions where as in case of B30 contains 6.40 %.The increase in CO_2 emissions is 6.66%.

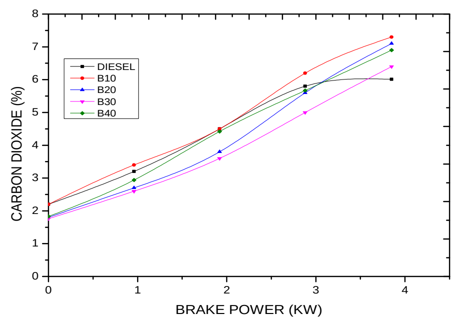


Figure 8: Variation of Carbon dioxide with Load

H) OXIDES OF NITROGEN (NO_X)

Variation of NOx with engine brake power for different fuels tested are presented in Fig 8. The nitrogen oxides emissions formed in an engine are highly dependent on combustion temperature, along with the concentration of oxygen present in combustion products. The amount of NOx produced for B30 is 471ppm, where as in case of diesel fuel is 490 ppm for diesel fuel.

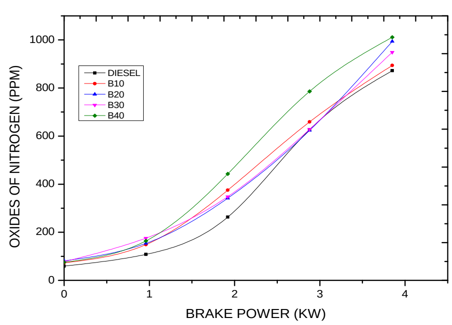


Figure 9: Variation of Oxides of nitrogen with Load

I) HYDROCARBONS EMISSIONS (HC)

the hydrocarbons (HC) emission trends for blends of ethyl ester of mahua oil and diesel are shown in Fig 9. That the HC emissions decreased with increase in brake power for all biodiesel at all loads. But in case of diesel fuel HC emissions are increases with load, because of there is no oxygen content present in diesel fuel. At full load diesel contains 58 ppm where as in case of B30 contains 99 ppm at same load.

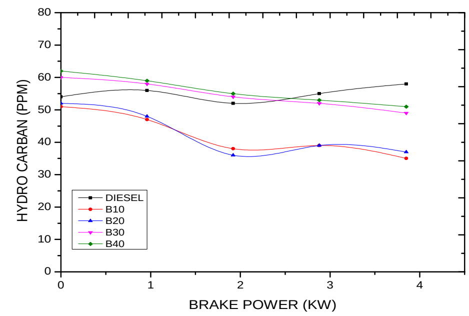


Figure 10: Variation of Hydrocarbons with Load

J) SMOKE DENSITY

The variation of Smoke density emissions with brake power for diesel fuel, biodiesel-blends is shown in the Fig. 10. The smoke is formed due to incomplete combustion in engine. The smoke density is lower for B30 compared to D100.The maximum smoke density recorded for the diesel was 83.57 HSU, 63.90 HSU for B30 at maximum load. The decrease in smoke density compared with diesel fuel at full load.

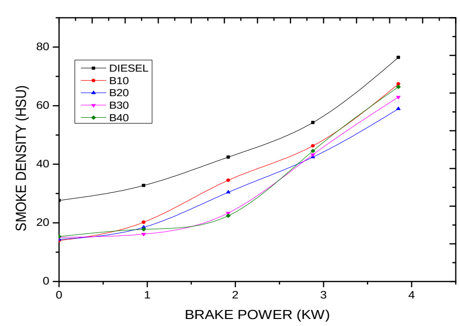


Figure 11: Variation of Smoke Density with Load

CONCLUSIONS

- The maximum brake thermal efficiency for B30 (33.46%) which is nearer to diesel but lower than the B30 blend.
- Brake specific fuel consumption was decreased for B30 compared to diesel. The decreased in BSFC in 8.74%.
- The maximum volumetric efficiency for B30 (82.04%) at full load condition, the volumetric efficiency of B30 blend is higher than diesel.
- Significant reductions were obtained in unburned hydrocarbon emissions of B30 blend compared diesel. Unburned hydrocarbons were decreased by 5.25%, compared to diesel at maximum load of the engine.
- The interesting things were obtained NOx emissions were decreased B30 compared to diesel. NOx emissions were decreased by 2.29% of B30 blend compared to diesel.
- The significant decrease in CO2 emissions were obtained B30 blend as compared to diesel. But slightly decreases at full load for remaining all blends.
- The marginal increases in smoke densities of B30 compared to diesel .The increment was in the order of 30.31% and 43.31% respectively.
- The maximum reduction in CO emissions of B30 blend compare to diesel was obtained .The order of decrees in 0.11% 0.12% compared with diesel.

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