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Influence of Ethanol with Karanja Oil on Exhaust Gas Emissions from a Variable Compression Ratio Engine

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ABSTRACT

Biodiesel is an alternative choice for diesel and have benefits over diesel because, it is renewable, biodegradable, sulfur free, and non-poisonous in nature and less exhaust emissions. The transesterification process is used to reduce the viscosity of the karanja oil. The aim of this paper is to examine the emission parameters under variable compression ratios (17 and 18) in a VCR diesel engine which runs using karanja oil 20% (B20) and ethanol as an additive by adding 5% and 10% at constant speed of 1500 rpm with variable loads. The outcomes of these blends have been compared with the normal diesel. The influences of compression ratios on exhaust gas emissions were investigated. The exhaust emissions, namely hydrocarbons, NOx, carbon monoxide and carbon dioxide are found to be reduced when compared with diesel.

Indexing terms/Keywords

Karanja oil, hydrocarbon, mono-nitrogen oxides, carbon monoxide, compression ratio.

Academic Discipline And Sub-Disciplines

Environmental Chemistry

SUBJECT CLASSIFICATION

Environmental Chemistry

TYPE (METHOD/APPROACH)

Experimental Study

INTRODUCTION

The emission parameters of variable compression ratio diesel engine were analyzed along with karanja oil 20% (B20) and ethanol as additive by adding 5% and 10% at constant speed of 1500 rpm with variable loads and two compression ratios 17 and 18 to reduce the vehicle exhaust gas emissions. The focus of this experimental work is to reduce exhaust emissions on earth by using green engines.

The emission characteristics of diesel engine operating in Karanja oil and the blends with diesel were analyzed and compared to the normal diesel. Transesterification process is used for the research of biodiesel, which reduces the viscosity of the oil. The various proportions of the biodiesel analyzed are B10, B20, B30 and these outcomes are compared with the diesel. The results of B10 and B20 were compared to diesel and also less than B20 can be used as a fuel to get better the performance and lesser emission of the CI engine. Carbon monoxide and Hydrocarbon emissions were reduced with augment in blend proportion of the biodiesel. The use of biodiesel could protect the environment by reducing the harmful emissions [1]. The biodiesel and biodiesel blends became alternatives to the diesel fuel. Although, clean biodiesel cannot be used in diesel engines due to technological problems, biodiesel blends have been engaged in diesel engines. The Engine is prepared with electric generator at 1500W, 3000W, 4500W and the various ranges of biodiesel used in the engine is from B10 to B100. It is observed that, B100 NOx emissions are larger than the diesel at 4500W of electric load. Specific fuel consumption increases with the quantity of the palm oil on the blended fuel [2]. The experiment evaluates the development of palm biodiesel-diesel blends with the assist of ethanol, n-butanol and diethyl ether. The additives were improved the brake power, brake thermal efficiency and reduced brake specific fuel consumption [3]. The experiments were agreed out at constant speed of 1500 rpm with full load and at compression ratios of 16:1 to 20:1. Emission parameters such as CO, CO_2, HC and EGT are discussed with different compression ratios (16:1 to 20:1) of dissimilar blends at full load situation. The experiment proves that inferior percentages of preheated palm oil can be used as diesel fuel. Major reduction in CO and HC are noted at high compression ratios under full load condition for all blends [4]. The emission characteristics of cottonseed oil in an unchanged engine and the effect of enlarging in injection pressure was studied. Tests were conducted with cotton seed oil and compared with normal diesel. High injection pressure has a significant improvement of engine performance and reduced emissions. Performance of engine with cotton seed oil is similar to the engine running with normal diesel [5].

EXPERIMENTAL

Biodiesel blend is the mixing of karanja oil with normal diesel at suitable amount of proportion. In this article using biodiesel blends called B20 (20% of biodiesel and 80 % of normal diesel) were used to run the engine. Ethanol is also added with biodiesel (B20) in two percentages viz., 5%, and 10% (B20 + 5% ethanol, B20 + 10% ethanol) as an additive. The variable compression ratio engine was used for testing the above blends by using a data acquisition system. The detailed specification of the engine bores 87.5 mm, stroke 110mm, single cylinder, four stroke 3.5 kW rated power and maximum speed of 1500 rpm. The engine has provision to modify compression ratio (CR) by tilting block arrangement of the engine head. The tilting cylinder building block array consists of a tilting block by way of six Allen bolts and a compression ratio adjuster with the lock nut and the compression ratio indicator. For setting a selected compression ratio, the Allen bolts are to be somewhat loosened. Then the lock nut on adjuster is to be loosened and the adjuster is to be rotated to locate a selected compression ratio by referring to the compression ratio pointer and to be protected using lock nut. At last all the Allen bolts are to be tightened gently. The compression ratio is to be reduced when the block is tilted, so that the clearance amount increases and swept volume remains same.

RESULTS AND DISCUSSION

This work depicts the reduction of exhaust emission from the internal combustion engines. The various blends are tested in variable compression ratio engine with change in compression ratios of 17 and 18. The blends are diesel, B20, B20+5% Ethanol, and B20+10% Ethanol respectively. The results of emission characteristics are analyzed with different load conditions.

Carbon monoxide

Fig.1 delineates the variation of carbon monoxide emissions with diesel, B20, B20+5% ethanol, B20+10% ethanol are evaluated for various loads of 0%, 25%, 50%, 75%, 100% at compression ratio 17.The CO emission is found to be decreasing with an increase in loads when B20+5% ethanol compared to the standard diesel emissions. The other blends also produce lesser emission with an increase in the loads. The reduction in CO emissions is due to complete combustion of the biodiesel.

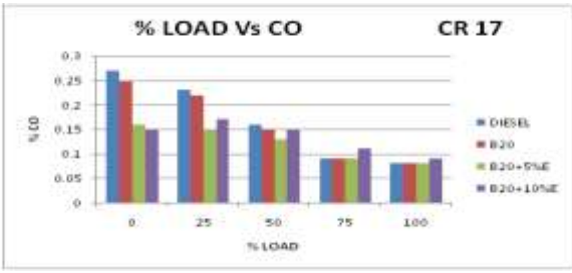

Fig.1. Variation of CO with loads (CR 17)

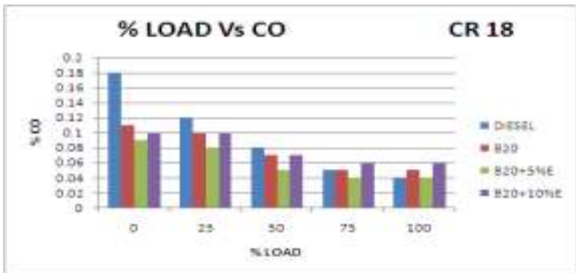

Fig.2. Variation of CO with loads (CR 18)

The variation of carbon monoxide with diesel, B20, B20+5% ethanol, B20+10% ethanol are evaluated with a various loads of 0%, 25%, 50%, 75%, 100% at compression ratio 18 is depicted in Fig.2. The CO got decreased with increasing loads when B20+5% ethanol when compared with same blends at compression ratio 17 due to high combustion temperature.

Hydrocarbon emission

Fig.3 shows that the variation of hydrocarbon emission with diesel, B20, B20+5% ethanol, B20+10% ethanol for various loads of 0%, 25%, 50%, 75%, 100% in compression ratio 17. The HC decreases when B20+5% ethanol at higher loads due shorter ignition delay and other blends are also gradually decrease with increasing loads.

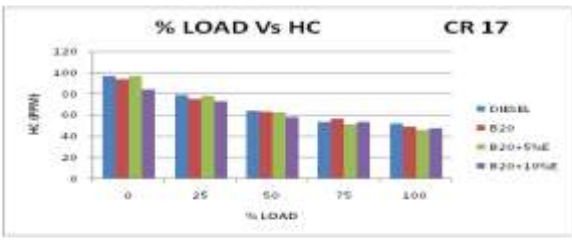

Fig.3. Variation of HC with loads (CR 17)

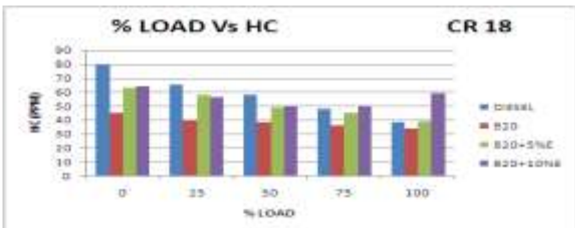

Fig.4. Variation of HC with loads (CR 18)

Fig.4 shows that the variation of hydrocarbon emission for diesel, B20, B20+5% ethanol, B20+10% ethanol are evaluated with various loads of 0%, 25%, 50%, 75%, 100% at compression ratio 18. The HC of all blends is decreasing compared to diesel and other blends are also got decreased due to minimum accumulation of fuels in combustion chamber.

Carbon dioxide

Fig.5 shows that the variation of carbon dioxide emissions with diesel, B20, B20+5% ethanol, B20+10% ethanol for various of loads of 0%, 25%, 50%, 75%, 100% in compression ratio 17. The CO_2 decreases compared to diesel when B20+5% ethanol at 0% load and gradually increasing with increasing loads.

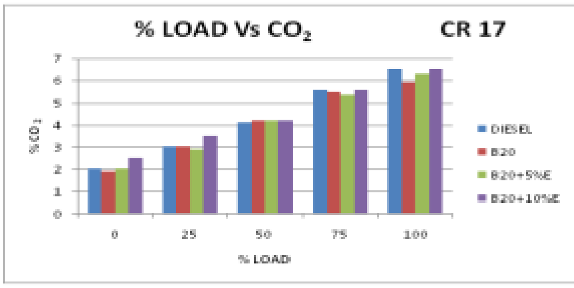

Fig.5. Variation of CO_2 with loads (CR 17)

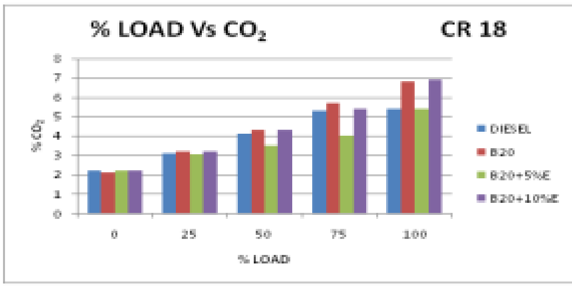

Fig.6. Variation of CO_2 with loads (CR 18)

Fig.6 shows the variation of carbon dioxide for diesel, B20, B20+5% ethanol, B20+10% ethanol for various loads of 0%, 25%, 50%, 75%, 100% at compression ratio 18. The CO_2 emissions decrease up to 100% load compared to diesel when B20+5% ethanol is used as a fuel. The CO emissions for B20 are equal to the diesel in all load conditions and other blends are increasing with increasing load due to insufficient oxygen.

Oxygen

Fig.7 shows the variation of oxygen with diesel, B20, B20+5% ethanol, B20+10% ethanol are evaluated to help of a variety of loads of 0%, 25%, 50%, 75%, 100% at compression ratio 17. The O_2 increases slightly up to 75% load compared to diesel when B20+5% ethanol is used as a fuel, but at 100% load B20 is increasing compared to diesel and B20+5% ethanol.

Fig.7. Variation of O_2 with loads (CR 17)

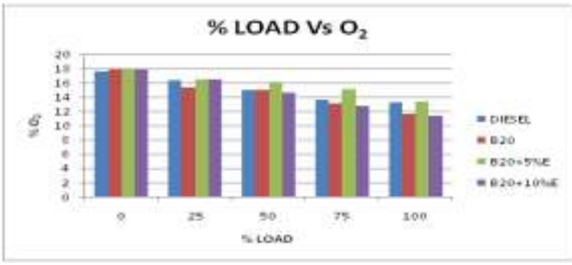

Fig.8. Variation of O_2 with loads (CR 18)

Fig.8 shows the results of oxygen with diesel, B20, B20+5% ethanol, B20+10% ethanol are evaluated with various loads of 0%, 25%, 50%, 75%, 100% at compression ratio 18. The O_2 increases slightly up to 75% load compared to diesel when B20+5% ethanol, but at 100% load B20+5% ethanol is almost equal to diesel.

NO_X Emission

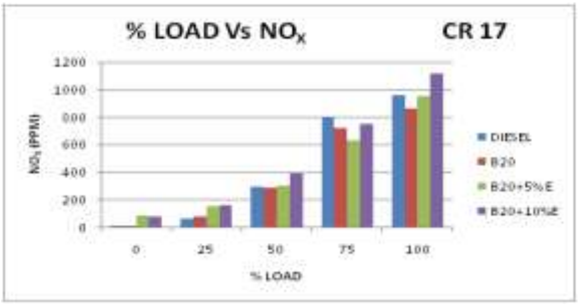

Fig.9. Variation of NO_x with loads (CR 17)

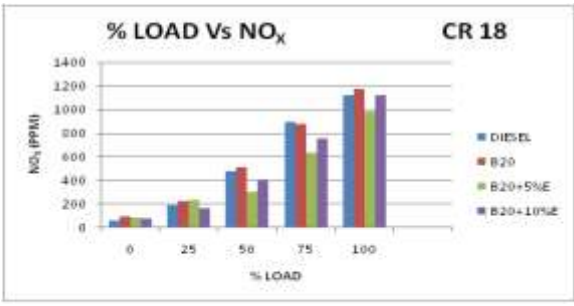

Fig.10. Variation of NO_x with loads (CR 18)

Fig.9 shows the variation of NO_X for diesel, B20, B20+5% ethanol, B20+10% ethanol for various loads of 0%, 25%, 50%, 75%, 100% at compression ratio 17. The NO_X decreases highly up to 75% load compared to diesel when B20+5% ethanol and it is equal at 100% load B20+5% ethanol.

Fig.10 shows the variation of NO_X for diesel, B20, B20+5% ethanol, B20+10% ethanol for various loads like 0%, 25%, 50%, 75%, 100% at compression ratio 18. The NO_X values are decreases compared to diesel when B20+5% ethanol and it should be higher values for all loads due to higher peak temperature.

CONCLUSION

An experimental investigation has been conducted on a VCR engine by taking of karanja oil as fuel also ethanol as additive and analyzed the exhaust emission characteristics of various diesel blends. The conclusions are arrived from this analysis as follows:

- Carbon monoxide emissions are decreasing when the blend B20+5% ethanol is used as a fuel in compression ratio 17, but when B20+5% ethanol fuel, nearly equal amount of emissions is compared to diesel fuel under compression ratio of 18 with varying loads.
- Hydrocarbon emissions are decreasing when the blend B20+5% ethanol is used as a fuel in compression ratio 17, but at compression ratio 18 the blend B20 gives reduced emissions compared to diesel.
- Carbon dioxide emissions decreases when the blend B20+5% ethanol is used as a fuel in compression ratio 17, but B20+5% ethanol is almost equal to diesel when the engine is operated at compression ratio 18 with varying loads.
- O_2 increases slightly up to 75% load compared to diesel when B20+5% ethanol is used as a fuel, but at 100% load B20 give high emissions compared to diesel and B20+5% ethanol in compression ratio 17, but in compression ratio 18 the O_2 increases slightly with B20+5% ethanol.
- NO_X decreases highly compared to diesel when B20+5% ethanol is used as a fuel when the engine is operated at compression ratio 17 and 18.

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