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EFFECT OF EXHAUST GAS RECIRCULATION ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE FUELED WITH MORINGA OLEIFERA OIL'DIESEL BLEND

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Abstract:**It is believed that crude oil and petroleum products will become very costly and scarce. Fuel economy of engines getting improved and will continue to improve. With increased use and depletion of fossil fuels, alternative fuel technology will become more common. This led to the search for an alternative fuel which should be not only environment friendly but also sustainable without compromising on the performance. Many alternative fuels gave improved performance, specifically vegetable oil present a very hopeful alternative fuel for diesel oil because they are renewable, clean burning and having properties analogous to that of diesel. Here, in this experiment using Moringaoleifera oil is a biodiesel. Experiments are carried out on a diesel engine using with and without Exhaust Gas Recirculation system and blends of Moringaoleifera oil biodiesel as alternative fuel, which is a single cylinder, four-stroke, water cooled, and constant speed engine at 1500 rpm.**

Keywords:MoringaOleifera oil, Exhaust Gas Recirculation System, Single cylinder 4-stroke diesel engine, Exhaust emissions.

I.INTRODUCTION

Despite diesel engines have advantages they produce higher levels of emissions which have significant effect on human, animal, plant, and environmental health and welfare. The search for energy independence and concern for a cleaner environment have created significant interest in biodiesel, despite its shortcomings. The use of biodiesel in diesel engines has both economic and environmental benefits. Biodiesel is an alternative diesel fuel which can be obtained from the transesterification of vegetable oils or animal fats. The use of biodiesel in diesel engines does not require any engine modification. An important property of biodiesel is its oxygen content which is usually not contained in diesel fuel. Biodiesel gives considerably lower emissions of PM, carbon monoxide (CO) and hydrocarbon (HC) without any extra fuel consumption or engine performance penalties. Exhaust gas recirculation (EGR) can be used with biodiesel in the diesel engines. EGR is an effective technique of reducing emissions from the diesel engine exhaust.

II. MATERIALSAND METHODS

2.1. Moringaoleifera oil (Biodiesel): In this project work consider the one of the bio fuel the name is moringaoleifera oil. The moringaoleifera oil is belongs to the moringa case family and it is obtained from moring tree another name is drumstick tree. This oil is also known as Ben oil. The moringa oil is derived from the moringa seeds. One of the reason for selecting the moringoieifera oil calorific value is near to the diesel.

Physical properties:

S.NO	Properties	Diesel	Biodiesel
1	Kinematic viscosity@ 40^{0}c (mm^2/s)	1.56	5.03
2	Calorific value (MJ/Kg)	45.042	40.519
3	Flash point (^{0}c)	62	152
4	Fire point (^{0}c)	66	156
5	Density (Kg/m^3)	805.4	863.1
6	Specific gravity	0.805	0.863

S.NO	Properties	B 10	B 20	B 30
1	Kinematic viscosity@ 40^{0}c (mm^2/s)	2.2	2.963	4.28
2	Calorific valu (MJ/Kg)	44.731	42.140	41.592
3	Flash point (^{0}c)	80	86	94
4	Fire point (^{0}c)	86	92	100
5	Density (Kg/m^3)	810.6	814.2	822
6	Specific gravity	0.810	0.814	0.822

III. EXPERIMENTALSETUP AND PROCEDURE

An experimental investigation was carried out to investigate the effect of exhaust gas recirculation on Performance and emission characteristics of a diesel engine fuelled with biodiesel. The engine used for the investigation was a single-cylinder, four-stroke, water cooled diesel engine. The technical specifications of the engine are given in Table I, and the schematic of the experimental setup is shown in Figure 1.The engine is supplied with moringaoleifera oil and diesel fuel by using with exhaust gas recirculation and without exhaust gas recirculation which some of their

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properties are given in Table II. The load is given to the engine by using electrical load. The exhaust emissions HC, CO, CO2 and NO_X

Fig 3.1Experimental set up

ENGINE SPCIFICATIONS:

Engine: Kirloskar Engine4 stroke-stationary

Type	: water-cooled
Ignition system	: compression ignition
Arrangement of cylinder	: vertical
Maximum speed	: 1500
Number of Cylinder	: 1
Bore	: 85 mm
Stroke	: 110 mm
Compression Ratio	: 16.5:1
Maximum HP	: 5 HP
Fuel	: HSD

Injection pressure: SAE 20/SAE

EXHAUST GAS RECIRCULATION ARRANGEMENT

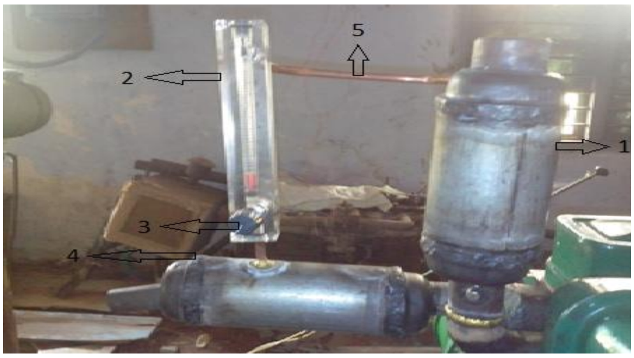

Fig 3.2 Exhaust gas recirculation arrangement

Various parts of exhaust gas recirculation arrangement are:

1) Pre-mixing chamber
2) Gas flow meter
3) Exhaust gas regulator
4) Settling chamber
5) Copper tube

*1) Pre-mixing chamber:*The material selected to prepare the pre-mixing chamber is galvanized iron. The length and diameter of pre-mixing chamber are 20cm & 8.5cm. In this chamber, the air coming from the atmosphere and the exhaust gases are mixing together and sent into the engine intake manifold. This chamber consists of a small provision at bottom end to measure intake charge temperature.

*2) Gas flow meter:*This flow meter consists of glass body, tube, needle, and regulator. The main function of this gas flow meter is to measure the gas flow rate in terms of litres per minute. The range of gas flow meter is 0 to 10%. Accuracy of this gas flow meter is ±0.25%.

*3) Exhaust gas regulator:*The main function of this regulator is to control the flow of exhaust gases. It regulates theflowofexhaustgases from settling chamber to the pre mixing chamber.

*4) Settling chamber:*The material selected to prepare the pre-mixing chamber is galvanized iron. The length and diameter of pre-mixing chamber are 25cm & 8.5cm. In this chamber a part of the exhaust gases re-circulated and remaining are sent to the atmosphere. This chamber consists of a small provision at one end to measure the exhaust gas temperature.

*5) Copper tube:*Copper tube is connected between the gas flow meter, premixing, and settling chambers. Copper tube is a connection pipe settling chambers. The main aim of selection of copper tube is it reduces the exhaust gas temperatures and easy to adjust in any direction. The diameter of copper tube is 8mm.

IV. RESULTS AND DISCUSSION

Brake specific fuel consumption:

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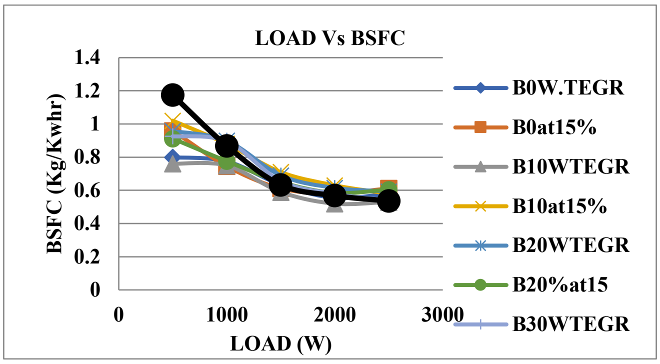

Figure 4.1 Load V_S Brake specific fuel consumption

The result for the variations in the brake specific fuel consumption (BSFC) is presented in the fig. 4.1. For all the fuels with and without EGR openings the BSFC falls with increasing load. The maximum BSFC value at B0 with and without EGR is 0.96 & 0.799Kg/KWh, at B10 with and without EGR is 1.02 & 0.76 Kg/KWh, at B20 with and without EGR is 0.912 &0.957 Kg/KWh, and at B30 with and without EGR is 0.926 & 1.17 Kg/KWh. The brake specific fuel consumption (BSFC) is remains unaffected at full load conditions.

Brake thermal efficiency:

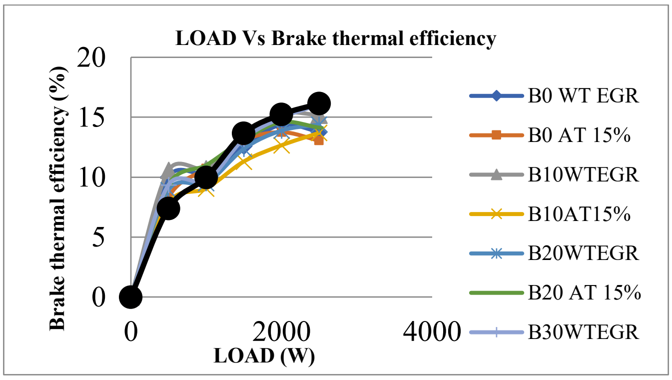

Figure 4.2 Load Vs Brake thermal efficiency

The variation of brake thermal efficiency with respect to load for moringaoleifera oil blends and diesel by using with and without EGR is shown in fig.4.2. It can be observed from the results the using EGR it improves the thermal efficiency when compared without EGR engine performance. For all fuels the brake thermal efficiency increases with load.

The maximum brake thermal efficiency values at B0 with and without EGR is13.05 & 13.75 %, at B10 with and without EGR is 13.07 & 15.18%, at B20 with and without EGR is 14.13 & 14.39 %, and at B30 with and without EGR is 16.14 & 16.05%. The higher brake thermal efficiencies between 1500W to 2500W at 15% EGR then compare to the other values. This may be due the replacement of oxygen with exhaust gases inside the combustion chamber.

Mechanical Efficiency:

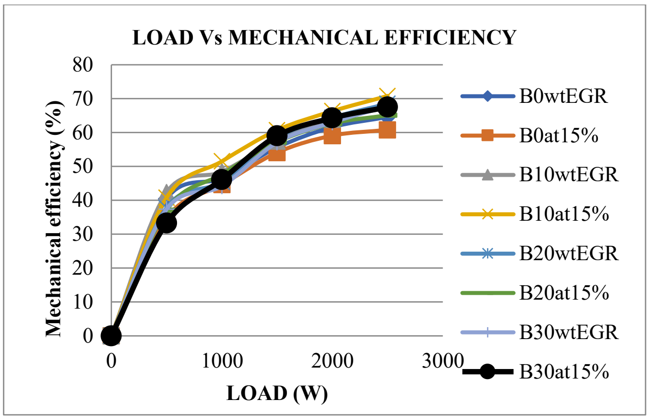

Figure 4.3 Load Vs. Mechanical Efficiency

From the fig.4.3 it can be concluded that the mechanical efficiency of the engine at a given load is independent of percentage of with and without EGR rates [6].

The observed Mechanical efficiency at B0 with and without EGR is60.79 & 64.6%, at B10 with and without EGR is 70.8 & 67.4%, at B20 with and without EGR is 65.1 & 68.5%, and at B30 with and without EGR is 67.5 & 67.8%. It is observed that the mechanical efficiencies for with EGR are increased than without EGR the increasing trend of mechanical efficiency with load [7].

Exhaust gas temperature:

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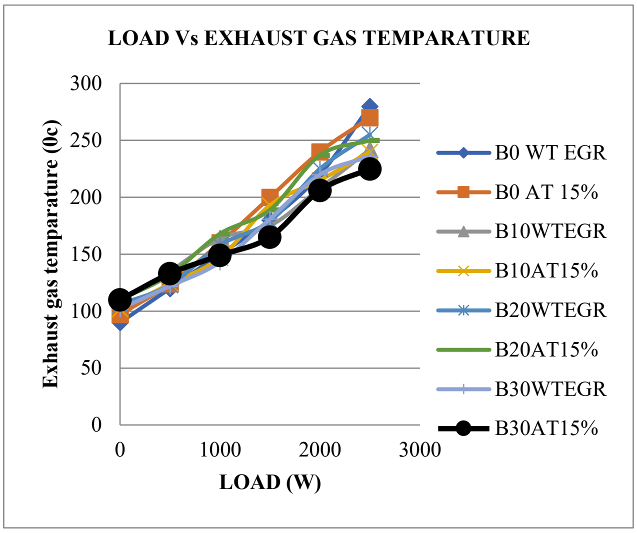

Figure 4.4 Load V_S Exhaust gas temperatures

It is observed that the exhaust gas temperature increases with load because more fuel is burnt at higher loads to meet the power requirement [8]. The exhaust gas temperatures are decreased when using EGR system. The maximum temperatures for without EGR is 280ºc and with EGR 270ºc at full load condition and minimum exhaust gas temperatures for without and with EGR are 236ºc and 225ºc [9].

HC Emission:

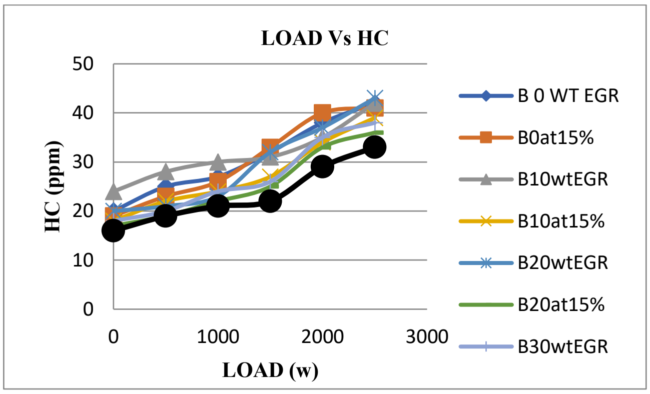

Figure4.5 Load VsHydrocarbons

The variation of hydro carbons respect to load shown in Fig.4.5 The HC emissions are minimum for with EGR at part loads when compared to without EGR. The Hydrocarbon emissions for B30 at 15% EGR are decreased at load 1500 to 2500W when compared to without EGR. Whereas, load increases the HC emissions are also increases for with EGR compared to without EGR [10].

CO Emission:

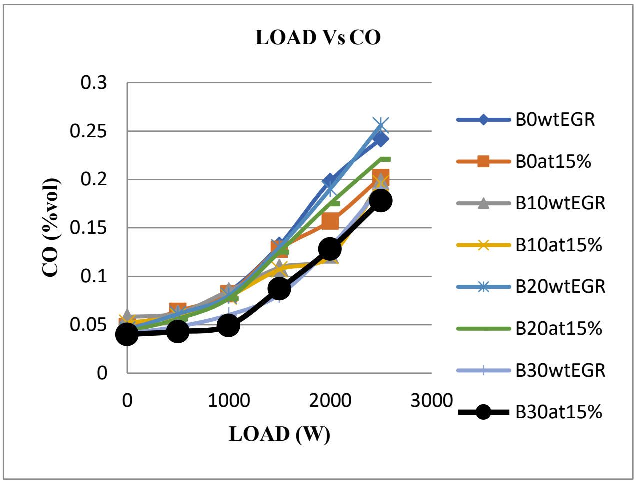

Figure 4.6 Load Vs Carbon monoxide

CO is predominantly formed due to the lack of oxygen. The fig. 4.6 shows that the CO emissions are increased with increase in load at with and without EGR rates. The observed values at full load at B0 with and without EGR is 0.178 &0.191%vol, at B10 with and without EGR is 0.221& 0.25%vol, at B20 with and without EGR is 0.196&0.198%vol,and at B30 with and without EGR is 0.256 & 0.242%vol.

CO_2 Emission:

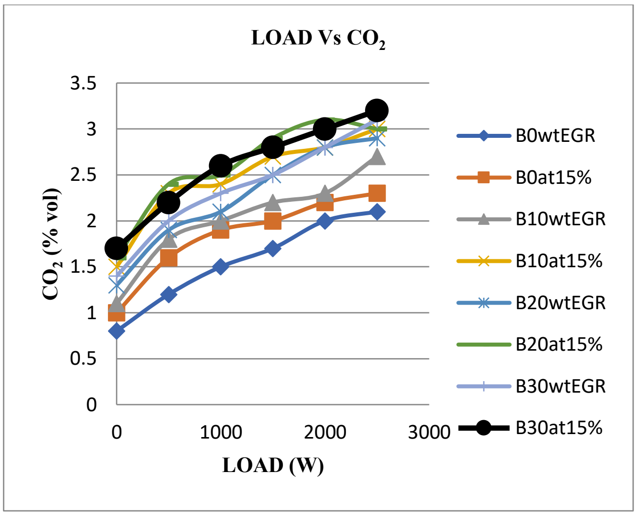

Figure 4.7 LOAD Vs Carbon dioxide

The variation of carbon dioxide emission with respect to load is observed. The $CO_2$are increased by increasing the load. At loads 2500W at B0 with and without EGR is 2.3 & 2.1%vol,

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at B10 with andwithout EGR is 3 & 2.7%vol, B20 with and without EGR is 3 & 2.9%vol, and at B30 with and without EGR is3.2 & 3.1%vol. From the observation the amount of CO_2 produced for with EGR system is increased when compared to without EGR.

NO_X Emission:

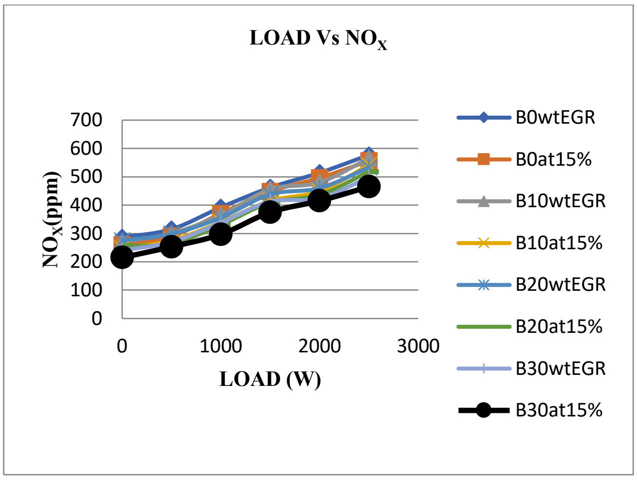

Figure 4.8 Load Vs Nitrogen oxide

The variation of NO_X emissions with respect to load at with and without EGR openings shown in fig.4.8 NO_X emissions are more for normal diesel engine without EGR. It is observed that NO_X emissions are drastically reduced by using the EGR system. The maximum NO_X values at full load at B0 with and without EGR is 556 & 577ppm, at B10 withand without EGR is 541 & 565ppm, at B20 with and without EGR is 518 & 533ppm, and at B30 with and without EGR is 465 & 498ppm.

CONCLUSION

Following are the conclusions based on the experimental results obtained while operating single cylinder water cooled diesel engine is filled with moringa oil and its diesel blends. Engine is operated with, with and without EGR system.

- Brake thermal efficiency is increased by 0.09% at 15% EGR, when compared to with and without EGR at load 2500W respectively.
- Brake specific fuel consumption is decreased at increasing loads for all blends by using with and without EGR.
- The Mechanical efficiency is increased at 15% EGR when compared to without EGR at maximum load.
- Exhaust gas temperature for all EGR openings is lower when compared to without EGR system.
- Hydro carbon emission at 15% EGR decreases when compared to without EGR at maximum load condition.
- Carbon monoxide emissions at 15% EGR are increased when compared to without EGR at full load.
- Carbon dioxide emissions at 15% EGR are increased when compared to without EGR at maximum load conditions.
- NO_X emissions are greatly decreased for all EGR openings, when compared with the without EGR.

From the present investigation, for 4-stroke single cylinder diesel engine, it is recommended that EGR system at 15% EGR for loads between 1500W & 2500W produces lesser emission and better performance than diesel.

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