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Experimental Investigation of EGR Effect on Emission Characteristics of a Diesel Engine Fueled with Biodiesel

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Abstract:-- **One of the greatest challenges of the 21st century is to solve the problem of depletion of fossil economy. In this era our environment is badly affected by the pollution of fossil fuel which led to introduce an alternative fuel for compression ignition engines. Biodiesel is receiving more attention as an alternate fuel to the diesel engine with no or fewer modification. Previous studies reported that the use of biodiesel in compression ignition engines leads to the reduction in Hydrocarbon (HC), Carbon Monoxide (CO) & PM emissions accompanying with increase in fuel consumption & Nitrogen Oxide (NOX). Exhaust Gas Recirculation (EGR) is one of the methods to reduce the NOX emitted by C.I. engines. NOX is formed in condition of higher flame temperature and high oxygen availability which is greatly reduced by the process of EGR.Experiments were conducted on a single cylinder, four strokes, Variable Compression Ratio (VCR), water cooled diesel engine at full load with provision for EGR. In this paper, the comparison of performance and emission characteristics on the C.I. engine when it is fueled with biodiesel and diesel with 0%, 5% and 10%EGR are shown. Experimentally has been proved that, 10% EGR with biodiesel blend have minimized NOX and improved performance.**

Keywords :- **Biodiesel, EGR, VCR, Rapeseed, NOX**

I. INTRODUCTION

Nowadays, environmental pollution is becoming a major problem due to globalization and very fast development of industrial and transport industries. C.I engines are the main power source for the automobile which is used by transportation industries. Vehicular traffic is a major contributor to today's environmental pollution. The emission of exhaust gas from vehicle includes CO, CO2, HC, and NOX, which of them NOX is very harmful for human beings. In order to reduce the depletion problem of fossil fuels and pollutions, the development of new alternating fuel which is biodiesel. One of the advantages of biodiesel is reduction of the emission like carbon monoxide (CO), Hydro Carbon (HC) and Particulates. However, decreasing in other pollutants is accompanied by increase in nitrogen oxide (NOX). The main drawback of biodiesel is emission of NOX in large amount is overcome by the process of EGR. NOX emission compared to diesel. EGR is an effective technique for reducing NOX emission from the diesel engine.

II. PROCEDURE AND EXPERIMENTAL TERMINOLOGY

A. Trans-esterification Process:

Biodiesel is produced by the process of producing biofuel, biodiesel through the chemical reactions trans-esterification and esterification. This involves vegetable or animal fats and oils which is reacted with short-chain alcohols. There are three basic routes to biodiesel production from oils and fats.

- Base catalyzed trans-esterification of the oil
- Direct acid catalyzed trans-esterification of the oil.
- Conversion of the oil to its fatty acids and then to biodiesel.

Triglyceride + 3Methanol =catalyst= Glycerin + 3 Methyl Esters (Biodiesel)

B. Properties of biodiesel:

Biodiesel is also called as rapeseed oil. Rapeseed oil used as diesel fuel, either as a biodiesel in heated fuel systems or blended with petroleum distillates for powering motor vehicle. Rapeseed oil is used in pure form in diesel engines with fewer or no modification. The biodiesel shows following properties:

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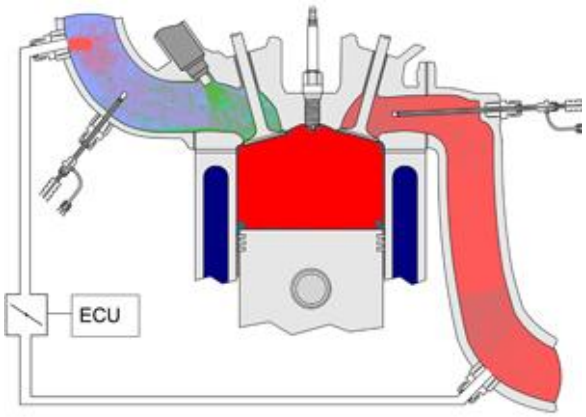
SR. NO.	TEST DESCRIPTION	RAPESEED METHYL EASTER
		B100%
1	DENSITY	0.876gm/cc
2	CALORIFIC VALUE	38.50Mj/kg
3	CETANE NO.	51.10
4	VISCOSITY	5.40mm^2
5	MAOISTURE	NA%
6	FLASH POINT	163 ^{O}C
7	FIRE POINT	171 ^{O}C
8	CLOUD POINT	3 ^{O}C
9	POURPOINT	1 ^{O}C
10	ASH	0.050%

C. EGR System terminology

Exhaust gas recirculation (EGR) is an emission control technic allowing significant NOX emission reductions from diesel engines. The most common reason for applying EGR to modern commercial diesel engines is to reduce NOX and knocks.

Working:

A widely adopted method to reduce NO_X emissions is Exhaust Gas Recirculation (EGR). This involves recirculating specific proportion of the engine's exhaust gas back into the intake airline. A regulating valve is usually used to control the flow of exhaust gas, and the valve may be closed completely if required. The addition of burnt gas in intake line reduces the oxygen rich air proportion of the cylinder contents which is available for combustion. These causes low heat release and peak cylinder temperature and ultimately reduce in the formation of NO_X.



Advantage of NO_X

- Reduced NO_X
- Potential reduction of throttling losses on spark ignition engines at part load
- Improved engine life through reduced cylinder temperatures (particularly exhaust valve life)

III. EXPERIMENTAL SETUP

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Research engine connected to eddy current dynamometer. It is provided with necessary instruments for combustion pressure, crank-angle, airflow, fuel flow, temperatures and load measurements. These signals are interfaced to computer through high speed data acquisition device. The setup has stand-alone panel box consisting of air box, twin fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and piezo powering unit. Rota meters are provided for cooling water and calorimeter water flow measurement. In petrol mode engine works with programmable Open ECU, Throttle position sensor (TPS), fuel pump, ignition coil, fuel spray nozzle, trigger sensor etc. The setup enables study of VCR engine performance for both Diesel and Petrol mode and study of ECU programming. Engine performance study includes brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, Air fuel ratio, heat balance and combustion analysis.

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A. Actual image of setup:

B.Specifications:

Product	Research Engine test setup 1 cylinder, 4 stroke, Multifuel, VCR, Code 240
Engine	Single cylinder, 4 stroke, water cooled, stroke 110 mm, bore 87.5 mm, 661 cc. Diesel mode: 3.5 KW, 1500 rpm, CR range 12-18. Injection variation:0- 250 BTDC Petrol mode: 4.5 KW@ 1800 rpm, Speed range 1200-1800 rpm, CR range 6-10,
Dynamometer	Type eddy current, water cooled, with loading unit
Fuel tank	Capacity 15 lit, Type: Duel compartment, with fuel metering pipe of glass
Calorimeter	Type Pipe in pipe
ECU	PE3 Series ECU, Model PE3-8400P, full build, potted enclosure. Includes pe-Monitor&pe-Viewer software.
Overall dimensions	W 2000 x D 2500 x H 1500 mm

IV. CALCULATIONS

A. Formulae

1. Air flow

$$C_d \text{ X } A \text{ X } \sqrt{2 \text{ X } gh \text{ X } \frac{\rho w}{\rho a}} \text{ X } \rho a X \text{ } 3600$$

Where,

ρw = density of water in Kg/m^3
ρa = density of air in Kg/m^3
h = Manometer difference in m
A = Orifice area in m^2

2. Brake power

$$\frac{2\Pi \text{ X } N \text{ X } T}{60 \text{ X } 1000}$$

3. Brake Thermal Efficiency

$$\frac{\text{Brake power (Kw) X } 100}{\text{Mass Of Fuel } \left(\frac{Kg}{s}\right) \text{ X Calorific value } \left(\frac{KJ}{Kg}\right)}$$

4. Brake Specific Fuel Consumption

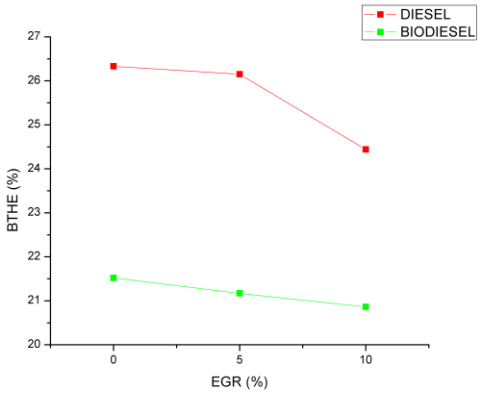
$$\frac{\text{Mass of fuel in } \frac{Kg}{hr}}{\text{BP (KW)}}$$

V. RESULT AND DISCUSSION

A. Performance

1. Brake Thermal Efficiency:

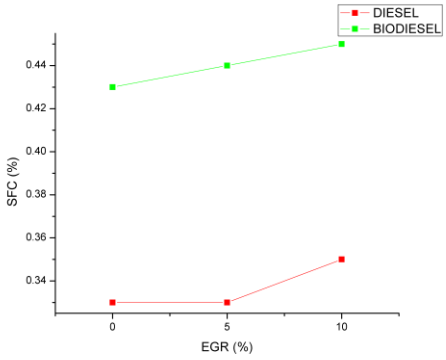
Graph 1 shows the variation of brake thermal efficiency for diesel and biodiesel with different EGR rates at 100% load. The brake thermal efficiency decreases with increase in EGR percentage. For biodiesel it is lower than that of diesel. The calorific value of Biodiesel is lower than that of Diesel fuel so, that the brake thermal efficiency is lower than diesel. On the other hand the brake thermal efficiency is high at low EGR because of recirculation of active radicals which enhances the combustion process.



Graph 1 Effect of EGR on BrakeThermal Efficiency at 100% load

2. Specific Fuel Consumption

Graph 2 shows the effect of EGR on the specific fuel consumption. At 10% EGR the specific fuel consumption is high. Specific Fuel consumption is very low in case of diesel compare to the Biodiesel's specific fuel consumption.



Graph 2 Effect of EGR on Specific Fuel Consumption at 100% load

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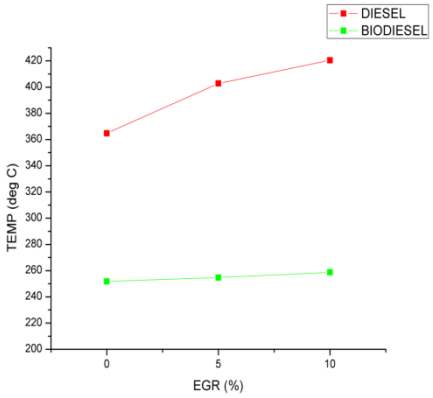
3. Effect of EGR on Temperature

Graph 3 shows less temperature variations in biodiesel as compared to diesel. Low temperature causes low HC and NO_X emissions.

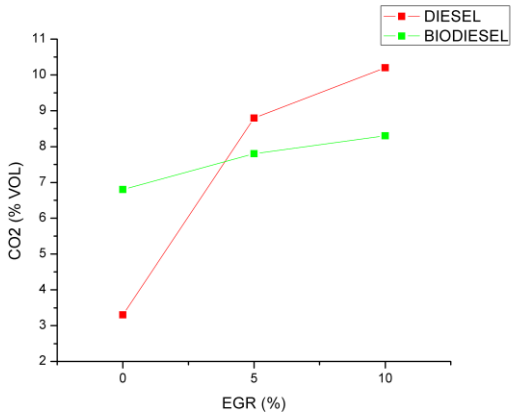


Graph 3 Effect of EGR on Temperature at 100% load

B. Emissions

1. Carbon Monoxide

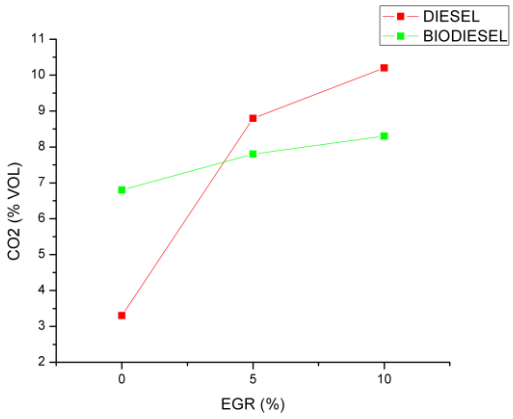
Graph 4 shows that the variation of CO with different percentage of EGR. As percentage of EGR increase the CO emission rate increases and the rate of increase in emission is high in diesel as compare to biodiesel.



Graph 4 Effect of EGR on CO emissions at 100% load

2. Carbon Dioxide

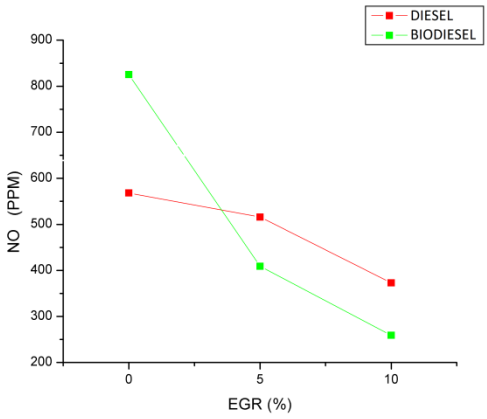
Graph 5 shows that at 0%of EGR the emission of CO2 are higher for biodiesel but as percentage of EGR increases it is seen that the increase in emissions of CO2 for Rapeseed oil is low compare to diesel



Graph 5 Effect of EGR on CO2 emissions at 100% load

3. Nitrogen oxide

Graph 6 shows the variation of NO with respect to EGR percentage. At 0% EGR the NO is very high for Diesel and biodiesel. As the EGR percentage increases it successfully decreases the NO for both Rapeseed oil and Diesel. And at the rate of 10% EGR it is seen that the NO emission for Biodiesel is considerably lower than that of Diesel engine.



Graph 6 Effect of EGR on NO emissions at 100% load

Biodiesel causes higher NO emissions than Diesel because the oxygen content in biodiesel is higher. NO emissions are decreased with increase in EGR as it reduces the peak combustion temperature.

VI. CONCLUSION

Biodiesel is an oxygenated fuel that undergoes improved combustion in the engine due to the presence of molecular oxygen but leads to higher NO_X emissions. In the experiment higher NO_X emissions is effectively controlled

by 10% exhaust gas recirculation. Recycled exhaust gas lowers the oxygen concentration in the combustion chamber and increases the specific heat of intake charge which results in lower flame temperature and reduction in NO_X formation. Brake thermal efficiency of biodiesel is found to be comparable with diesel at full load. The present experimental analysis on a single cylinder diesel engine with diesel and biodiesel blend at10% EGR has proved minimized pollution and improved performance. There is an average reduction of 40% NO_X emission is obtained by 10% EGR

1. When the engine utilizes biodiesel, It conclude that the Brake Thermal Efficiency of engine reduces with increase in EGR percentage.

2. It is seen that at 10% EGR the Specific Fuel Consumption increases considerably. As many research says the NO increases rapidly by using Bio-diesel. Applying EGR was an impressive technique to reduce the NO emission

REFERENCES

[1] N.S. Senthur "AN EXPERIMENTAL INVESTIGATION ON PERFORMANCE, COMBUSTION AND EMISSION PARAMETERS BIODIESEL-WATER EMULSION ON A DI DIESEL ENGINE" [Senthur* et al., 5(8): August, 2016] ISSN: 2277-9655IC™ Value: 3.00

[2] K.Venkateswarlu, B.S.R Murthy "Performance and Emission Improvement of Biodiesel Fueled Diesel Engine with Exhaust Gas Recirculation and Ethyl Hexyl Nitrate Additive" International Journal of Bio-Science and Bio-Technology Vol.7, No.2 (2015), pp.87-106

[3] JinlinXue, Tony E. Grift "Effect of biodiesel on engine performances and emissions" Renewable and Sustainable Energy Reviews 15 (2011) 1098–1116

[4] S. A. Ransing, M. H. Attal, S. B. Chavan "Critical Review of Effect of EGR on CI Engine Running on Biodiesel and Its Blends" ISSN (Print): 2319-3182, Volume -4, Issue-1, 2015

[5]Pratik Mane, AniketPawar "Review for biodiesel is an Economical fuel to the Diesel Engines"IJSED Vol. 4, Issue 06, 2016 ISSN(online): 2321-0613