"EXPERIMENTAL ANALYSIS OF EMISSION PERFORMANCE CHARACTERISTICS ON DIESEL AND DIESEL-BIODIESEL BLENDS WITH EXHAUST GAS RECIRCULATION" A REVIEW

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ABSTRACT

The method of experimental work in the first stage, the stationary diesel engine of direct injection of constant speed of four times and a single cylinder is operated with different mixtures of diesel and biodiesel from Jatropha in natural aspiration mode. Different mixtures such as B10, B20, Jatropha biodiesel with diesel are tested on a conventional diesel engine, to find the best in terms of performance and emission characteristics.

In the second stage, the experiments are carried out in a single-cylinder constant-speed direct injection diesel engine in exhaust gas recirculation mode (EGR) with the best combination (B10 and B20) of Jatropha biodiesel to different rates of exhaust gas recirculation (EGR) (10 and 20%).

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1. INTRODUCTION

In the face of soaring oil prices and the depletion of oil reserves, the search for alternative fuel sources has become more intense than ever in human history. Apart from energy security issues, the issue of climate change as a result of carbon dioxide (CO2), nitrogen (NOX) and carbon monoxide (CO) emissions related to the use of fossil fuels. It was also one of the driving forces in the search for alternative resources to respect. The use of biodiesel in diesel engines dates back to when Rudolph Diesel demonstrated his new invention (diesel engine) using peanut oil (peanut) as fuel. Aside from the economies of scale that favored petroleum fuel later, other factors have also impeded the use of biodiesel in diesel engines. Of great concern are the relatively high viscosity and low volatility of most bezels and carbon deposits in the piston during engine operation. All these factors have been observed to adversely affect engine performance. A possible remedy suggested by many authors is to mix biodiesel and diesel fuel in a certain ratio. This can reduce costs, improve the properties of fuels suitable for engine use, reduce the amount of greenhouse gases released into the atmosphere, and reduce global warming. Another possible remedy is to fix the car engine to work only with B100 (100% biodiesel). While this can be expensive, it can provide a long-term solution that avoids conflicts with food production. The main source of biodiesel in India is inedible oil from plant species such as Jatropha, Pongamia, pinnata and karanja. In addition, the use of biodiesel in conventional diesel engines results in a significant reduction in unburned hydrocarbons (HC). The use of carbon monoxide (CO) and joining problems but biodiesel slightly increases nitrogen oxides (NOX), which can be reduced by incorporating an EGR system.

1.1 HISTORY OF BIODIESEL

The term "Biodiesel", also commonly known as FAME (Methyl Fatty Acid Ester), refers to monoalkyl esters of long chain fatty acids derived from vegetable or animal fats that meet (a) the registration requirements for fuels and additives for fuels established by the Environmental Protection Agency pursuant to section 211 of the Clean Air Act (42 USC 7545), and (b) the requirements of the German Standards Institute (Deutsches Institut für Normung e. V.) DIN EN 14214

The Belgian patent 422.877 ("Procédé de Transformation d'Huiles Végétales in Vue de Leur Utilization comme Carburants") granted to Chavanne in 1937 is the first report on the transesterification of vegetable oils catalyzed by acid (using ethanol or methanol) and its use as fuel In internal combustion engines. At the beginning of the 20th century, due to the abundant availability of mineral oil, the market changed to the use of mineral oils as a source of fuel. But when the cost of mineral oils increased in the 1970s, the scenario changed again and interest in biodiesel was renewed again. The first commercial production of biodiesel was started in South Africa in 1981, followed by Austria, Germany and New Zealand in 1982. In 1985, the RME was first produced in a pilot plant in Austria, and in 1990 the farmers' cooperative began its commercialization biodiesel production.

1.2 BIODIESEL PRODUCTION AND MARKET

In Europe, the legislation requires the use of renewable sources in fuels, in accordance with the EU Directive (2003/30 / EG) (Biokraftstoffquotengesetz, 2006) on the promotion of biofuels, which allows the use of % of biofuels mixed with fossil fuels. , as well as the Energy Tax Directive (2003/96 / EG), which restructured the taxation framework for energy products to promote biofuels as a strategic element of fuel supply. The other important factor is that biofuels produced from domestic raw materials reduce dependence on imported oil. The production of biodiesel in Germany has skyrocketed from 2004 onwards, and according to the UFOP report, Germany is the largest biodiesel producer followed by the Netherlands in the European Union states today. Biofuels are a source of energy that respects the environment due to the fact that the CO2 emission of biofuels is partially carbon neutral, apart from the use of methanol and the process and technical energy invested in their production. The introduction of biodiesel created an increase in the reserves of crude glycerol, which led to the closure of many industries that produce glycerol synthetically. The cost of producing biodiesel in Germany is comparatively lower than the price of diesel oil due to a substantial subsidy granted by the German government to the production of biofuels.

2. THE SCOPE FOR PRESENT RESEARCH WORK

The present study foresees highlighting the need to move from petroleum-based fuels to biofuels for current C.I. engines. The study supports the opinion through the search for new food reserves as an alternative to diesel oil and various methodologies for the use of biofuels in the diesel engine that promise low emissions and better performance. The results of the tests would improve the understanding of engines that work in similar conditions. Jatropha oil and other inedible oils are being identified as raw material to convert them into biodiesel through the use of transesterification and pyrolysis processes. Biodiesel (jatropha oil and other inedible oils) has been optimally prepared for better efficiency. Methods such as natural aspiration and exhaust gas recirculation (EGR) have been adopted to understand the performance and emission nature of the fuels selected with the engine C.I. Performance, combustion parameters, emissions of carbon monoxide (CO), hydrocarbons (HC), smoke and nitrous oxides (NOx) were measured under all test conditions.

3. METHODOLOGY

The experimental work is considered in the background of modest information available in the literature for the constant speed engines. A possible thorough investigation has been launched to understand the engine performance with biofuels in different modes of operation. For this a commercially available single cylinder Kirloskar diesel engine was chosen. The engine operations have been found to be exigent, operating simultaneously in natural aspirated, and EGR modes. Some minor problems, experienced during the engine tests were resolved subsequently through proper maintenance and precautionary measures.

3.1 BIODIESEL PRODUCTION

Here, from this beginning, the raw materials used for the production of biodiesel are analyzed and then each step with which the entire production process was carried out is explained. The properties of biodiesel are also discussed in this section. The crude oil was used for the preparation of biodiesel. The first step included an acid catalyzed esterification reaction and, second, the base catalyzed transesterification reaction was carried out.

3.1.1. ACID ESTERIFICATION

3.1.2. ALKALINE TRANSESTERIFICATION

3.2. DESCRIPTION OF THE ENGINE

The experiments were performed on a single-cylinder constant speed diesel engine with a fixed compression ratio of 16.5 and a constant speed of 1500 rpm in different modes as explained above. The choice of this type of engine is made taking into account that these engines are the main engines for agricultural, construction, industrial and power generation applications in India. The results of the tests would be useful for engines that work in similar operating conditions, motors powered by similar biofuels and for imminent research work on the development of biofuels.

3.3. INSTRUMENTATION OF THE ENGINE TEST SETUP

3.3.1. OSCILLOSCOPE FOR MONITORING IN-CYLINDER PRESSURE

An oscilloscope has been used to track the pressure pulses in the cylinder. The input to the oscilloscope is the load amplifier where the signals of a piezo-resistive pressure sensor are amplified and the indicated pressure developed during a thermodynamic cycle has been monitored under different operating conditions of the motor. The pressure sensor is a diaphragm formed on a silicon substrate, which bends with the applied pressure and a deformation occurs in the crystalline network of the diaphragm due to that bending. This deformation causes a change in the structure of the band of piezoelectric resistors that are placed in the diaphragm, which leads to a change in the resistivity of the material. Changes in resistivity can be amplified by a load amplifier.

3.3.2. DC SHUNT DYNAMOMETER WITH SPEED MEASUREMENT

A universal dynamometer equipped with a DC bypass generator as an absorption unit that is used to measure the motor torque together with an additional arrangement to measure the speed in RPM. The dynamometer unit also has a provision for measuring the friction power of the engine.

3.3.3. FLOW MEASUREMENT

The rotameters have been used to measure the flow of the inlet air charge and exhaust gases (EGR). The rotameter is a particular type of flow meter, based on the principle of variable area; They provide a simple, accurate and economical means to measure flow rates in fluid systems.

3.3.4. EMISSION MEASUREMENT

Emissions and exhaust temperature were measured in the exhaust manifold. Temperatures have been measured using a K-type thermocouple (Chromel-Alumel). Appropriate measures were taken to condition the flue gas sample prior to the measurements and the combustion gas composition was analyzed using a multi-component analyzer based on chemical and infrared cell techniques. The substances measured were nitric oxide (NO), carbon monoxide (CO), carbon dioxide (CO2), hydrocarbons (HC), unused oxygen (O2) and intermittent smoke emissions.

3.4. ENGINE SET-UP

This experimental research was carried out in a single cylinder, 4 times, manufactured by Kirloskar (model TV1), DI diesel engine. It was connected to the control panel unit, which consists of a rotameter, a water temperature indicator, a load switch, a speed indicator and a fuel flow transmitter, etc. The thermal efficiency of the brakes (BTE), the exhaust gas temperature (EGT), the cylinder pressure and the rate of heat release were determined by the engine performance analysis software (EnginesoftLV).


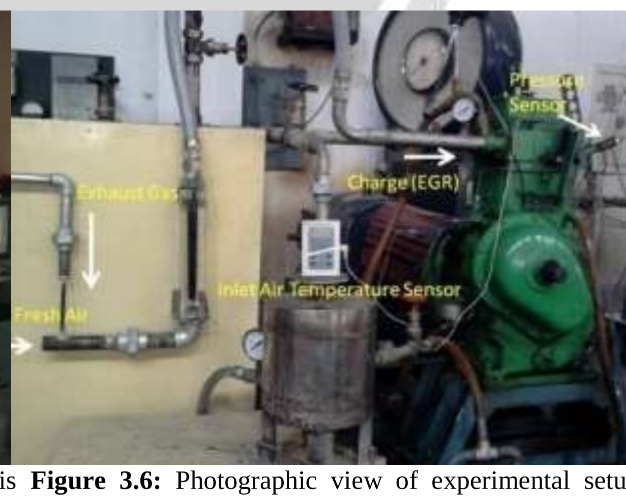

Figure 3.5: CI Engine used for Performance Analysis **Figure 3.6:** Photographic view of experimental setup showing EGR path

3.5. EXHAUST GAS RECIRCULATION (EGR) SET UP

Engine setup has been modified to work with exhaust gas recirculation. The EGR system designed as cooled low pressure system, and the cooling of exhaust gas was carried out by a water cooled heat exchanger. The flow rate of water through the heat exchanger was adjusted to get the desired inlet charge temperature. The EGR rate was calculated based on the equation (4.1) and EGR flow rate was measured by a rotameter. The EGR rates maintained were, 10%, and 20%. Observable engine speed fluctuations were noticed with higher EGR rates (greater than 10%) and EGR rate more than 20% resulted in shutting down of the engine process due to increased dilution of the incoming air charge with exhaust gases.

$$\% \text{ EGR} = \frac{\text{Volume flow rate of recirculated exhaust gas}}{\text{Volume flow rate of charge into the cylinder}} \times 100$$

Obtaining a desired EGR rate has been accomplished by mixing of the inlet air and exhaust gas of known flow rates using the equation (3.1). To achieve fruitful operation of EGR a venturi tube has been designed and coupled with engine setup to mix the fresh air with exhaust gas before the process of combustion.

3.6. DETAILS OF EXPERIMENTAL WORK

3.6.1. PREPARATION OF BIODIESEL BLENDS

For this experimental investigation four blends i.e. B10 and B20 are prepared and tested for different characterization. The blends are shown follows.

- B10 – 10% Biodiesel and 90% Diesel
- B20 – 20% Biodiesel and 80% Diesel

3.6.2. DETERMINATION OF BIODIESEL PROPERTIES

Several properties of biodiesel and its blends with diesel have been determined in this experimental investigation. These are

Table 3.1: Different Properties of Different Biodiesel

Property	Unit	Diesel	Jatropha biodiesel	B10	B20
Density	g /cm^3	0.820	0.880	0.877	0.866
Kinematic Viscosity	mm^2 /s	2.98	4.328	4.320	4.230
Acid value	mgKOH/gm	0.35	0.32	88	89
Cloud point	℃	-16			
Flash point	℃	144	140		
Cetane number		49.0	57	55	51
Calorific value	Kcal/KG	42850	40000	42000	41200
Moisture	%	0.02	0.03	0.023	0.02
Ash content	wt %	0.02	0.02	0.017	0.019

4. RESULT ANALYSIS

The experiment results related smoke, NOx discharge, execution qualities, and warmth discharge rate of an IDI car diesel motor for biodiesel was examined and looked at. The primary outcomes got from these assessments are introduced in the accompanying passage. some data of biodiesel and diesel is given. Likewise, plausible impacts of biodiesel mixing process, smoke obscurity, and NOx discharge are introduced in individually. After the effects on the engine performance characteristics, in-cylinder pressure and temperature and heat release rate and Brake thermal efficiency will be given in respectively and obtained results discussed comprehensively.

4.1. HYDRO CARBON v/s BRAKE POWER

HC emissions from the test fuels B10 and B20 with 10 and 20 % EGR at even with dissimilar engine brake power. There are quantities of motives for the HC emission through combustion. Fuel trapping in the split volumes of the combustion chamber is one of the main motives of HC emission. It can be seen from the fig.4.1

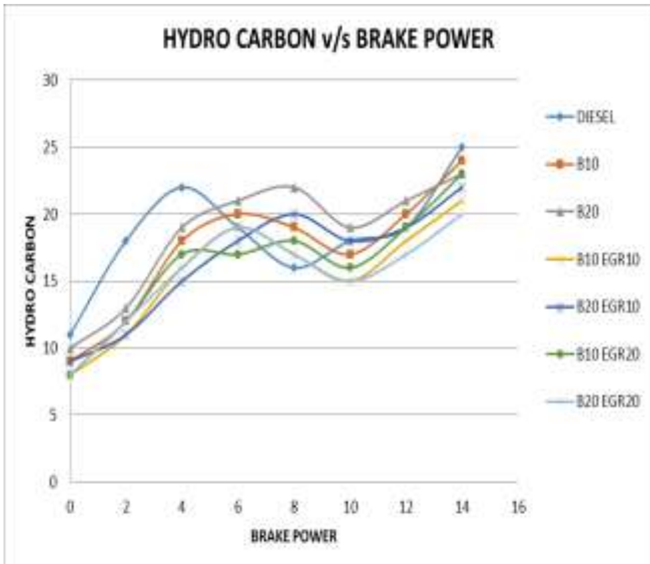

Figure 4.1: Hydrocarbon v/s Brake power

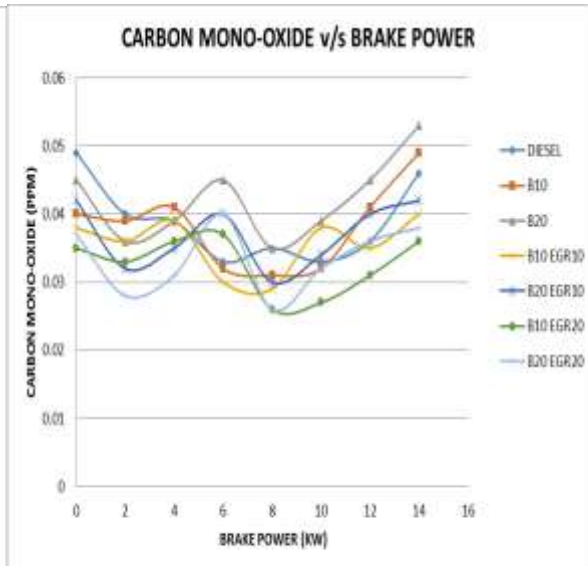

Figure 4.2: Carbon monoxide v/s Brake power

4.2. CARBON MONO-OXIDE v/s BRAKE POWER

In two ways carbon mono-oxide (CO) can be created, through an overly lean blend B10 and B20 with 10 and 20% EGR. Flame cannot propagate from end to end blend in overly lean blends; consequently fuel paralysis with imperfect oxidation creators CO. The fig. 4.2 shows about decrement on average was noticed for B20 than diesel. It can be attributed to higher oxygen content of biodiesel which assisted to achieve also complete combustion.

4.3. NOx v/s BRAKE POWER

The mechanisms which typically take part in the cylinder for NO configuration are thermal mechanism and the fuel bound nitrogen. NO configuration usually depends on oxygen concentration, air extra coefficient, in cylinder temperature and abode time. In this investigation fig.4.3 shows, B10 and B20 with 10 and 20% EGR NOx emission on normal than diesel.

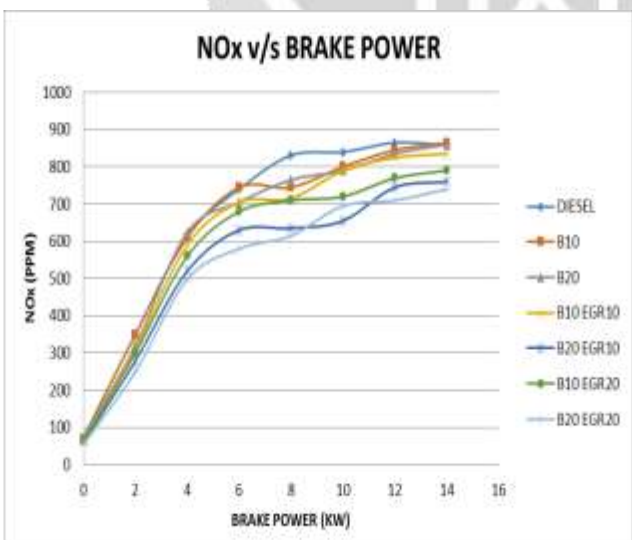

Figure 4.3: Nox v/s Brake power

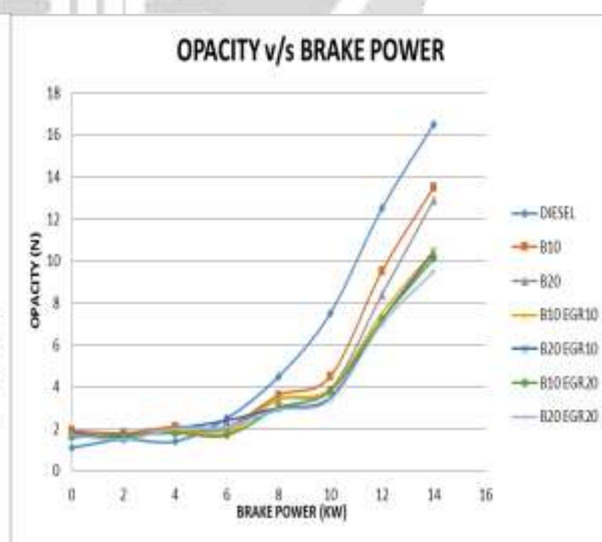

Figure 4.4: Opacity v/s Brake power

4.4. OPACITY v/s BRAKE POWER

Smoke opacity indicates the stain content of the exhaust gas which is one of the main mechanisms of particulate substance on B10 and B20 with 10 and 20% EGR. Hence, the fig.4.4 indicated that structure can be connected with fuels tendency to form particulate matter through combustion.

5. CONCLUSION

In these review paper, the study of emission analysis of HC, NOx, CO and CO_2 are carried out for jatropha oil biodiesel with an additive of ethyl tetra nitrate. It was observed that HC emissions decrease with biodiesel percentage at all loads.

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