# AN EXPERIMENTAL STUDY OF BIO-DIESEL IN AN AUTOMOBILE ENGINE

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***Abstract***— *The increasing energy demand along with the expected depletion of fossil fuels and global warming have promoted to search for alternative fuels that can be easily obtained from renewable energy resources. There are many reasons as mentioned above why we should consider more environmentally friendly solutions to satisfy the current energy consumption. In order to meet the current global requirement bio diesel (diesel + bio fuel) blend can be used. Bio fuel is a renewal energy source which are produced from living organisms and uses energy from a carbon fixation.*

*In present experimental study of emission characteristics like carbon dioxide ($CO_2$%), carbon monoxide (CO%), hydro carbon (HC), nitrous oxide (NOx), exhaust temperature, fuel consumption rate, and performance of diesel engine at different load is done by using diesel and bio diesel (50% diesel+50% ungenna bio fuel) blend separately. Hence from the above study it has been found that using bio diesel blend there is a significant reduction in emissions of toxic gases in comparison with diesel.*

***Keywords— Bio-Diesel, Bio-Diesel blend, experimental study, $CO_2$, CO, HC, NOx***

## I. INTRODUCTION

It is very essential to look for other energy sources than fossil fuel which are more secure and produce less greenhouse gas emissions. Bio-diesel, an environment friendly fuel is first choice of consumer and a renewable source of alternative fuel occupies a great volume of the world's fuel sector. Due to its clean emission characteristics, availability of continued and increasing use of petroleum and its limited resources enhances the production of bio-diesel. Considering economic and environmental benefits, use of bio-diesel is increasing quickly as an alternative fuel of petroleum diesel around the world. A biofuel uses energy from carbon fixation.

Bio fuel or bio-diesel is generally defined as ester-base fuels (fatty esters) made from animal fats or from vegetable oil through a simple transesterification process. Rudolf Diesel (1858–1913) first brought the concept of using vegetable fuel as an engine fuel that then developed the first engine and ran it with peanut oil vegetable fuel. Vegetable oils are important energy sources though sometimes vegetable oils may create some problems in engine components. This problem may be due to their different molecular structure and volatility from diesel fuel as well as high viscosity compared to diesel fuel [2–4]. It can be rectified from bio diesel by applying different chemical process such a supercritical, transesterification and catalyst-free process on vegetable oils. Through this process properties of vegetable oil and molecular structure is changed and fatty acid methyl esters is formed which is also known as Bio-diesel fuel. Bio-diesel can produce 4.5 units of energy against every unit of fossil energy needed to produce biodiesel [5, 6]. Beside this, bio-diesel is nontoxic, biodegradable and safer to breathe [7].Today's compression ignition (CI) or diesel engines require clean burning, stable fuel that operates and performs well under numerous conditions. Bio-diesel satisfies all these objectives and is the only alternative fuel that can be used in any unmodified compression ignition engine [8].

Physicochemical properties of bio-diesel from different sources, such as oxygen content, cetane number, viscosity, density and heat value greatly influence the engine performance and emissions characteristics. Properties of bio-diesel are dependent on the sources (rapeseed, soya bean, or animal fats) of bio-diesel [3, 4]. . When using bio-diesel (diesel and ungena) is aware of bio-diesel freezing properties, wipe painted surfaces immediately after contact with bio-diesel, store bio-diesel or bio-diesel blended soaked rags in a safe place to avoid spontaneous combustion and use the bio-diesel within 1 year. Diesel engines are a major source of air pollutions that are now widely known to have bad impact on human health and overall greenhouse gases. The National Environment Protection Council, the Australian State and Territory Governments have all agreed on a National Environment Protection Measure for Ambient Air Quality. [9]

The aim of present work is to investigate the engine performances (power, torque, fuel consumption rate) and emissions (carbon dioxide, un-burnt hydrocarbon, carbon monoxide and nitric oxide) of diesel engine using petroleum diesel and bio-diesel. A comparative study of performance of diesel and bio-fuel is carried out.

## II. OBJECTIVES

- To study the use of bio-diesels in unmodified diesel engines, with specific reference to performance and emissions analysis of bio-diesel blends.
- To study the influence of bio-diesel on emissions of HC, $CO_2$ and CO.
- To study fuel consumption of bio-diesel blend and diesel.

## III. EXPERIMENTAL SETUP

Experiment was conducted in a single cylinder four stroke air cooled vertical diesel engine of 5.9 kW rated power and 1500 rpm rated speed. Accurate measurements of exhaust temperature, fuel flow rate was done. Emissions of Bio Diesel and Diesel were measured using Gas Analyser. Constant speed load test was conducted on the engine and the measurements above mentioned were taken under different load.

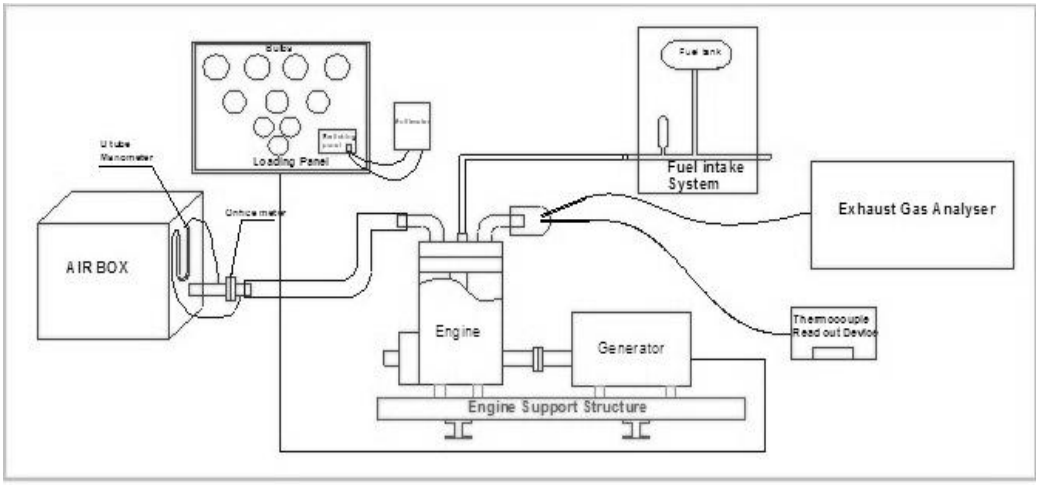


**Fig .1 Schematic of the experimental set up**

Experiment schematic is shown above. Set up consists of Air box of size approximately 500 times the volume of engine cylinder. The idea is to make the air inflow free from any pulsations (which occur due to piston movement) which may affect the combustion. The engine shaft is attached to the AC generator. Electrical loading is applied to the engine using AC generator. Temperature and emissions of the exhaust gas are measured using thermocouple and Gas analyser respectively. Current and voltage generated by AC generator corresponding to the different loads is also measured. While conducting experiment room conditions have been kept constant, proper ventilation have been provided to make the ambient free from exhaust emission which may affect the emission reading. First of all diesel is used for experiment. And then under different load conditions exhaust temperature, exhaust gas emissions, and fuel consumption rate are measured.

**Table-1: Engine Specification**

| | |
|---|---|
| Engine type: | Vertical, Single Cylinder, air-cooled, Four Stroke Cycle, Compression Ignition Diesel Engine. |
| No. of Cylinders : 1 | 1 |
| Bore & Stroke | 110*85 mm |
| Cubic Capacity | 0. 78 ltr |
| Compression Ratio | 18 |
| Rated Output | 7.5 KW(hp) |
| Rated Speed | 1500 rpm |
| Combustion System | Direct Injection |

## IV. BLENDING OF BIO FUEL AND DIESEL

Ungenna (bio fuel) is mixed with petroleum diesel (50% by volume).Bio fuel is more viscous than diesel. Blending Biodiesel is when you take conventional petroleum diesel and Mix that with biodiesel to give you a biodiesel blend. Biodiesel can be added in any proportion to the petro-diesel. Biodiesel blends are usually called, for example: B5 biodiesel or B20 Biodiesel or simply just B5 or B20.The numbers is to let you know what the proportion biodiesel to petroleum diesel is. For Example: B5 biodiesel is 5% biodiesel to 95% petro-diesel & B20 will be 20% Biodiesel to 80% petro-diesel.B100 is not a biodiesel blend but 100% pure biodiesel. B99 is biodiesel with 1% petroleum diesel added.

## V. RESULTS AND DISCUSSION

The performance of engine is greatly influenced by bio-diesel. Bio-diesel is likely to produce less power with high fuel consumption than diesel as the gross calorific value (energy content) of bio-diesel is lower than petroleum diesel. Blends of bio-diesel with petroleum fuel are widely used in diesel engine although the high viscosity of the fuels causes fuel flow and ignition problems in un-modified CI (compression ignition) engines and also decreases in power output. The lubricant and oxidative stability of the bio diesel are much better. By experimentally it has been seen that most of the performance parameters and emission characteristics are affected by the use of bio diesel. The results of performances and emissions of bio-diesels tested in this study compared to diesel are presented and discussed in this section, as follows.

*Fuel consumption rate*

Fig.2 shows the graph of fuel consumption for the bio-diesel and diesel on unmodified diesel engine. Using the weighting factors designated in the test procedure a value for fuel consumption during each test is found, and then compared for each fuel. From Fig.2 it can be seen that fuel consumption rate for biodiesel is slightly more than the petroleum diesel.

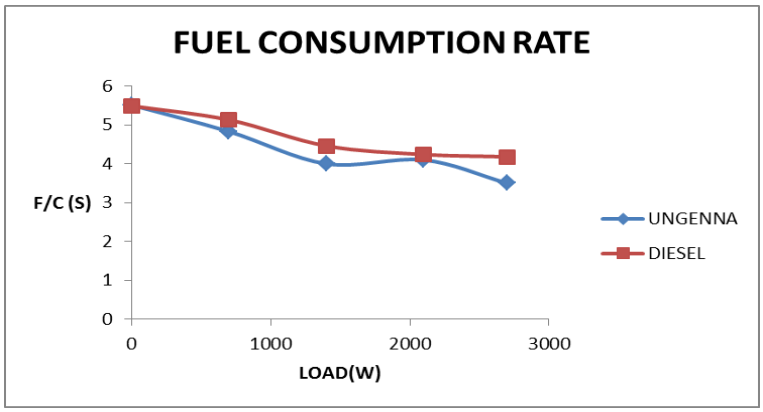


**Fig.2 Fuel Consumption Rate**

1) $NO_X$ emission

Fig.3 shows the NOx emission for the diesel and bio diesel. From the fig.3 it can be seen that at different loading condition emission of NOx is slightly less for ungenna bio diesel blend in comparison with petroleum diesel.By mixing 50% (by volume) bio fuel with diesel NOx emission is less which may further decrease by increasing bio fuel ratio.

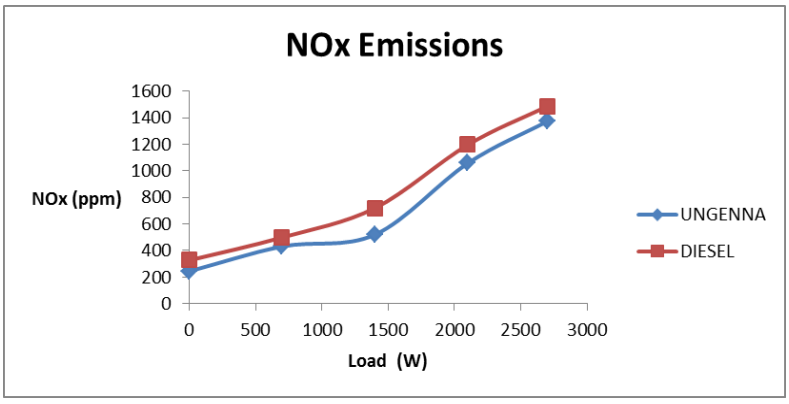


**Fig..3 NOx Emissions**

2) Carbon dioxide ($CO_2$) emission

Fig.4 shows the emission of carbon dioxide ($CO_2$) for bio diesel blend and diesel. Initially the emission for bio diesel blend and diesel is almost same but with increase in load emission is more for diesel as compare with bio diesel. It may be noted that with increase in bio fuel ratio with the petroleum diesel emission of carbon dioxide could be controlled.

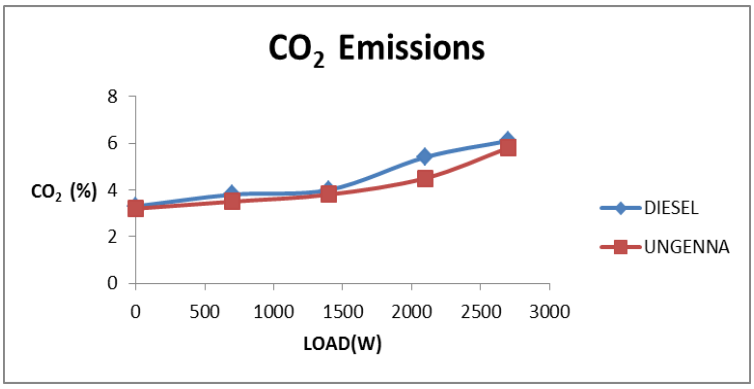


**Fig.4 Carbon dioxide ($CO_2$) emission**

3) Carbon monoxide (CO) emission

Fig.5 shows the emission of carbon monoxide for bio diesel blend and diesel. Bio diesel displayed significant decrease in CO emissions with increasing blend ratio compared to petroleum diesel. It can be said that bio-diesels having a higher oxygen content compared to diesel can result in a more complete combustion and leading to less CO in the exhaust stream.Fig.5, shows the change in CO emissions for blend ratio for the bio-diesels.

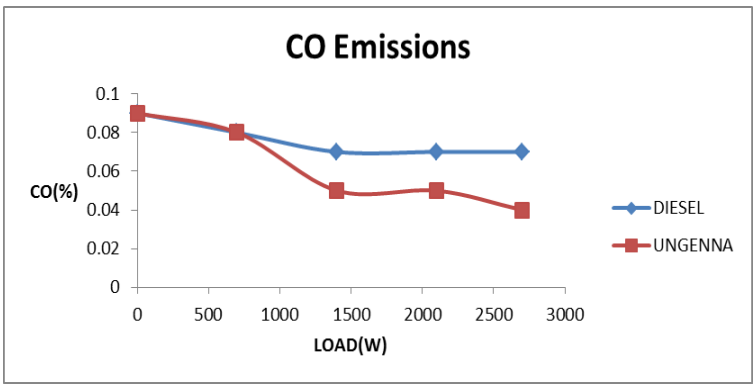


**Fig.5 Carbon monoxide (CO) emission**

(4) Hydrocarbon emission (HC)

The hydrocarbon emissions results for the bio-diesels are shown in Fig. 6. It can be seen from graph that bio diesel blend reduces the hydrocarbon emissions. By experimental calculations 33.33% hydrocarbon were reduced when bio fuel is mixed with (50%) diesel. This is a significant reduction.

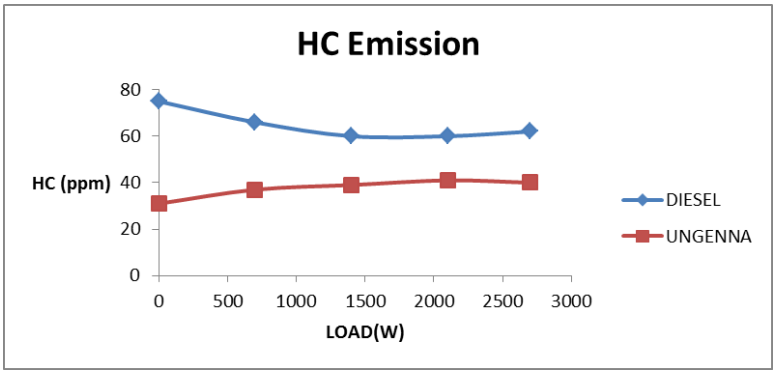


**Fig.6 Hydrocarbon emission (HC)**

(5) Exhaust gas temperature

Exhaust temperature graph for bio diesel blend and diesel is shown in fig.7.It is found that exhaust gas temperature for biodiesel is slightly less than petroleum diesel.

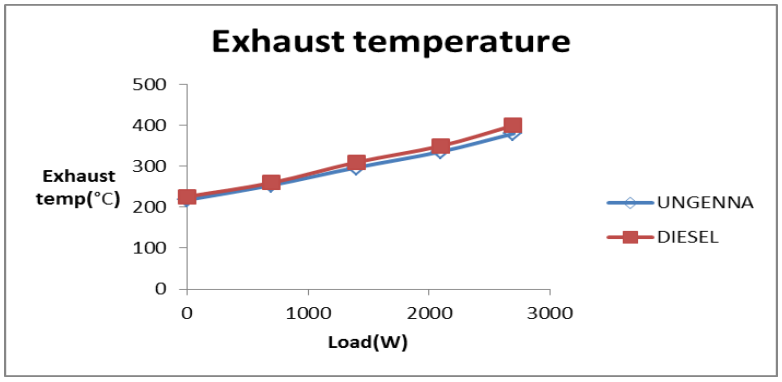


**Fig.7 Exhaust gas Temperature**

## VI. CONCLUSION

- This study investigated the use of bio-diesels in unmodified diesel engines, with specific reference to performance and emissions analysis of bio-diesel blends. Overall, Bio-diesel was found to have lower exhaust emissions across the board compared to petroleum diesel. The following conclusions can be drawn from this study:
- Emissions of HC and $CO_2$ for bio-diesel decrease with increasing the amount of bio-diesel in their blend, and also CO emission decreases with increasing the amount of bio-diesel in blend.
- Fuel consumption for bio-diesel blend is higher than diesel. This indicates that fuel consumption is higher for fuel with lower energy content.
- Bio-diesel blend has lower emission and exhaust gas temperature than diesel.
- NOx emission depends on a number of factors such as bio-diesel type, engine type and test procedure used. In this experiment bio-diesel shows a decreasing trend with increasing blend ratio.
- Bio-diesels having higher oxygen content can lead less CO emissions with increasing blend ratio due to complete combustion in the diesel engine.

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