ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 3, Issue 4, July 2014

Performance & emission of C I Engine Using Diesel & Ethanol blended with linseed oil

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Abstract — In view of increasing pressure on crude oil reserves and environmental degradation as an outcome, fuels like Biofuel may present a sustainable solution as it can be produced from a wide range of carbon based feedstock. The present investigation evaluates Biofuel (30% ethanol + 70% linseed oil) as a C I engine fuel. The objectives of this report is to analyze the fuel consumption and the emission characteristic of a twin cylinder diesel engine that are using Biofuel & compared to usage of ordinary diesel that are available in the market. This report describes the setups and the procedures for the experiment which is to analyze the emission characteristics and fuel consumption of diesel engine due to usage of the both fuels. Detail studies about the experimental setup and components have been done before the experiment started. Data that are required for the analysis is observed from the experiments. Calculations and analysis have been done after all the required data needed for the thesis is obtained. The experiment used C I engine with no load which means no load exerted on it. A four stroke Twin cylinder C I engine was adopted to study the brake thermal efficiency, brake specific energy consumption, and emissions at zero load & full load with the fuel of Biofuel. In this study, the diesel engine was tested usingBiofuel (30% ethanol + 70% linseed oil). By the end of the report, the successful of the project have been started which is Twin cylinder C I engine (Cooper engine) is able to run with Bio fuel but the engine needs to run by using diesel fuel first, then followed by Bio fuel and finished with diesel fuel as the last fuel usage before the engine turned off. The performance of the engine using Biofuel compared to the performance of engine with diesel fuel. Experimental results of Bio fuel and Diesel fuel are also compared.

Keywords: **Diesel, Ethanol, Performance, Emissions, biofuel, linseed oil.**

I. INTRODUCTION

Rising petroleum prices, increasing threat to the environment from vehicle exhaust emissions and fastly depleting stock of fossil fuels have generated an intense international interest in developing alternative renewable fuels for IC engines. Bio fuel is an oxygenated fuel which increases the combustion and makes reduce exhaust emission. It can be produced from crops with high sugar or starch content. Some of these crops include; sugarcane, sorghum, corn, barley, cassava, linseed plants. Sugar beets etc. Besides being a biomass based renewable fuel, ethanol has cleaner burning and higher octane rating than the various vegetable oils [1-5]. Jason and Marc (2002) presented the exergetic environmental assessment of lifecycle emissions from M-85, E-85 (used for the gasoline engine) and other alternative fuels [6]. Diesel exhaust is a major contributor to various types of air pollution, including particulate matter (PM), oxides of nitrogen (NOx), and carbon monoxide (CO) [7]. It has been demonstrated that the formation of these air pollutants can be significantly reduced by incorporating or blending oxygenates into the fossil fuels matrix [8]. Diesel engines are an important part of the public and private transportation sector and their use will continue and grow into the future. But their smoke has become biggest threat to health and environment [9]. Keeping in mind the higher octane number of the ethanol, variable compression ratio engine is a good option in this direction using the ethanol diesel blend as fuel; Shaik et al. (2007) demonstrated VCR engine has great potential for improving part-load thermal efficiency and reducing greenhouse gas emissions [10].

There were many attempts made to use Biofuel in compression ignition (CI) engine. Huang et al. (2008) carried out tests to study the performance and emissions of the engine fuelled with the ethanol diesel blends [11]. They

ISSN: 2319-5967
ISO 9001:2008 Certified
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found it feasible and applicable for the blends with n-butanol to replace pure diesel as the fuel for diesel engine. Bhattacharya and Mishra (2002) evaluated the feasibility of preparing diesel-ethanol blends using 200° (anhydrous ethanol) and ethanol lower proof [12]. They found that ethanol blends indicated power producing capability of the engine similar to that of diesel. Hansen et al. (2001) found that the properties of ethanol-diesel blends have a significant effect on safety, engine performance, durability and emissions [13]. Wang et al. (2003) analyzed that the most noteworthy benefits of E-diesel use lie with petroleum fuel reductions and reductions in urban PM_{10} and CO emissions by heavy vehicle operations [11]. Ajav and Akingbehin (2002) experimentally determined some fuel properties of local ethanol blended with diesel to establish their suitability for use in compression ignition engines [14]. Eckland et al. (1984) presented, State-of-the-Art Report on the Use of Alcohols in Diesel Engines [15].

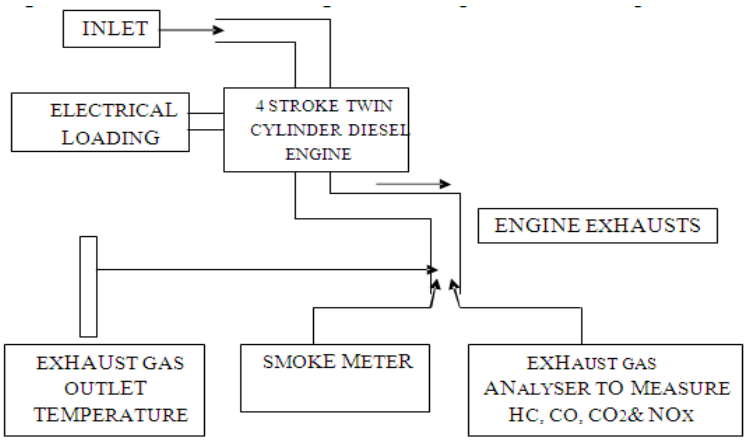

Fig 1: Schematic arrangement of Experimental Set-up

II. OBJECTIVES OF THE PROJECT

- It is proposed to use Bio Fuel in the diesel engine (CI engine).
- The emissions like CO, CO_2, NOx in the exhaust gases are also proposed to reduce during the combustion itself.
- To study the performance evaluation of the using Bio fuel as fuel in the diesel engine.
- Analyze the exhaust emissions and measurement, reduction in the exhaust gas.

a) Properties of diesel and Bio Fuel

Table-1Properties

Sl. No	Properties	Diesel	Linseed oil
1	Density(kg/m2)	850	921
2	Calorific value (kJ/kg)	46,500	35225
3	Kinematic viscosity @ 40C (cst)	2.97	22.22
4	Cetane number	55	34.6
5	Flash point ºC	52	241
6	Octane number	03	50
7	Specific gravity	0.84	0.929
8	color	Light brown	Yellowish

ISSN: 2319-5967
ISO 9001:2008 Certified
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b) Sources of Bio Fuel

Biofuel *(30% ethanol + 70% linseed oil)* is a renewable energy source because the energy is generated by using a resource, sunlight, which cannot be depleted. It is derived from flax plant.

c) *Following are methods to produce bio fuel*

Tran's esterification process is used.

d) Experimental setup

The experimental test set up Figure-1 consisted of twin cylinder diesel engine, four stroke, Forced cooling system, crank start. The setup is provided with a resistance load bank, Multi gas analyzer made by testo and Stack monitoring kit for particulate matter & formaldehyde as HCHO…etc for performance and emissions analysis. The engine is cooled using the water jackets on the engine block and cylinder head using a Forced Feed System. While the recommended injection timing given by the manufacturer is 27º BTDC (static), the opening pressure of the nozzle was set at 170bar and the engine speed at 1500rpm.There are a number of transducers used in the engine such as piezoelectric pressure transducer flush with the cylinder head surface to measure cylinder pressure. Specifications of engine are shown in Table 2.

Fig 2: Test engine

e) Engine specification

Table-2 Test Engine specification

Injection Pressure	1800 bar
Engine type	Four stroke Twin cylinder diesel engine
No. of cylinders	02
Stroke	100 mm
Bore Diameter	87 mm
Engine power	19 KW
Compression ratio	17.5:1
RPM	1500
Type of starting	Crank starting
Load type	Electric load bank

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f) Load bank specification

Table-3 Load bank specification	
Max. Output	15 KVA / 12.06 KW
Generator type	1 Phase
Amps	63
RPM	1500
PF	0.8
Volts	240

a) Precaution Observed Starting the Engine

At the time of starting the engine for each of the tests it was measured that the engine level was in the safe zone and its condition is also good in case the condition was bad, then fresh SAE 40 was introduced into the pump after draining the old . The foundation and mounting bolts were checked periodically as they may go loose due to high speed operations and vibrations.
In the course of experiments the following precautions were observed:

- The ambient temperature variations during the experiment should not be more than 6°Cand this was observed as far as possible.
- After each load is applied the engine in allowed to settle before further loads are applied.

Before stopping the engine, it was allowed to run on pure diesel for some time. This is done so that the engine can be restarted easily

Table-4 Diesel readings

Load in Kw		LOAD in %	TORQUE in NM	SPEED IN RPM (N)	SFC Mg/stroke	BP in KW	η_{bth} in %
V	I						
230	0	0	8.297	1500	7.5	1.303	16.54
	52	100	76.484	1500	33	12.01	34.67

b) Experimental procedure

Experiments were initially carried out on the engine using diesel as fuel in order to provide base line data. The Bio fuel were prepared and made to run on the engine.
1st Case:-The engine was started using neat diesel and allowed to run for at least 30 minutes before taking observations. After engine conditions stabilized and reached to steady state, the base line data were taken. Load was varied (Zero load & full load condition) using the alternator load bank and the same was recorded. Gaseous emissions, fuel consumption were also recorded from the respective sensor.

2nd Case:-The engine was started on diesel and when engine became sufficiently heated; the supply of diesel was slowly substituted by Bio fuel for which a two way valve was used. After engine conditions stabilized and reached to steady state, the base line data were taken. Load was varied (Zero load & full load condition) using

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ISO 9001:2008 Certified
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the alternator load bank and the same was recorded. Gaseous emissions, fuel consumption were also recorded from the respective sensor.

III. RESULTS AND DISCUSSION

The performance and exhaust emission parameters of the engine with diesel and at Biofuel oil *(30% ethanol + 70% linseed oil)* at zero and full load condition are presented and discussed below.

Performance parameter

Specific fuel consumption:

Table-5 Bio fuel readings

Load in Kw		LOAD in %	TORQUE in NM	SPEED in RPM (N)	SFC Mg/stroke	BP in KW	[illegible] in %
V	I						
230	0	0	8.297	1500	7.5	1.303	11.70
	52	100	92.528	1500	41.00	13.28	42.45

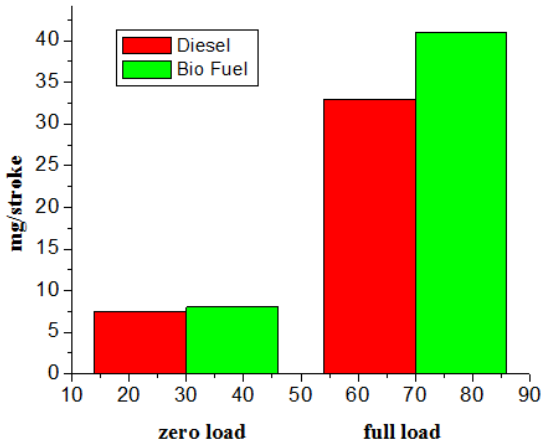

Fig –3. Specific Fuel Consumption

At higher temperature the effect of Bio fuel on specific fuel consumption (SFC) are shown in figure3. From that figure 6.7 it is clear that at different loads the SFC of Bio fuel is more than the diesel. The reasons behind these results are lower energy value substitute Bio fuel thus engine responds to the load by increasing the fuel flow. Thus SFC decreases with the increase in thermal efficiency.

Brake thermal efficiency: Figure 4, shows the variation of brake thermal efficiency with respect to Bio fuel& Diesel at different loads. From the plot it is observed that as load increases brake thermal efficiency is also increases for diesel as well as Bio fuel. At full load condition, the brake thermal efficiencies obtained are 34.6% & 55.7% for the diesel &Bio fuel respectively. Among these two fuels Bio fuel has maximum BTE i.e 55.7% which is obtained from 100 %Bio fuelat full load. The BTE usingBio fuelis increased by 31.3% as compared to the diesel at full load condition. The increment in Brake thermal efficiency is due to low heat value of Bio fuel as compared to diesel & better combustion because of less viscosity of Bio fuel.

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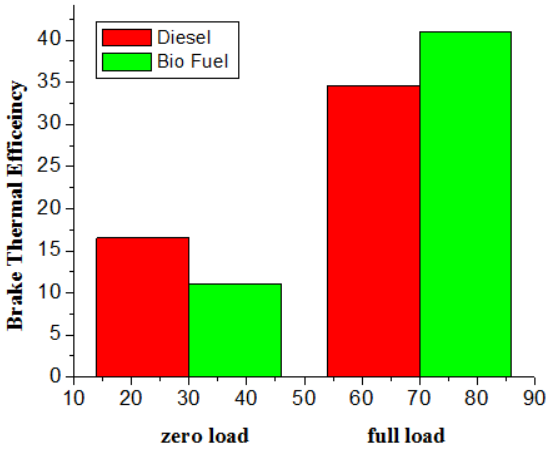

Fig – 4. Brake Thermal Efficiency

Emission parameters:

Table-5 Emission parameters of the engine with diesel and Ethanol at zero and full load

Parameter	Unit	Diesel Zero load	Diesel full load	Bio fuel Zero load	Bio fuel full load
Unburnt hydro carbon	ppm	20	40	20	10
Carbon monoxide	ppm	38.00	44.0	040	200
Particulate Matter	mg/ Nm^3	47.00	134.0	1.0	7.2

Particulate Matter:

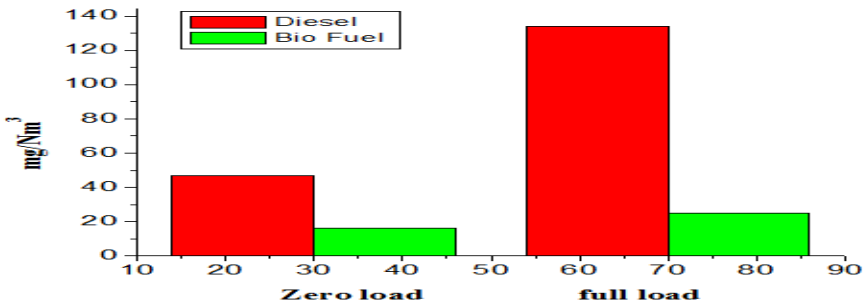

Fig –5. Particulate Matter

Figures 5, shows the variation of Particulate Matter level with respect to diesel and Bio fuel at different loads. Particulate Matter tends to increase with load, this increase in Particulate Matter is explained by the fact that at low loads, but as the load increases, the temperature also increases which in turn increases the Particulate Matter emissions. Result shows that Particulate Matter is comparatively lower with Bio fuel. It is found that Particulate Matter emission increases with increase in load in Diesel as fuel but in Bio fuel as fuel minor increase with increase load. 100% Diesel has higher Particulate Matter level when compared to 100% Bio fuel. This is due to rise in exhaust temperature. Particulate Matter is decreased (80 to 90%) when using Bio fuel as fuel in diesel engine compared to diesel fuel.

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CO Concentration:

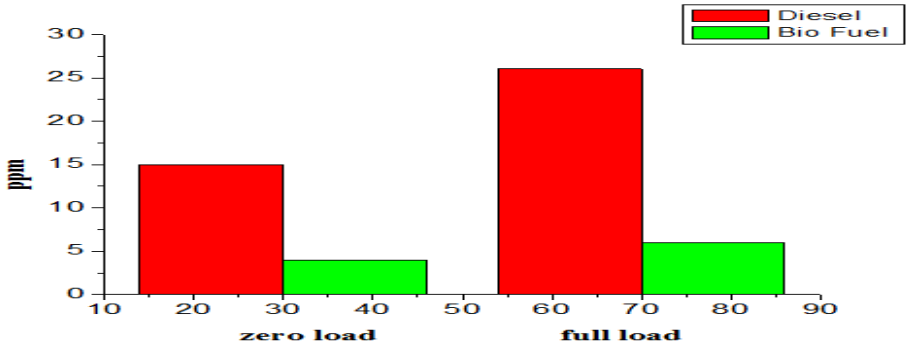

Fig –6. CO Comparison

Figures 6, shows the variation CO level with respect to Diesel and Bio fuelat different loads. From the graph it is clear that the CO level increases whenBio fuelhas a fuel. This is due to the fact that engine is not optimized to run with Bio fuel, so there is a large possibility of rich fuel-air mixture in the cylinder and the higher specific fuel consumption resulting in a higher CO level. Carbon monoxide occurs in engine exhaust. It is a product of incomplete combustion due to insufficient amount of air in the air fuel mixture or insufficient time in the cycle for the completion of combustion.

Carbon Dioxide (CO2) Concentration:

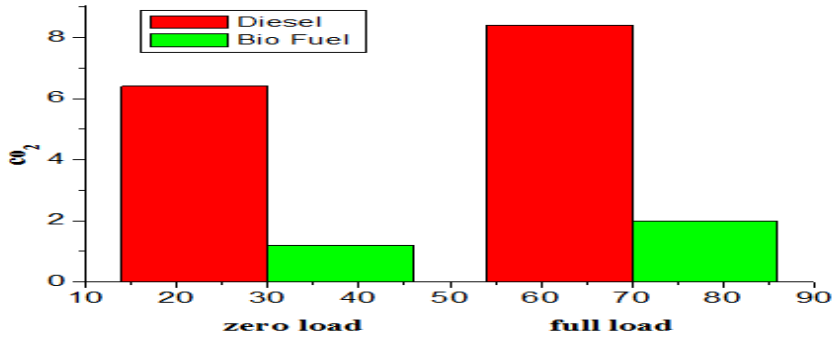

Fig -7. Carbon di-oxide Comparison

Figures 7, shows the variation of CO2 level with respect to Diesel and Bio fuel at different loads. From the graph it is clear that the CO2 level decreases when Bio fuel has a fuel. This is due to the fact that engine is not optimized to run with Bio fuel, so there is a large possibility of lean / reach fuel-air mixture in the cylinder and the lower compression ratio & temperature resulting in a higher CO2 level.CO2 occurs in engine exhaust. It is a product of incomplete combustion due to insufficient time in the cycle for the completion of combustion.

IV. CONCLUSION AND FUTURE SCOPE

Based on the performance and emissions of Bio fuel, it is concluded that the bio fuel oil represents a good alternative fuel with closer performance and better emission characteristics to that of a diesel. From the above analysis the bio fuel shows better performance compared to the Diesel in the sense of better performance characteristics like Brake thermal efficiency, Specific fuel consumption and decrease in the emission parameters like, Particulate matter ,CO2 but CO is little higher than the diesel which can be reduced by increasing the compression ratio. Hence the bio fuel can be used as a substitute for diesel.

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