Emission Characteristics of Palm Biodiesel and Its Blends in the Single Cylinder Diesel Engine

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Abstract— Environmental worry and availability of petroleum fuels have caused interest in the search for new alternative fuels for internal combustion (petrol and diesel) engine. Several alternate fuels are tried by various researches. An experimental study has been carried out for palm biodiesel blended with diesel used in a single cylinder diesel engine. The Palm seed oil is obtained from the seeds of palm tree. Palm seed oil presents a very promising scenario of functioning as alternative fuels to fossil diesel fuel. Experimental work will perform for five loads, i.e. 1,3,5,7 and 9 using Diesel, Palm biodiesel- diesel blends i.e. diesel, P10, P20, P40, P60, P80 and pure Palm biodiesel with load variation of 1kg load to 9kg load and compared with base cases i.e. engine using diesel as a fuel. The emission parameters which will study in emission CO emission, HC emission, CO2 emission, NOx emission. The results of experimental investigation with palm biodiesel blends were compared with that of baseline diesel. As the percentage of Palm biodiesel increased in the diesel fuel the HC, NOX and CO2 emission is increased slightly as compared to the diesel fuel.

Key words: Palm Biodiesel, Single Cylinder Diesel Engine

I. INTRODUCTION

Direct injection engines dates reverse to 1892 once Rudolf Diesel made-up the compression ignition engine. It is widely used in power production, transportation and agrarian equipment sectors. Nowadays, the diesel engines (CI) are living a more and more imposing role due to its superior thermal efficiency and fuel economy. (Dr. Hiregoudar Yerrennagoudaru & Lohit H A, 2014) However, its exhaust emissions have become the major worry payable to their ecological impacts. As such, emission rules have been prepared additional stiff during the earlier period, and this has posed perilous challenges to the researchers and engine manufacturers. As advance technologies becoming available, discoverer is looking into new strategies such as MPFI, CRDI and lowly temperature combustions to decrease the dangerous emissions and increase the engine efficiency. But, the excess oil costs and concern on the reduction of fossil fuel reserves have forced researchers to no more than look into engine modification, but also find substitute resources to attempt the energy crisis. Palm seed oil has gained a rising concern as individual most promising solutions. Its major advantages are environmental, renewable, carbon neutral and do not create risky toxic gases. Among this, Palm seed oils have established increasing advertence as an alternative fuel for the reason that they can be functioning in direct injection engines without require modification(Fattah, Masjuki, Kalam, Mofijur, & Abedin, 2014) .

II. LITERATURE REVIEW

Mohite K.C et al. (2010) was studied on emission and performance quality of Karnja biodiesel and its blended in C.I engine. The CO emissions were a slight superior for B20 and B40 Karanja biodiesel blends. Hydro Carbon emissions decreased by up to 12.8 % in support of B20 and 2.85% B40 determine to diesel at maximum load (Nagarhalli & Nandedkar, 2011). J.arbune et al. (2014) conducted tests to evaluate the performance, emission, and combustion attribute of a diesel engine (CI) fueled with 10%, 20%, 30%, and 50% of Jathropha and chicken fat blended with diesel fuel (DF). BTE of 10% blend and diesel fuel is almost equal at maximum load. The brake power (BP) and torque are almost same for diesel fuel (J0) and all the blends. We get BTE better at 30% than 0%, 10% & 20% and also carbon % is within limit at 30% blending (Arbune, Manatkar, Koparde, & Hingane, 2014). Perminderjit sing et al. (2013) was studied that experimental investigation of the cause of compression ratio in a diesel engine running on different blends of rice bran oil and ethanol. The maximum BTE of 21% was observed with the blend B15E3 which is 5% superior to diesel at 18 compression ratio. The brake thermal efficiency of the diesel and all the other fuel blends improves with an increase in the compression ratio. The BSFC of the blend B10E2&B15E3 shows minimum values than that of diesel and B10 at a higher compression ratio, whereas the BSFC decreases with increase in compression ratio from 16.5 to 18 (Jindal, Nandwana, Rathore, & Vashistha, 2010). V.nandedkar et al. (2014) was studied on calculation of performance and emission of palm oil in diesel engines. Brake specific energy consumption (SEC) is increasing for B20 on 60°C with full load and maximum for B80 on 55° C with no load. Brake mean effective pressure raise because of smoke density increases. It is maximum for B80 on 60°C and poor for B20 on 60°C at maximum load.B40 at 50°C and B20 at 60°C show very gradual increasing (approximately flat). B20 at 55°C shows unexpected rise in smokier density up to maximum load (Ingle, Nandedkar, & Nagarhalli, n.d.). Iqbal Ahmad Et Al. (2013) was studied that the performance and emission characteristics of diesel engine successively running on blended palm oil. The lower absorption of such P20 palm oil indicates the properties relatively close to that of diesel. Engine performance parameters also show that the palm-oil blends have lower BTE and higher BSFC consumption assure with brake thermal efficiency (BTE) same as diesel (Iqbal, Zainal, Mazlan, Al-Bakri, & Salim, 2013).

III. PALM BIODIESEL

The fuel properties of pure palm biodiesel (made by Transterification process) and diesel like fire point (°c), kinematic viscosity (at 40°c (cSt)), flash point (°c), density (@15°c kg/m3), calorific value(KJ/Kg). These fuel properties of palm biodiesel compared with diesel fuel. Flash point and fire point be higher than diesel this complete the safety of palm biodiesel storage. Kinematic viscosity at 40°c (cSt) and density (@15°c kg/m3) were higher than diesel this may result in unsuitable spray characteristics. Cetane number of palm biodiesel was higher than diesel and it would have a positive effect on combustion quality of biodiesel.

Property	**Testing method**	**Palm biodiesel**	**Diesel**
Kinematic viscosity	U-tube	4.8	3.0
Density@15°c	Gravimeters	876	833
Flash point (°c)	Open cup	130°c	74°c
Fire point (°c)	Open cup	171°c	120°c
Cetane number	ISO-5165	62.8	49
Calorific	Bomb	38600	42850

Table 1: The Fuel Properties of Palm biodiesel and Diesel

IV. EXPERIMENTAL SETUP

The experimentation was carried out to inspect the performance parameters and emission characteristics of palm oil biodiesel. Diesel, Palm biodiesel (P100) and its blends P10, P20, P40, P60, P80 were used to test the engine of the specifications mentioned in Table.2. The experiments setup was conducted on a single cylinder, 4 stroke D.I. Diesel engines. No engine modification was required. The biodiesel is preheated using preheating setup, which is connected to fuel tank of the engine. The engine was used the Eddy current dynamometer .The engine speed in rpm and load in kg was sensed using a sensor pre-installed in the dynamometer was recorded from the display on the control panel of the dynamometer.

V. EXPERIMENTAL SETUP

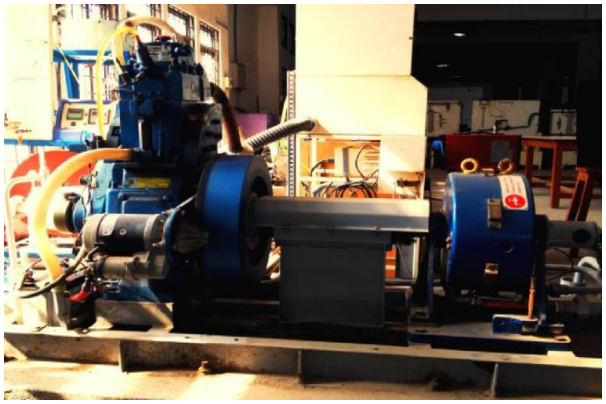

Fig. 1: Engine testing Rig(Trivedi, Patel, Patel, & Rathod, 2015)

Engine manufacturer	Apex Innovations (Research Engine test setup)
Software	Engine soft Engine performance analysis software
Engine type	Single cylinder four stroke multi fuel research engine
No. of cylinder	1
Type of cooling	Water cooled
Rated power	3.5 kW @ 1500 rpm
Cylinder diameter	87.5 mm
Orifice diameter	20 mm
Stroke length	110 mm
Connecting rod length	234 mm
Dynamometer	Type eddy current, water cooled, with loading unit

Table 2: Technical Specification

Fig. 2: Exhaust Gas Analyzer

	Specified range	Accuracy Volume	Accuracy	Resolution
CO	0-10 %	0.06 %	3 %	0.01 %
HC	0-20000 PPM	12 PPM	5 %	1 PPM
CO2	0-20 %	0.4 %	4 %	0.1 %
O	0-21 %	0.1 %	3 %	0.01 %
NO	0-5000 PPM	25 PPM	5 %	1 PPM
Lambda	0-9.99			0.001
RPM	200-6000 RPM	10 RPM		1 RPM
Oil Temp.	0-1500	0.20 C	0.3 %	1.00 C

Fig. 3: Specification of 5-gas analyser

VI. METHODOLOGY

The steps involved in Experimental methodology are given below:

- To assemble the objective, experimental setup is developed first of all.
- A test assemble with a single cylinder 4-stroke diesel engine with eddy current dynamometer is used which contains the engine setup, exhaust gas analyzer and measuring equipments.
- To use Different mixture of Diesel-palm biodiesel were used for the performance and emission analysis of single cylinder 4-stroke diesel engine.
- The experiment reading such as engine performance like fuel consumption (FC), brake thermal efficiency (BTE), mechanical efficiency (ME), specific fuel consumption (SFC) and

emission like CO, HC etc. is to be found out and compared with the diesel.

VII. RESULT AND DISCUSSION

In this experimental work following result analysis is being made with the help of graphical representation.

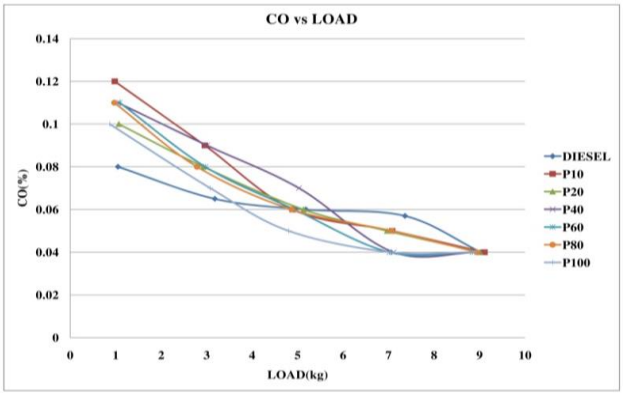

Fig. 2: Effect of various blends on Carbon Monoxide Emission

The graph shows that the CO emission reduced as the load is increased. At a full load condition the CO emission is minimized. As the percentage of palm biodiesel increased in the diesel fuel the CO emission decreased. P100 blend the CO emission is same as compared to the diesel fuel.

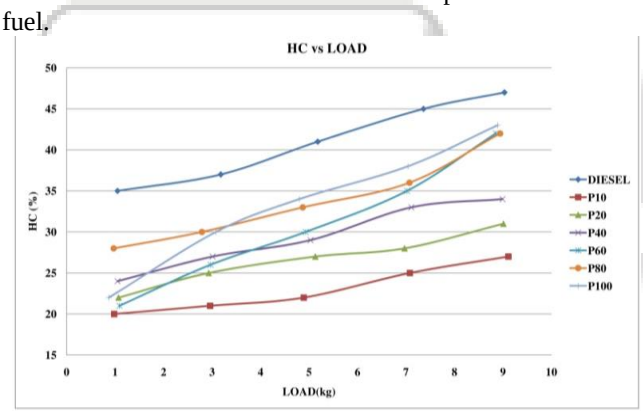

Fig. 3: Effect of various blends on hydrocarbons Emission

The hydrocarbon reacts with air to produce smog. This may reduce visibility. In a conventional internal combustion engine the hydrocarbon fuel burns inside the engine in presence air. The amount of hydrocarbon fuel, which is not taking part in combustion process, is likely to come out as unburned hydrocarbon. There is normally same region within the combustion chamber of an engine fueled with diesel where the mixture is either too lean or too rich ignite. HC emission increased with increased the palm biodiesel concentration.

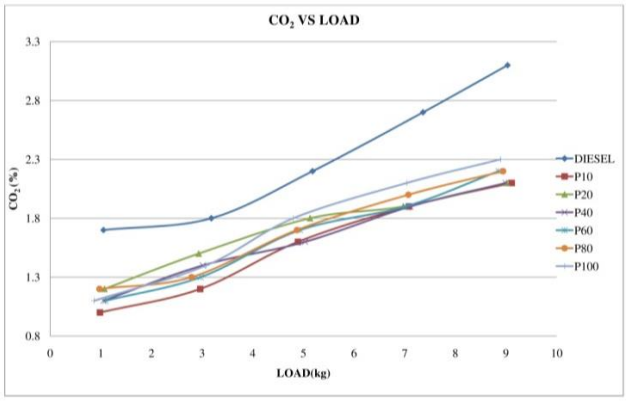

Fig. 4: Effect of various blends on Carbon Dioxide Emission

Fig 4 shows the variation of Carbon dioxide (CO2) with Load at various Oxygen admission levels. The generation of CO2 emission is incomplete combustion and it is generally due to insufficient availability of oxygen. The graph shows that the CO2 emission increased as the brake power is increased. As the percentage of palm biodiesel increased in the diesel fuel the CO2 emission increased.

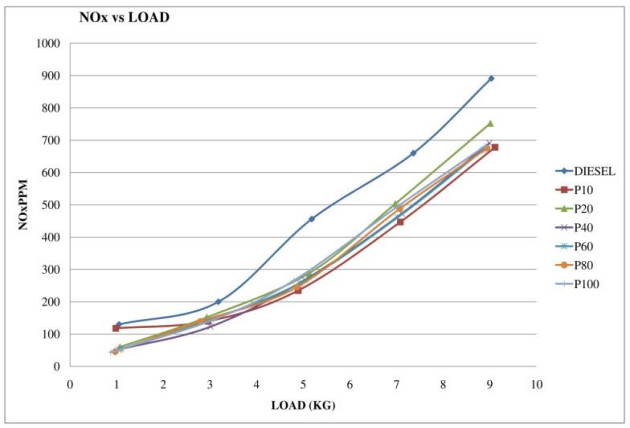

Fig. 5: Effect of various blends on Nitrogen oxide Emission

The slow burning character of the fuel causes a slight delay in the energy release, which results in higher temperature in the later part of power stroke and exhaust stroke. This high temperature favors the formation of nitric oxide. The higher release of nitric oxide can also be attributed to the presence of nitrogenous compounds in the fuels of plant origin. At higher loads, more fuel is burnt and higher temperature of the exhaust gases results in higher production of nitric oxide. Increase in blend concentration NOX is increases.

VIII. CONCLUSION

Following are the conclusions based on the l results obtained while operating single cylinder diesel engine fueled with Palm biodiesel blends in different proportion with diesel fuel.

As the percentage of Palm biodiesel increased in the diesel fuel the CO emission decreased as compared to the diesel. In the P100 blend the CO emission is same as compared to the diesel fuel.

As the percentage of Palm biodiesel increased in the diesel fuel the HC, NOX and CO2 emission is increased slightly as compared to the diesel fuel.

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