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Performance Investigation of the Single Cylinder Diesel Engine Fueled With the Palm Biodiesel-Diesel Blend

Harsh Y Parikh[1], Dr. Tushar M Patel[2], Mr. Gaurav P Rathod[3], Prof. Pragna R Patel[4]

[1](Master Scholar Ldrp-Itr, Gandhinagar, India)
[2,4](Assistant Professor, Department Of Mechanical Engineering, Ldrp-Itr, Gandhinagar, India)
[3](Lecturer, Department Of Mechanical Engineering, Ldrp-Itr, Gandhinagar, India)

Abstract: *Environmental worry and accessibility of petroleum fuels have caused attention in the look for new substitute fuels for engine. Several alternate fuels are tried by various researches. A Test study has been took out for palm biodiesel blended with diesel operate in a single cylinder diesel engine. The Palm seed oil is acquired from the seeds of palm tree. Palm oil presents a very hopeful outline of operating as alternative fuels to fossil diesel fuel. The effect of these can be collated approvingly with the characteristics required for internal combustion engine fuels especially direct injection (diesel) engine. Experiments 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 and palm biodiesel blends as a fuel. The performance parameters which will study in performance brake power (BP), specific fuel consumption (SFC) and brake thermal efficiency (BTHE), mechanical efficiency. The results of this experimental study with palm biodiesel blends were compared with that of pure diesel. The result indicates Palm biodiesel increased the SFC (Kg/kwh) also increased and brake thermal efficiency slightly decreased In the P40 blend the FC (Kg/hr) is nearest to the diesel fuel.*

Keywords: *Performance Investigation, palm Bio Diesel, kirloskar diesel engine, dynamometer.*

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.

Table-1: The Fuel Properties of Palm biodiesel and Diesel

Property	**Testing method**	**Palm biodiesel**	**Diesel**
Kinematic viscosity at 40°c (cSt)	U-tube	4.8	3.0
Density@15°c kg/m3	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 value(kJ/kg)	Bomb calorimeter	38600	42850

IV. Experimental setup

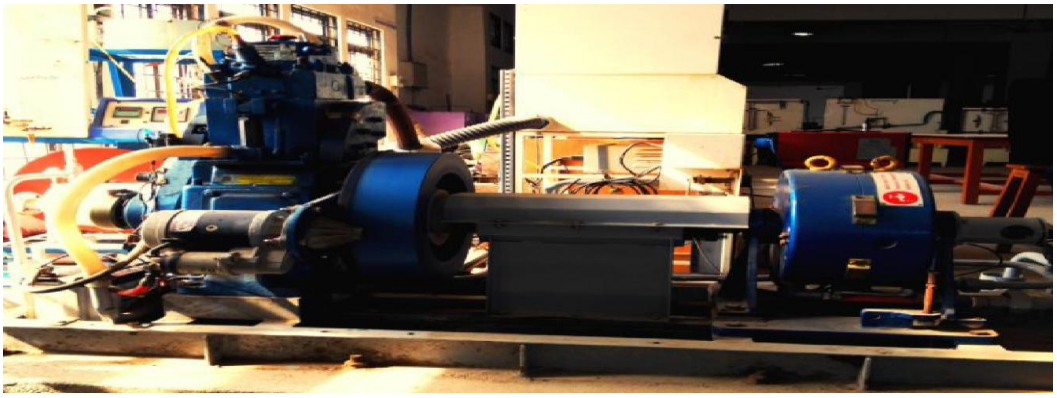

Fig. 1: Engine testing rig(Trivedi, Patel, Patel, & Rathod, 2015)

The experimentation was carried out to inspect the performance parameters (FC, SFC, and BTE) and emission characteristics of palm biodiesel. Diesel (P0), Palm biodiesel (P100) and its blends P10, P20, P40, P60, and P80 were used to test the engine of the specifications mentioned in Table.2. The experimental setup was conducted on a single cylinder, 4 strokes D.I. Diesel engines. No engine modification was required. The biodiesel is preheated utilize preheating arrangement, 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 evidence from the display on the control panel of the dynamometer(Modi, Patel, & Rathod, 2014).

Table 2: Technical specification of engine

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

V. 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.

VI. Result And Discussion

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

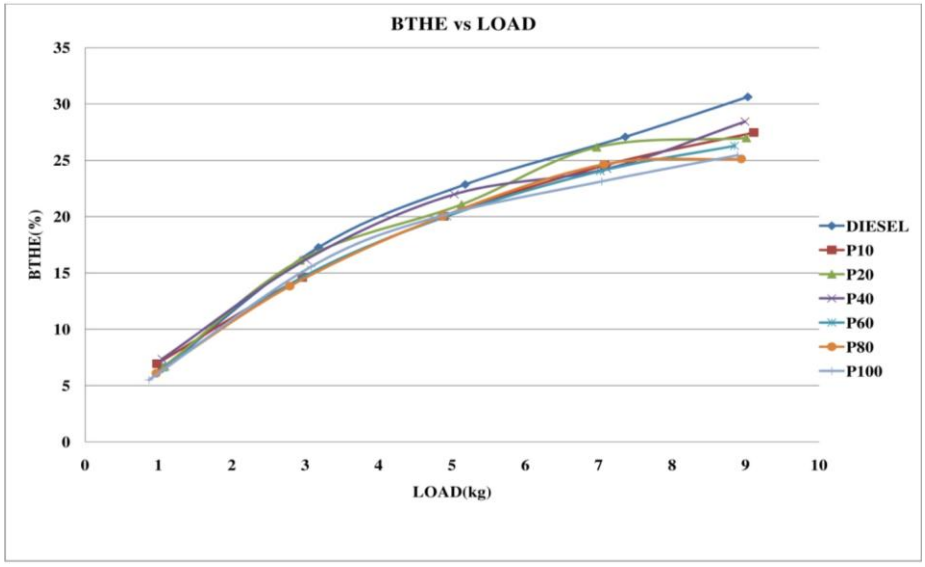

Fig. 2: Effect of various blends on brake thermal efficiency

Brake thermal efficiency (BTE) is the ratio of brake power To product of fuel consumption and calorific value. The above graph (fig 2) shows that the brake thermal efficiency increased with increased in the load. As the palm biodiesel assemblage increased in the diesel fuel the brake thermal efficiency is to be decreased slightly. The Brake thermal efficiency in the D60P40 and D80P20 blends which is finest compare to DIESEL and other blend.

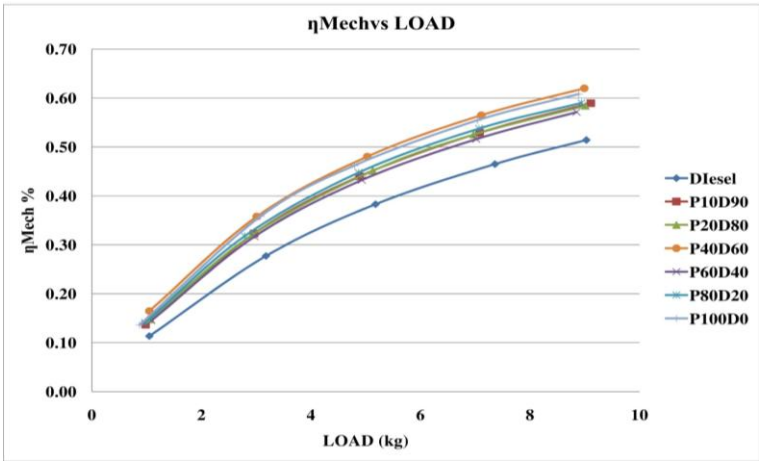

Fig. 3: Effect of various blends on mechanical efficiency

From the figure 3 it is assigned that the mechanical efficiency is high using blends of D60P40 and P100 that of the blends of diesel. From the graph it is in additional conclude that the up to D60P40 blend mechanical efficiency is maximum as compared to pure diesel fuel (P0D100) as well as other blends.

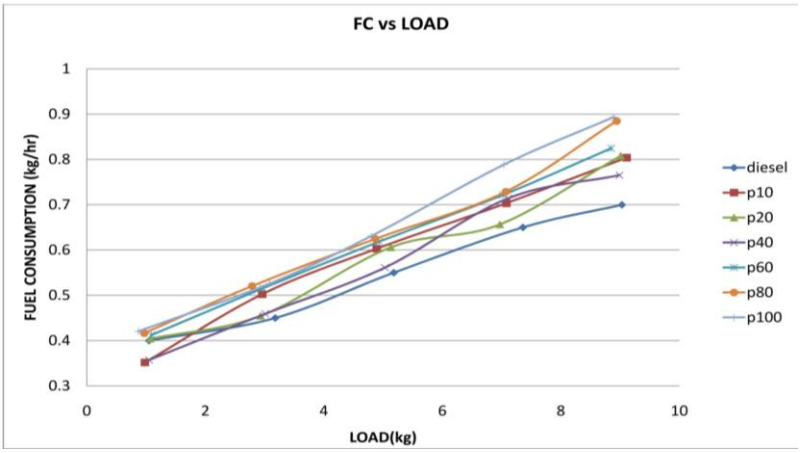

Fig. 4: Effect of various blends on fuel consumption

From the graph it is completed that the Fuel consumption (FC) of the 100% diesel fuel (P0D100) is less as compared to the other palm biodiesel-diesel blend. It also shows that as the load increased the fuel consumption also increased. In the D60P40 blend the fuel consumption is close to diesel compare to other blend. Also shows that the palm biodiesel increased fuel consumption also increased.

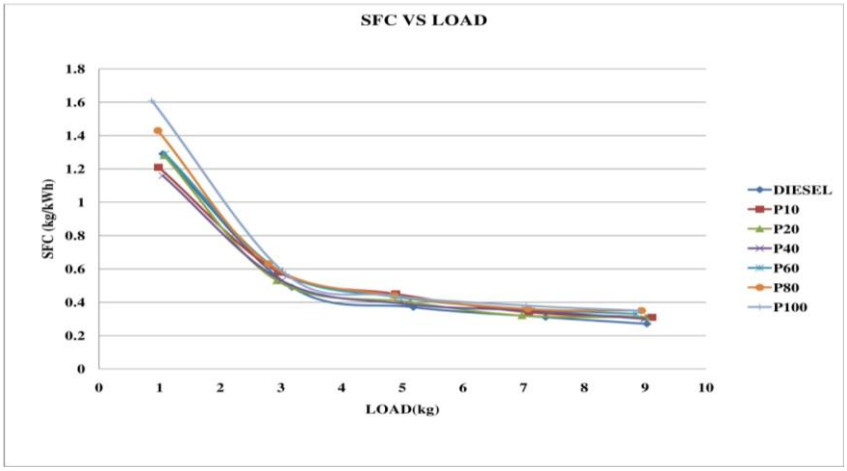

Fig. 5: Effect of various blends on specific fuel consumption

Specific fuel consumption (SFC) considerably increased for all load conditions. It means conclude as the concentration of palm biodiesel increased the SFC also increased. But from the above graph (fig 5) it shows that the Specific fuel consumption is best in the D60P40 blend which is finest compare to other blend.

VII. 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 Palm biodiesel blends greater in the diesel fuel the brake thermal efficiency is to be lessened. The break thermal efficiency during the D60P40 blends which is economical balance to other blend.
- As the concentration of Palm biodiesel increased the SFC also increased. But the SFC is in the D60P40 blend which is close to the diesel fuel.
- Mechanical efficiency is higher in D60P40 and P100 blend as compared to the pure diesel fuel (P0D100).
- Fuel consumption of the diesel fuel is less as compared to the other blend. In the D60P40 blend the fuel consumption (FC) is close to the diesel fuel. Also the focus of Palm biodiesel increased the fuel consumption also increased.

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