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Research Article

Performance Analysis of Diesel Engine with Bio-Diesel

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Abstract

This study is aimed at determining the use of PALM OIL Bio-Diesel as an alternative fuel. For this the performance and different emissions have been studied and compared with the baseline diesel fuel. The fuels were tested at different loading conditions. The various performance parameters studied are BTE, BSFC, and BP different unregulated emissions. The result was compared and presented in this paper. The PALM OIL Bio-Diesel showed the comparable performance and emissions characteristics as that of diesel.

Keywords: *Bio-Diesel; Blending; Transesterification; Palm oil.*

1. Introduction

In present times the demand of petroleum products increases due to increase in large number of vehicles. With crude oil recourses estimated to last for few decades, there has been an active search for alternative fuels. The depletion of crude oil would cause a major impact on the transportation industry. Of the various alternative fuels under consideration, Bio-diesel, derived from vegetable oil, is the highly favorable substitute fuel to diesel due to the following reasons:

1) Bio-diesel can be used in the exiting engine without any modification.
2) Bio-diesel is made entirely from vegetable oil; it does not contain any sulfur, pungent hydrocarbons, metals scraps or crude oil residuum.

Bio-diesel is the name of an unpolluted substitute fuel, formed from domestic, inexhaustible resources. Bio-diesel does not contain any petroleum product, but it can be merge at any level with petroleum diesel to form a bio-diesel blend. It can be used in CI (diesel) engines with small or no change. Bio-diesel is easy to use, it is en eco-friendly, non injurious, and completely free of sulfur and aromatic.

Bio-diesel is made by a chemical operation called transesterification whereby the glycerin is parted from the vegetable oil. The operations leaves behind 2 products- methyl esters (the chemical name for bio-diesel) and glycerin (a valuable byproducts usually sold to be used in soaps and other products).Bio-diesel is better for the environment because it is made from renewable resources and has lower emission compared to petroleum diesel. Bio-diesel exhaust emission has been extensively characterized under field and laboratory conditions, but there have been limited cytotoxicity and mutagen city studies on the effects of Bio-diesel exhaust in biologic systems.

1.2 Bio-diesel

Bio-diesel is a natural and renewable domestic fuel alternative for C.I. engines made from vegetable oils and plant oils. It contains no petroleum, nontoxic and biodegradable.

Bio-diesel is made using an alcohol like methanol and a chemical process that separates glycerin and methyl esters (Bio-diesel) from fats or vegetable oils.

Facts about bio-diesel

1) Biomass can be converted directly into liquid fuels. i.e. transportation needs (cars, trucks, buses, airplanes, and trains)
2) The two most common types of bio fuels are ethanol and Bio-diesel.
3) Ethanol – alcohol- fermenting biomass in carbohydrates similar to brewing beers.
4) Bio-diesel similar to vinegar many vegetable oils, animals' fats, or even recycled cooking greases are used to produce Bio-diesel.
5) It can be used as diesel additive to reduce vehicle emissions or in its pure form as vehicle fuel.
6) Other bio-fuels including methanol and reformulated gasoline components.

1.3 Palm oil

Palm oil can however be effectually used to shifts our diesel demands. Diesel has been the strength of our

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economy. Diesel is not only used in the transport industry but in industries and agriculture for transport and big machines, running pumps and generating electricity also .The entire use of diesel oil can be replaced with oil. The properties of palm oil are quite similar to that of diesel and can be used without conversion in machines and engine. The oil can also be gradually converted to bio-diesel and then used in vehicles.

There are various advantages of palm oil

1. The cost of 1 liter plant oil is less then Rs. 40 hence it is a reasonable substitute for diesel.
2. Palm oil if used as fuel it can also provide better lubrication for the engine.
3. No greenhouse gas emission as the carbon which is taken during the growth of plant would be sent back into the air, no large amount of harmful gases of plant would be emitted .This is known as neutrality of carbons.
4. Palm seeds can be grown in wastelands and the plant is also a Nitrogen fixer.

The trust on palm oil would create large scale employment in rural areas .The average income of the households will increases the government which spends thousands of crores providing subsidies on the petroleum goods can use this huge pool of money in other seconds.

Hence we observe that the use of palm oil is definitely useful which has the potential to solve our energy goods need I the future. And also the Iodine value of the palm oil varies between43 to 58.

Composition of fatty acids in Palm oil

Fatty acids	Fuel	% in Palm oil
Saturated	Stearic (C18) Palmitic (C16)	3-8 33-46
Unsaturated	Lineleic (C18:2) Oleic (C18:1)	6-12 39-53

It is observed that, palm oil is mainly composed of two fatty acids: oleic (18:1) and palmitic (16:0).The read proportion in fatty acids is maintained constant after the reaction. Thus, it is clear that palm oil increases stable impact on the nature and is able to meet the world energy of oil and fats in sizeable proportion.

Chemical and Physical properties of Petroleum diesel and Palm oil Bio-diesel

Characteristics	Petroleum Diesel	Palm Bio-Diesel (Palm Methyl Ester)
Type of source	Fossil	Renewable
Viscosity at 40°C(cST)	4.0	4.5
Pour point(°C)	15.0	16.0
Flash point(°C)	98.0	174.0
Cloud point (°C)	18.0	16.0
Cetane level	53	65
Gross heat of combustion(KJ/kg)	45.8	40.135
Calorific value(MJ/kg)	46.8	41.3
Density at 40°C (kg/L)	0.823	0.855
Sulphur content (wt. %)	0.10	0.04
Carbon residue (wt. %)	0.14	0.02

Palm Bio-diesel an Alternative Green Renewable Energy for the Energy Demands of the Future: ICCBT 2008-F-(7)-PP79-94

Blend of palm Bio-diesel have become promising renewable fuel for diesel engine, which have paid more attention in Malaysia .Blends of 20% palm oil with 80% petroleum diesel have been currently used in unmodified diesel engine and higher blends even crude palm oil (CPO) has been used for experimental purposes in some diesel engine with little or no modification.

Commercial production of palm Bio-diesel in the Malaysian Bio-diesel industry uses refined, bleached and deodorized palm oil in the presence of excess methanol and alkaline catalyst, which is heated to the transesterification reaction temperature and is passed through multistage. Glycerol is removed after each reactor. After the reaction is completed ,the excess methanol is recovered by flashing through the flash vessels and is distilled by using a methanol purification column with structured packing .The recovered methanol is then recycled a reused in the reaction process .The crude Bio-diesel is washed using hot water and is separated by centrifugal separation .the Bio-diesel is then dried under vacuum to achieve low moisture content of the final production ,and is sent to the glycerol .Evaluation of the carbureting quality of vegetable oil required the determination of their physical and chemical properties ,such as :calorific value center level distillation curve ,viscosity ,cloud point etc.

Experiment analysis of Palm oil blends in (CI) engine: 2008 august Edwardantwi

Palm oils have been used as possible substitute to diesel in IC engine with the possibility of also reducing harmful exhaust gas emission .Various blends have been reported by researches in this area as the optimum, giving higher or comparable engine performance .The research considered three locally available but marginal utilized vegetable oil and their respective blends with diesel in IC engine. physical properties relevant to the fuel industry were determined for the three pure vegetable oil and their respective blend with diesel .A four stroke single cylinder fixed throttle CI engine was run on blend containing 1,2,3,4,5,10,50 and 100%of the three palm oil and diesel to measure their performance characteristics .

Comparative analysis of performance and emissions of an engine with palm oil bio-diesel blend with diesel: N.Janardhana Rao

Bio-diesel is an environmentally friend renewable diesel fuel alternative. A single cylinder direct injection diesel engine was first run with diesel fuel and then with blend of Bio-diesel based palm oil. The performance and emission characteristic of the engine run with both the fuel have been compared and with results obtained. From the result obtained, it understood that the thermal efficiency is slightly less and the specific fuel consumption is slightly higher with Bio-diesel when compared with diesel. This is due the lower calorific value of the Bio-diesel.

Successful alternative fuels fulfill environmental and energy security need without sacrificing operating performance. The real advantages for used of Bio-diesel are in reducing petroleum consumption and greenhouse gas emission. Bio-diesel produces lesser exhaust emission (CO, CO2, HC, Smoke etc) from the engine. Use of Bio-diesel blends can significantly reduce PM and toxic compound emission, but may slightly increase NOx which can be reduced by retarding the fuel injection timing and by blending Bio-diesel blends with kerosene or Fischer–Tropsch diesel. Bio diesel blends (B10, B20, B30) can be directly used in the engine with little or no engine modification. The read advantages for use of Bio-diesel's are in reducing petroleum consumption and greenhouse gas emission. However the brake thermal efficiency for Bio-diesel is found to be nearly equal to diesel. The specific fuel consumption is noticed to be decreased with increase in load and increasing with the increase in blends ratio.

Performance of Palm Oil-Based Bio-diesel Fuels in a Single Cylinder Direct Injection Engine: Azhar Abdul Aziz, Mohd Farid Said and Mohamad Afiq Awang

Direct injection diesel engines are fuel-efficient power plants for automotive applications because of their superior fuel economy over spark ignition and indirect injection engines. However, the rising cost of diesel, stringent emission regulations and depletion of petroleum emissions, Bio-diesel is a fuel to consider

The palm oil diesel blends were successfully tested in a single cylinder unmodified diesel engine. The salient points derived on their use in typical conventional diesel engine are: throughout the engine speed range due to the lower calorific values of the blended fuels, the Bio-diesel fuels produced less smoke than diesel under similar engine operating conditions, probably because palm oil contains oxygen which helps the combustion in the cylinder. Low and medium engine loads. However, BSFC for the Bio-diesel fuels were slightly higher over the entire engine speed and load. The brake power was generally lower throughout the engine speed range due to the lower calorific values of the blended fuels the Bio-diesel fuels produced less smoke than diesel under similar engine operating conditions, probably because palm oil contains oxygen which helps the combustion in the cylinder. The Bio-diesel produced more NOX emissions, especially at the higher engine load. The oxygen content in Bio-diesel may be the cause of this, as more oxygen during combustion will raise the combustion bulk temperature. It was, however, possible that the other properties of Bio-diesel or interaction with the injection process and combustion chamber dynamics contributed towards the higher NOX. The Bio-diesel and reference fuels provided similar combustion pressure patterns at low and medium engine loads, suggesting that the Bio-diesels had no adverse effect in terms of knocking. The Bio-diesel fuels lowered the premixed combustion of heat release because of the lower volatility. The ignition delay decreased as the palm oil content increased. This was suspected to the higher oxygen content in the Bio-diesel.

2. Methodology

Methodology is divided in several parts:

1) Specification of Engine.
2) Blending of Bio-diesel and pure diesel in different proportions.
3) Analysis of Diesel engine with blending.

Four stroke diesel engine has a loading system, of rope brake arrangement, engine base to minimize the vibration, a manometer, water cooling system and thermocouples for temperature measurement.

2.1 The specification of Diesel Engine in which experiment is performed is as follows

Fig.1

1	Maker	Kirloskar
2	Power	3.7 KW
3	Speed	1500RPM
4	Fuel	Diesel
5	BHP	5
6	Type	VRC-1
7	Compression ratio	16.5:1
8	No. of cylinder	ONE
9	Stroke	110mm
10	Bore	80mm
11	Type of Ignition	Compression
12	Orifice Diameter	22mm
13	Method of Starting	Crank start
14	Method of Loading	Rope break
15	SFC	250gm/kwh
16	Type of Governor	Centrifugal
17	Type of Governing	Quality governing

2.2 Blending of Bio-diesel and pure diesel in different proportions

The mixture of bio-diesel and petroleum diesel fuel, defined as bio-diesel blends, is designated as (BY) where Y is the percentage of bio-diesel, for example: (B10) is a blend of 10% of bio-diesel and 90% of diesel fuel; (B15) is a 15% bio-diesel; (B0) is 0% bio-diesel.

Bio-diesel and petroleum diesel have similar properties, hence, nearly all conventional diesel engines is able to work fueled without any modification with blends from pure diesel up to B30 Compared to convectional diesel fuel, Bio-diesel has some disadvantages, such as higher viscosity; lower energy content; higher (NO_x) emissions; slight reduce in performance; decrease in torque, power and fuel efficiency.

Therefore to get the best out of Bio-diesel fuel we are blending it with pure diesel in different proportions such as B10 and B15. And the similar analysis of diesel engine is being carried out by each of these proportionate fuels as of with pure diesel fuel.

2.3 Analysis of Diesel engine with blending

For analysis of Diesel Engine the following procedure are followed:

3. Experimental

1) Fill up diesel into the diesel tank & prime the fuel pump if required.
2) Check the lubricating oil level in the sump with dipstick provided.
3) Connect the water inlet of engine jacket, calorimeter & rope brake dynamometer to a constant head water source and open the inlet values for a suitable desired flow rate.
4) Unfold the engine on the hydraulic brake dynamometer.
5) Press the decompression level and start the engine by rotating the crank by mean of hand crank level by leaving down the decompression level at sufficient speed.
6) Allow the engine to run for few minutes.
7) Now open the dynamometer inlet gate valve gradually to load the engine through hydraulic dynamometer.
8) If the spring balance is attached with the engine then, the load is indicated on a dial type spring balance in terms of kgf. The dynamometer arm having a length of r=0.32 meter give the torque T=W*r.
9) Where, W=load indicated on the spring balance.
10) T=Torque (N-m)
11) If the spring balance is not present in engine then the torque is given T=W*R, where, W=load indicated on the spring balance
12) T= Torque (N-m)
13) R = Rd + Rr
14) Rd =Radius of drum,
15) Rr= Radius of rope
16) Now the engine speed decreases due to application of load. Operate the accelerator knob simultaneously with hydraulic dynamometer inlet gate valve and set the load to ¼ of all load to bring the engine till steady state of engine.
17) Again allow the engine to run for few minutes such that all operating variable gets a constant value.
18) Make the observation.

3.1 Loading

The engine is fitted with brake drum and a rope is around it with a dead weight platform at one end (bottom end). The engine can be loaded in terms of 1/4,1/2,3/4 full load by adding necessary dead weight on to the platform.

3.2 Fuel Measurement

19) The Fuel supply from main fuel tank through a measuring burette system. To measure the fuel consumption of the engine fill the burette by opening the cock marked tank in the manifold block by starting the stop clock measure the time taken to consume 5cc of fuel.

3.3 Air Flow Measurement

An air drum fitted on the panel frame connected with an air hose to the engine facilitate on the orifice manifold with orifice and pressure pick up point at the up and down stream of the Orifice. The pressure pickup point is joined to a U tube manometer. The difference in the manometer reading is taken at different loads and air is absorbed by the engine.

4. Calculation

Observation table for pure diesel (B0 fuel)

S.No.	Load (kg)	Speed (RPM)	Time(sec)for 5cm^3 fuel consumption(t)
1	0	1518	41.85
2	1	1505	36.52
3	3	1503	29.41
4	5.25	1497	24.89
5	8.75	1484	19.42

4.1 Calculation for B0 fuel

A) Brake Power

bp = 2*3.14*N*T/60000
Where,
N=Speed of engine in rpm
T=Torque in N-m =mg*r
R=Rd+Rr
Rd= Drum Radius=0.178m
Rr=Rope Radius=0.010m
bp1=2*3.14*1518*9.81*0/60000=0
bp2=2*3.14*1505*9.81*1/60000=0.29066 kw
bp3=2*3.14*1503*9.81*3/60000=0.87082 kw
bp4=2*3.14*1497*9.81*5.25/60000
=1.5178 kw
Bp5=2*3.14*1484*9.81*8.75/60000
=2.5077 kw

B) Mass flow rate of fuel

mf = Xcc *sp. gravity of fuel/(1000*t)

Where,
Xcc = Volume of fuel consumed in t sec.
ρf = Density of diesel = 0.802 gm/cm^3
t = Time
mf1=5*0.802/(1000*41.85)=9.5818*10^{-5} kg/sec = 344944kg/hr
mf2=5*0.802/(1000*36.52)=1.098*10^{-4} kg/sec = 0.39528kg/hr
mf3=5*0.802/(1000*29.41)=1.3634*10^{-4} kg/sec = 0.490824kg/hr
mf4=5*0.802/(1000*24.89)=1.6111*10^{-4} kg/sec = 0.57999kg/hr
mf5=5*0.802/(1000*19.42)=2.06488*10^{-4} kg/sec = 0.743356kg/hr

C) Brake specific fuel consumption

bsfc =mf/bp
(bsfc)1 =0
(bsfc)2 =0.39528/0.29066=1.3599kg/kwh
(bsfc)3 =0.49082/0.87082=0.5636kg/kwh
(bsfc)4=0.57999/01.5178=0.38213kg/kwh
(bsfc)5=0.74335/2.5077=0.2964kg/kwh

D) Break thermal efficiency

ηbth = bp/(mf*cv)

Where,
C.V= Calorific value of fuel = 45350 kcal./kg
ηbth1 =0
ηbth2 =0.29066/(1.098*10^{-4}*45350)
=5.8372%
ηbth3 =0.87082*/(1.3634*10^{-4}*45350)
=14.084%
ηbth4 =1.5178*3600/(1.6111*10^{-4} *45350)
=20.7737%
ηbth5 =2.5077/(2.06488*10^{-4}*45350)
=26.7795%

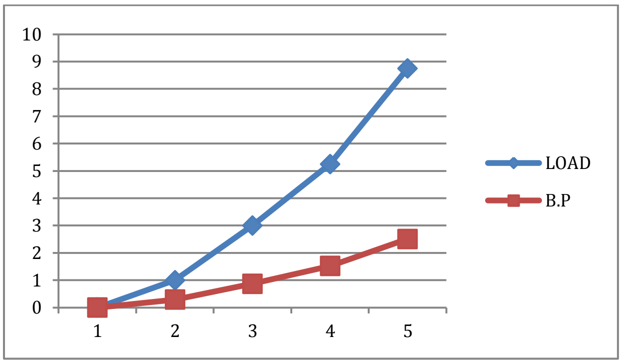

Fig.1.1 Load v/s Brake Power (For B0 fuel)

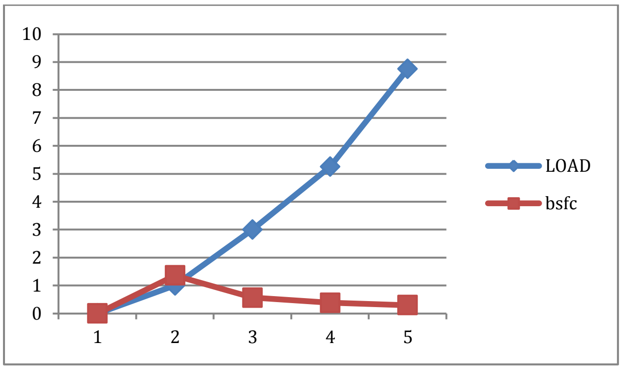

Fig.1.2 Load v/s Brake specific fuel consumption (for B0 fuel)

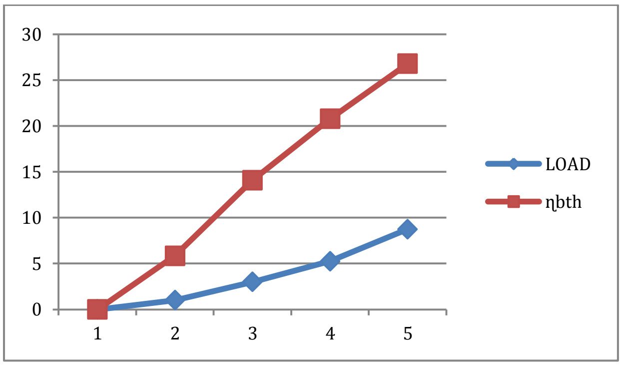

Fig. 1.3 Load v/s Brake Thermal Efficiency (for B0 fuel)

Observation table for pure diesel (B10 fuel)

S.No.	Load (kg)	Speed (RPM)	Time(sec)for 5cm^3 fuel consumption(t)
	0	1520	41.00
2	1	1513	36.65
3	3	1503	30.94
4	5.25	1496	26.41
5	8.75	1483	19.50

4.2 Calculation for B10 fuel

A) Brake Power

bp = 2*3.14*N*T/60000
Where,
N=Speed of engine in rpm
T=Torque in N-m =mg*r
R=Rd+Rr
Rd= Drum Radius=0.178m
Rr=Rope Radius=0.010m
bp1=2*3.14*1520*9.81*0/60000=0
bp2=2*3.14*1513*9.81*1/60000=0.2922 kw
bp3=2*3.14*1503*9.81*3/60000=0.8708 kw
bp4=2*3.14*1496*9.81*5.25/60000
=1.5168 kw
Bp5=2*3.14*1483*9.81*8.75/60000
=2.5061 kw

B) Mass flow rate of fuel

mf = Xcc *sp. gravity of fuel/(1000*t)

Where,
Xcc = Volume of fuel consumed in t sec.
ρf = Density of diesel = 0.802 gm/cm^3
t = Time
mf1=5*0.802/(1000*41.00)=9.79*10^{-5} kg/sec =0.35244kg/hr
mf2=5*0.802/(1000*36.65)=1.095*10^{-4} kg/sec =0.3942kg/hr
mf3=5*0.802/(1000*30.94)=1.298*10^{-4} kg/sec =0.46728kg/hr
mf4=5*0.802/(1000*26.41)=1.520*10^{-4} kg/sec= 0.5472kg/hr
mf5=5*0.802/(1000*19.5)=2.059*10^{-4} kg/sec =0.74124kg/hr

C) Brake specific fuel consumption

bsfc =mf/bp
(bsfc)1 =0
(bsfc)2 =0.3942/0.2922=1.349kg/kwh
(bsfc)3 =0.46728/0.8708=0.5366kg/kwh
(bsfc)4=0.5472/1.5168=0.3607kg/kwh
(bsfc)5=0.74124/2.5061=0.29577kg/kwh

D) Break thermal efficiency

ηbth = bp/(mf*cv)

Where,
C.V= Calorific value of fuel = 45350 kcal./kg
ηbth1 =0
ηbth2 =0.2922/(1.095*10^{-4}*45350)
=6%
ηbth3 =0.8708/(1.298*10^{-4} *45350)
=15.09%
ηbth4 =1.5168/(1.520*10^{-4} *45350)
=22.45%
ηbth5 =2.5061/(2.059*10^{-4}*45350)
=27.38%

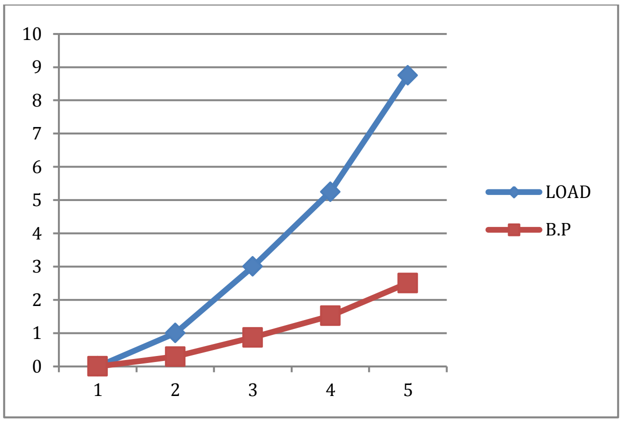

Fig.1.4. Load v/s Brake Power (For B10 fuel)

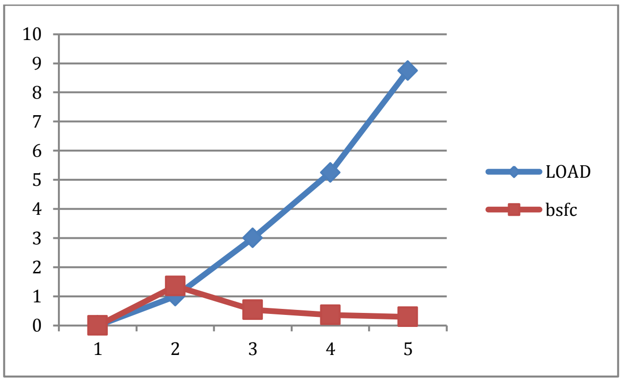

Fig.1.5. Load v/s Brake specific fuel consumption (for B10 fuel)

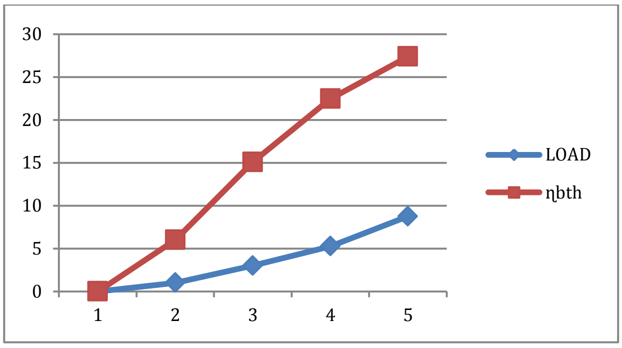

Fig.1.6. Load v/s Brake Thermal Efficiency (for B10 fuel)

Observation table for pure diesel (B15 fuel)

S.No.	Load (kg)	Speed (RPM)	Time(sec)for 5cm^3 fuel consumption(t)
1	0	1508	40.50
2	1	1502	36.71
3	3	1500	29.92
4	5.25	1493	25.10
5	8.75	1482	19.43

4.3 Calculation for B15 fuel

A) Brake Power

bp = 2*3.14*N*T/60000
Where,
N=Speed of engine in rpm
T=Torque in N-m =mg*r
R=Rd+Rr
Rd= Drum Radius=0.178m
Rr=Rope Radius=0.010m
bp1=2*3.14*1508*9.81*0/60000=0
bp2=2*3.14*1502*9.81*1/60000=0.2900 kw
bp3=2*3.14*1500*9.81*3/60000=0.8690 kw
bp4=2*3.14*1493*9.81*5.25/60000
=1.5168 kw
Bp5=2*3.14*1482*9.81*8.75/60000
=2.5027 kw

B) Mass flow rate of fuel

mf = Xcc *sp. gravity of fuel/(1000*t)
Where,
Xcc = Volume of fuel consumed in t sec.
ρf = Density of diesel = 0.8055 gm/cm^3
t = Time
mf1=5*0.8055/(1000*40.50)=9.944*10^{-5} kg/sec =0.35798kg/hr
mf2=5*0.8055/(1000*36.71)=1.097*10^{-4} kg/sec =0.39492kg/hr
mf3=5*0.8055/(1000*29.92)=1.346*10^{-4} kg/sec =0.48456kg/hr
mf4=5*0.8055/(1000*25.10)=1.604*10^{-4} kg/sec =0.57744kg/hr
mf5=5*0.8055/(1000*19.43)=2.073*10^{-4} kg/sec =0.74628kg/hr

C) Brake specific fuel consumption

bsfc =mf/bp
(bsfc)1 =0
(bsfc)2 =0.39492/0.2900=1.361kg/kwh
(bsfc)3 =0.48456/0.8690=0.5576kg/kwh
(bsfc)4=0.57744/1.5168=0.3607kg/kwh
(bsfc)5=0.74628/2.5027=0.2982kg/kwh

D) Break thermal efficiency

ηbth = bp/(mf*cv)

Where,
C.V= Calorific value of fuel = 45350 kcal./kg
ηbth1 =0
ηbth2 =0.2900/(1.097*10^{-4}*44032)
=6%
ηbth3 =0.8690/(1.346*10^{-4}*45350)
=14.662%
ηbth4 =1.5168/(1.604*10^{-4} *45350)
=21.476%
ηbth5 =2.5061/(2.073*10^{-4}*45350)
=27.418%

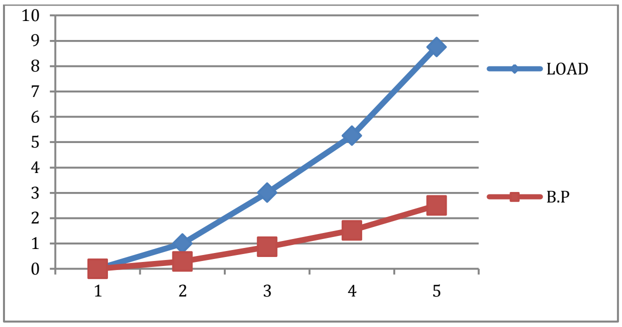

Fig.1.7. Load v/s Brake Power (For B15 fuel)

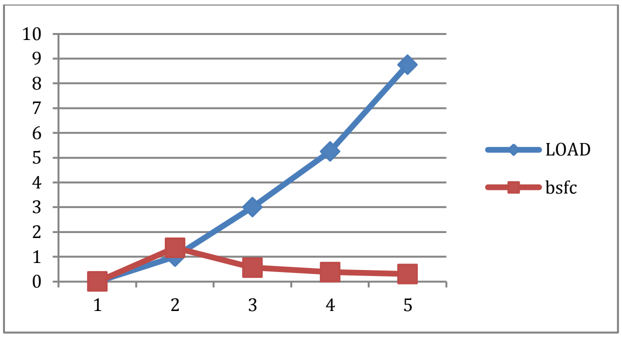

Fig.1.8. Load v/s Brake specific fuel consumption (for B15 fuel)

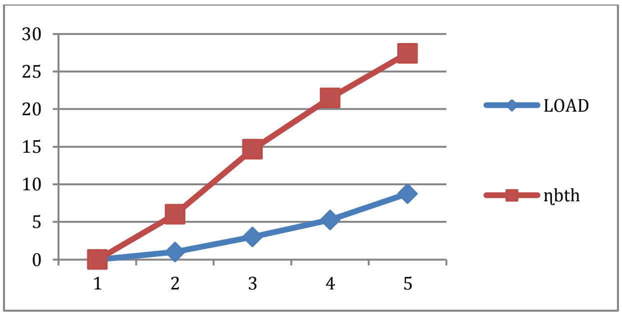

Fig.1.9. Load v/s Brake Thermal Efficiency (for B15 fuel)

5. Result and discussion

5.1 Performance Curves

The following performance curves are shows the comparison between fuel blend B0, B10 and B15.

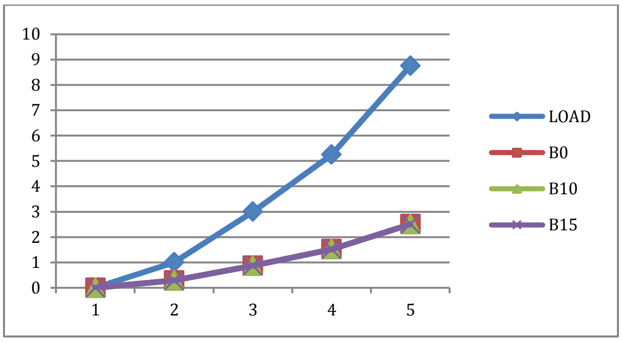

Fig.1.10. Load v/s Brake Power comparison

From the above graph we can see that all the blending is showing linear deviation of load w.r.t. Brake power. Brake power doesn't get affected much by using different blends.

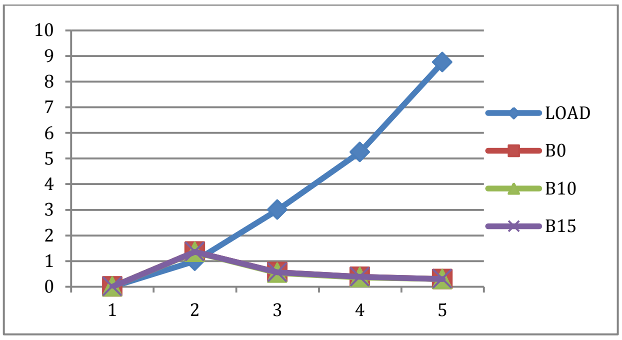

Fig.1.11. Load v/s Brake specific fuel consumption comparison

Above graph shows that B10 has lowest brake specific fuel consumption, pure diesel is just above the B10 and B15 is having highest value. Bio-diesels having slightly higher values than pure diesel because of lower C.V of bio-diesel.

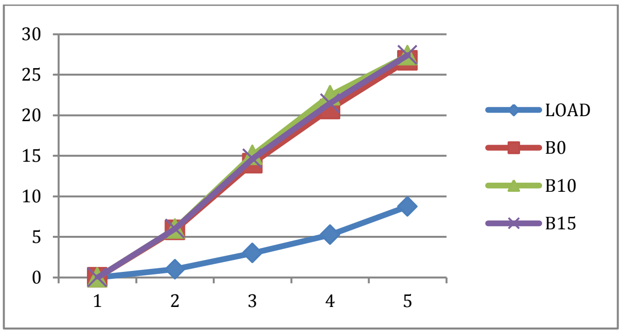

Fig.1.12. Load v/s Brake Thermal Efficiency comparison

The above graph shows the bio-diesel blended fuels have greater brake thermal efficiency as compare to pure diesel fuel. Researches say that addition of oxygen atoms with increase in bio-diesel blending results in complete combustion of fuel.

5.2 Future Scope of Bio-Diesel

1) The future of Bio-diesel lies in the world ability to produce renewable feedstock such as vegetable oils and fats to keep the cost of Bio-diesel competitive with petroleum, without supplanting land necessary for food production or destroying natural ecosystem in the process.
2) Bio-diesel is substance that preserves air quality. Various organizations are setup to control air pollution and find new sources of fuels for vehicles. Not only does Bio-diesel help the environment.
3) Farmers can save money by manufacturing Bio-diesel on-site to use in their tractor engines.
4) Producing Bio-diesel fuels can help create local economic revitalization and local environmental benefits. Many groups interested in promoting the use of Bio-diesel already exist at the local, state and national level.

5.3 Benefits of Bio-Diesel

A. Environmental Benefits

1) Bio-fuels benefit environmental by reducing GHG sand reducing local pollution.
2) Bio-ethanol is water soluble, non toxic and biodegradable.
3) Ethanol can replace 20% of the world's gasoline.
4) Bio-fuels offer low level of CO_2 emission.

B. Social Economics Benefits

1) Reduce the cost of oil- Cheaper ethanol decreases the demand of oil and the cost of oil.
2) Reduce fossil fuel imports- The use of gasoline can be reduced by using ethanol some of the dependence on unstable foreign sources of oil.
3) Reduce the poverty rate- Most of the ethanol plants are in rural communities and operation and maintenance, ethanol production increases jobs due to plant construction.
4) Rise in farm land value- Due to of High demand of corn leads to rise in farm land values.
5) Health benefits from reduced global warming.
6) More efficient use than gasoline and protect vehicles- Ethanol can help prevent engine knocking, and it increases gasoline's lubricity.
7) Low adoption cost- Ethanol can be used by all gasoline vehicles in the United States in concentrations up to about 10%. Ethanol provides lower vehicle emissions without the need to purchase a hybrid vehicle.

Conclusion

Bio-diesel is an eco friendly diesel fuel substitute. A single cylinder direct injection diesel engine was first run with diesel fuel and then with bio-diesel blend based palm oil. The accomplishment characteristics of the diesel engine run with both the fuel have been compared and the results obtained are shown in this paper. From the result obtained, it is understood that the thermal efficiency of diesel engine is slightly less with Bio-diesel when compared with pure diesel. This is due to addition of O_2 atoms with increase in value of blending. And specific fuel consumption is slightly higher with bio-diesel when compared with pure diesel due to the lower C.V of the bio-diesel. It is concluded that the bio-diesel can be used as substitute fuel in the Diesel engine without any engine modifications.

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