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Performance Test on Diesel Engine Using Mahua Oil & Diesel Blends

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Abstract
This paper titled "Performance Test on Diesel Engine Using Mahua Oil & Diesel Blends" describes that steadily escalating gasoline prices, increased environmental concerns, and poor international politics have sparked new interests for alternatively fueled vehicles. There are numerous alternative fuel technologies including gasoline-hybrids, diesels, full electrics, as well as hydrogen and ethanol. These technologies are changing rapidly and consumers are having difficulty trying to decipher which type of vehicle is the most worthy investment.

I. Literature Survey

1. Biodiesel

Biodiesel is a safe alternative fuel to replace traditional petroleum diesel. It has high-lubricity, is a clean-burning fuel and can be a fuel component for use in existing, unmodified diesel engines. This means that no retrofits are necessary when using biodiesel fuel in any diesel powered combustion engine. It is the only alternative fuel that offers such convenience. Biodiesel acts like petroleum diesel, but produces less air pollution, comes from renewable sources, is biodegradable and is safer for the environment. Producing biodiesel fuels can help create local economic revitalization and local environmental benefits. Many groups interested in promoting the use of biodiesel already exist at the local, state and national level.

2. History of Bio Diesel

Use of Bio diesel in Diesel engines is not a new concept but century old. In fact Rudolf Diesel, the inventor of the Diesel Engine just used Peanut oil in his engine as early as1901. But later on the cheap availability of petroleum diesel completely replaced the use of vegetable oil. Today, since the availability is becoming scarce, it will be wise to go back to the traditional natural fuels like vegetable oil

Day-by-day the diesel oil is becoming costlier and dearer and within a few years it may not be available at all. Even now its availability is influenced by various extraneous factors like political situations, wars, terrorist activities etc. The worst affected are the developing countries like India, who do not have adequate resources of Petroleum products.

To-day we import 70% of our crude oil and in the coming years the requirement will increase greatly. Of all the petroleum products diesel oil is the maximum

Hence it is high time the world develops an alternate fuel devoid of all the above problems. Bio diesel fits the slot perfectly to replace Petroleum diesel. Bio diesel is nothing but processed vegetable oil or animal fats. The vegetable oil can be either edible or non-edible. Also used as cooking oil or fresh vegetable oil.

Engine and Vehicles

All diesel engines and vehicles can use biodiesel or biodiesel blends. Certain older vehicles built before1993 may require replacement of fuel line which contain natural rubber, as biodiesel can cause these lines to swell or crack

Blending and Switching with Diesel Fuel

Biodiesel can be used 100% (B100) or in blends with petroleum diesel fuel. When biodiesel is first used in a vehicle, it may release fuel tank deposits which can lead to fuel filter plugging. After this initial period, a user can switch between biodiesel and petroleum diesel whenever needed or desired, without modification.

3. Power, Performance and Economy

Many alternative fuels have difficulty gaining acceptance because they do not provide similar performance to their petroleum counterparts. Pure biodiesel and biodiesel blended with petroleum diesel fuel provide very similar horsepower, torque, and fuel mileage compared to petroleum diesel fuel. In its pure form, typical biodiesel will have energy content 5%-10% lower than typical petroleum diesel. However it should be noted that petroleum diesel fuel energy content can vary as much as 15% from one supplier to the next.

II. Madhuca Longifolia

A. History of The Plant

Fig. Madhuca long folia plant

Madhuca long folia is an Indian tropical tree found largely in the central and north Indian plains and forests. It is commonly known as mahua, mahua or Iluppai . It is a fast-growing tree that grows to approximately 20 meters in height, possesses evergreen or semi-evergreen foliage, and belongs to the family Sapotaceae. It is adapted to arid environments, being a prominent tree in tropical mixed deciduous forests in India in the states of West Bengal, Chhattisgarh, Jharkhand, Uttar Pradesh, Bihar, Maharashtra, Madhya Pradesh, Kerala, Gujarat and Orissa.

It is cultivated in warm and humid regions for its oleaginous seeds (producing between 20 and 200 kg of seeds annually per tree, depending on maturity), flowers and wood. The fat (solid at ambient temperature) is used for the care of the skin, to manufacture soap or detergents, and as a vegetable butter. It can also be used as

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a fuel oil. The seed cakes obtained after extraction of oil constitute very good fertilizer. The flowers are used to produce an alcoholic drink in tropical India. This drink is also known to affect the animals. Several parts of the tree, including the bark, are used for their medicinal properties. It is considered holy by many tribal communities because of its usefulness.

Fig. M. longifolia(Leaves) in Hyderabad, India

The tree is considered a boon by the tribal s who are forest dwellers and keenly conserve this tree. However, conservation of this tree has been marginalized, as it is not favored by non tribal s. The leaves of Madhuca indica (M. longifolia) are fed on by the moth Antheraea paphia , which produces tassar silk (tussah), a form of wild silk of commercial importance in India. The Tamils have several uses for M. longifolia (iluppai inTamil). The saying "aalai illaa oorukku iluppaip poo charkkarai "indicates when there is no cane sugar available, the flower of M. longifolia can be used, as it is very sweet. However, Tamil tradition cautions that excessive use of this flower will result in imbalance of thinking and may even lead to lunacy this is good for dog's hair. The alkaloids in the press cake of Madhuca seeds are reportedly used in killing fishes in aquaculture ponds in some parts of India. The cake serves to fertilize the pond, which can be drained, sun dried, refilled with water and restocked with fish fingerlings.

Mahuwa flowers

Fig. Mahua flowers

The mahua flower is edible and is a food item for tribal s. They are used to make syrup for medicinal purposes. They are also fermented to produce the alcoholic drink mahua, a country liquor. Tribal s of Bastar in Chhattisgarh and Orissa, Santhals of Santhal Paraganas(Jharkhand), Koya tribals of North-East Andhra Pradesh (vippa sara) and tribal s of North Maharashtra consider the tree and the mahua drink as part of their cultural heritage. Mahua is an essential drink for tribal men and women during celebrations. The main ingredients used for making it are chhowa gud (granular molasses) and dried mahua flowers. The liquor produced from the flowers is largely colour less, with a whitish tinge and not very strong. The taste is reminiscent of Sake with a distinctive smell of mahua flowers. It is inexpensive and the production is largely done in home stills. Mahua flowers are also used to manufacture jam, which is being made by tribal cooperatives in the Gadchiroli district of Maharashtra.

Fig. Mahua Flower.

Fig. Mahua for sale in local market which is usually used to make wine at home.

B. Other botanical names of mahua flower

1. Bassia longifolia L.
2. B. latifolia Roxb.,
3. Madhuca indica J. F. Gmel.,
4. M. latifolia (Roxb.)
5. J.F.Macbr.,
6. Illipe latifolia (Roxb.) F.Muell.,
7. Illipe malabrorum (Engl.)

C. Madhuca longifolia Scientific classification

1. Kingdom: Plantae
2. Order: Ericales
3. Family: Sapotaceae
4. Genus: Madhuca
5. Species: M. longifolia
6. Binomial name: Madhuca longifolia

D. Comparison of mahua oil with diesel oil:

Calorific Value and Carbon Residue: The calorific value of mahua oil was observed as 88.26% of diesel on weight basis and 96.30% on volume basis. The calorific value of mahua oil was found nearer to diesel fuel in comparison with other liquid fuel options like ethanol and methanol. The carbon residue of mahua oil was found higher than that of the limit specified for grade A diesel and this may increase the chances of carbon deposition in the combustion chamber. The higher carbon residue may be due to the difference in chemical composition and molecular structure of mahua oil.

Brake thermal efficiency and A/F ratio: Brake thermal efficiency decreased with the increase of mahua oil in diesel at all three compression ratio in comparison with pure diesel. Exhaust gas temperature increased with the increase in concentration of mahua oil in diesel. The air-fuel ratio and volumetric efficiency decreased with increase in concentration of mahua oil in diesel.

Table shows the characteristics of mahua oil

Properties	Value
Refractive index	1.452-1.462
Saponification value	187-197
Iodine value	55-70
Unsaponifiable matter,%	3-Jan
Palmitic acid,%	24.5
Stearic acid,%	22.7
Oleic acid,%	37
Linoleic acid,%	14.3

Procedure (single cylinder engine)

Fig.: 4-stroke diesel engine with electrical loading

The engine is started and run for at least 15 minutes for warming up. Motor for circulating the water is simultaneously started .Then, under no load condition, the time taken for the consumption of 10cc of fuel, the load applied, the speed and manometer recorded The load is increased and allowed to run for 10 minutes. Then, the time taken for the consumption of 10cc of fuel, the load applied, the speed and manometer readings are recorded. The load is further increased in approximately four equal steps up to the rated value and readings are noted as in earlier steps.
In addition, the temperature of cooling water at the inlet and outlet, temperature of exhaust gas and discharge of water are required at every load. The engine is then stopped taking suitable precautions.

The test samples are

1. B0(Pure Diesel)
2. B10 (10% Soya bean Oil and 90% Pure Diesel)
3. B20(20% mahua Oil and 80% Pure Diesel)
4. B30(30% Ethanol Oil and 70% Pure Diesel)

Testing Procedure

The testing procedure is carried by mixing the specimen samples with diesel in calculated proportions. The mixture of specimen sample and diesel is used in single cylinder diesel engine and several tests are conducted under controlled atmospheric conditions.

Fig. Single cylinder diesel engine.

Step1:Take bio diesel blend say ethanol B10, the composition contains 100 ml of ethanol and 900 ml of diesel, as ethanol is very dangerous proper atmospheric condition are to be maintain, water is used as the cooling agent in the experiment when the fuel is added to engine and cranking is done. Calculated proportions are taken and constant atmospheric conditions are maintained.
Step 2: load to be added to engine to engine and increased simultaneously with the help of the electrical loading and the mean difference of the two gauges are calculated to fine the exact torque applied on engine.The adding of load the rpm of the engine will be changing simultaneously that will be displayed on the digital meter. All this testing will give the performance of the fuel used in the engine and will be used in calculating to find the brake power and mechanical efficiency of the engine with using different types of test specimens.

Fig. Blending diesel with mahua biodiesel

Step 3: The temperature rise in the engine will noted with help of thermo couples placed inside the engine and the time taken for consumption of 10 ml of fuel will be calculated with help of stop watch The readings for the gauge and temperature indicators are tabulated, with help of these readings the work done by the engine is calculated and the fuels efficiency is calculated with help of calculating the following:
1. Volumetric efficiency
2. Brake power
3. Specific fuel consumption
4. Brake thermal efficiency
5. Indicated thermal efficiency
6. Mechanical efficiency

Different graphs are plotted to find the effectiveness of specimen fuel and there consistency on the engine working.

E. Experiments conducted ON

1. Performance Analysis
2. Heat Balance Sheet

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Table: B0 (pure diesel)

1	Volts	192	195	215	226	228
2	Ammeter reading	0	0.9	2.6	4.2	5.8
3	Speed(rpm)	1530	1525	1512	1500	1477
4	Manometer(h1)	25	25	24	24	21
5	Manometer(h2)	10	9	8	8	7
6	Time taken for 10ml of fuel onsumption (sec)	76	62	48	37	33
7	Time taken for water(sec)	7	7	7	6	8
8	Brake power(KW)	0	0.175	0.559	0.949	1.322
9	TFC(kg/hr)	0.388	0.476	0.615	0.797	0.894
10	SFC(kg/hr)	0	2.712	1.1001	0.839	0.676
11	Volumetric efficiency (%)	36.59	40.74	43.92	42.93	46.18
12	Brake thermal efficiency (%)	0	3.041	7.5	9.817	12.19

Table : B10

1	Volts	175	204	221	228	229
2	Ammeter reading	0	0.9	2.7	4.4	5.9
3	Speed(rpm)	1530	1523	1512	1505	1483
4	Manometer(h1)	27	27	27	26	26
5	Manometer(h2)	8	8	7	7	7
6	Time taken for 10ml of fuel consumption(sec)	104	79	56	45	37
7	Time taken for water(sec)	5	5	5	5	5
8	Brake power(KW)	0	0.183	0.596	1.003	1.351
9	TFC(kg/hr)	0.323	0.425	0.600	0.747	0.909
10	SFC(kg/hr)	0	2.319	1.006	0.745	0.673
11	Volumetric efficiency (%)	32.97	43.96	46.08	46.41	47.06
12	Brake thermal (efficiency (%)	0	4.163	9.592	12.95	14.35

Table : B20

1	Volts	192	211	221	227	228
2	Ammeter reading	0	1.2	2.8	4.5	6
3	Speed(rpm)	1515	1506	1490	1475	1450
4	Manometer(h1)	27	27	27	26	26
5	Manometer(h2)	7	7	7	7	6
6	Time taken for 10ml of fuel consumption(sec)	108	77	59	46	38
7	Time taken for water(sec)	5	5	5	5	5
8	Brake power(KW)	0	0.253	0.6188	1.022	1.368
9	TFC(kg/hr)	0.312	0.437	0.5703	0.731	0.886
10	SFC(kg/hr)	0	1.726	0.9216	0.716	0.647
11	Volumetric efficiency (%)	47.52	47.81	47.58	48.32	48.18
12	Brake thermal efficiency (%)	0	5.597	10.48	13.48	14.92

Table : B30

1	Volts	190	210	222	227	229
2	Ammeter reading	0	1.1	2.7	4.2	5.7
3	Speed(rpm)	1535	1525	1493	1475	1450
4	Manometer(h1)	28	28	28	28	28
5	Manometer(h2)	6	6	5	5	5
6	Time taken for 10ml of fuel consumption (sec)	101	76	58	45	37
7	Time taken for water(sec)	6	6	6	6	6
8	Brake power (KW)	0	0.231	0.5994	0.953	1.305
9	TFC(kg/hr)	0.333	0.044	0.5801	0.748	0.909
10	SFC(kg/hr)	0	0.191	0.9678	0.784	0.697
11	Volumetric efficiency (%)	49.17	49.49	51.71	51.19	52.34
12	Brake thermal efficiency (%)	0	50.39	9.97	12.31	13.86

F. Sample Calculations

Under no load condition (Pure Diesel)

Speed (N) = 1530 rpm

Time taken for consumption of 10 cc of fuel(t) =76 seconds.

Brake power (BP) = $(V\times I)/1000$ kW $=(192\times 0)/1000=0$ KW.

Hence, BP = 0 kW.

TFC = (10 × 3600 × Sp.Gravity)/ (t×1000) Kg/hr.

= (10 ×3600×0.82)/(76*1000) Kg/hr.

= 0.3884 Kg/hr. (Sp.Gravity of diesel 0.82)

Brake specific fuel consumption =T.F.C/B.P=0 kg/hr.

Volumetric Efficiency

m_a = mass flow rate of air (Kg/s)

C_d = Coefficient of discharge = 0.62

a = cross sectional area of orifice = $\pi/4 \times d^2 = \pi \times (0.1143)^2 =$ 0.01026 m^2

ρ_a = Density of air = 1.193 Kg/m^3 ,C_a = velocity of air

ρ_w = 1000 Kg/m^3

Δh_w = water head difference = h_2-h_1 =25-10= 15

D = Diameter of cylinder bore = 80 mm

L = Stroke length = 110 mm

A = Cross sectional area of cylinder

$C_a = \sqrt{(2 \times 9.81 \times \rho_w \times \Delta h_w / \rho_a)}$

$= \sqrt{(2 \times 9.81 \times 1000 \times (25\text{-}10) \times 10^{-2} / 1.193)}$
$= 49.66$ m/s
$m_a = C_d \times a \times \rho_a \times C_a$
$= 0.62 \times 0.01026 \times 1.193 \times 49.66$
$= 0.3768$Kg/s
Volumetric efficiency ($\eta_{v)}$) = ma / [($\rho_a \times V_{dsp} \times N$)] / (2*60)
$V_{dsp} = (\pi /4 \times D^2 \times L) = 3.141/4 \times 80^2 \times 110 \times 10^{-9} = 0.06m^2$
Volumetric efficiency ($\eta_{v)}$)
= { 0.3768/[1.193×((0.0608× 1530)/60)] × 100}= **40.74%**

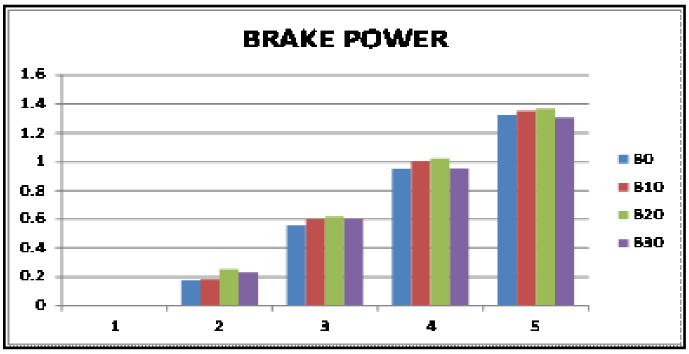
Calculation of density of mahua biodiesel
Calorific value of mahua oil = 37270 KJ/Kg,
Calorific value of diesel = 43626 KJ/Kg
By principle of allegations,
Calorific value of B20 = (0.05 ×39000)+ (0.95×44800)
= **44510 KJ/Kg**

Brake thermal efficiency:
Brake thermal efficiency = Brake power/heat supplied × 100
Heat supplied = mf in kg/s ×calorific value of diesel in KJ/kg
Calorific value of diesel =43626 KJ/hr
Thus, heat supplied= 0.3884 × 43626
And brake thermal efficiency = 0/16944.33 × 100 = 0
Friction power = 1Kw
(From graph, using Williams line method)

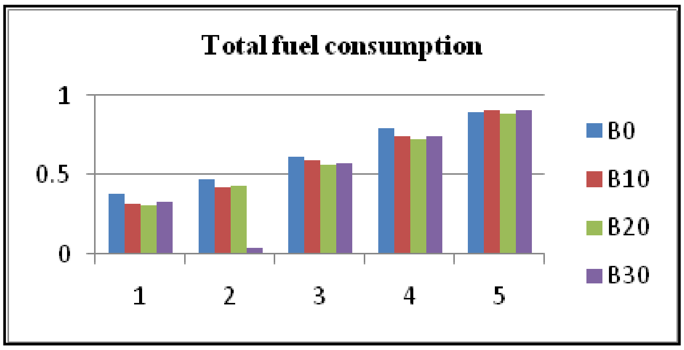
Indicated power:
IP= BP+FP = 0.60122 +1 = 1.60122Kw
Indicated thermal efficiency = IP/heat suppied × 100
= 1.60122/7.68751 × 100
= 20.828%
Indicated specific fuel consumption = mf/IP =0.63/20.82
= 0.0304 Kg/Kw-hr
Brake specific fuel consumption = mf/BP =0.6341/6.5114
= 0.0973 Kg/Kw-hr
Mechanical efficiency = (brake thermal efficiency/indicated thermal efficiency) × 100
= 6.5114/20.8288 × 100
= 31.26%
Similar calculations are done for the other readings obtained at different loads.

III. Comparison Of Mahua Biodiesel Blends With Diesel

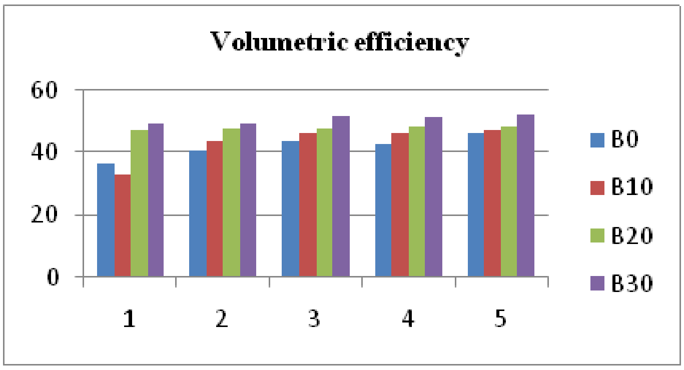
A. Brake Power



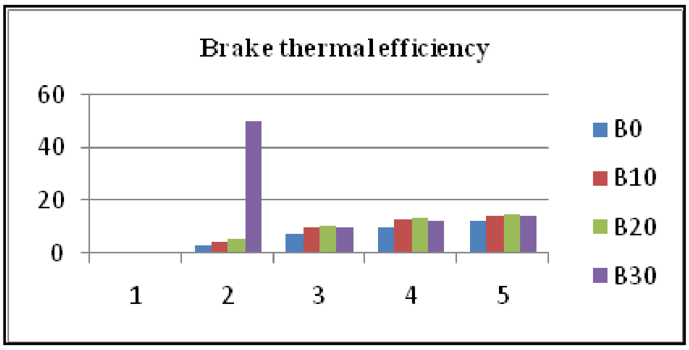
B. Total Fuel Consumption



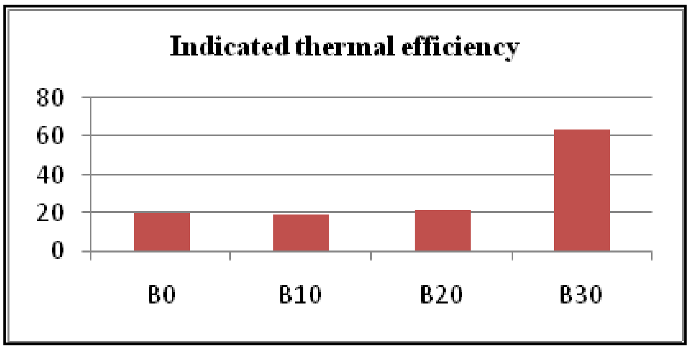
C. Volumetric Efficiency



D. Brake Thermal Efficiency



E. Indicated Thermal Efficiency



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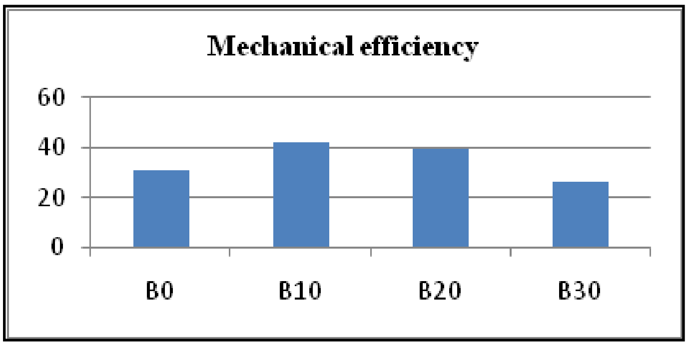
F. Mechanical Efficiency



IV. Conclusions

The experiments are conducted on the Single-cylinder 4 Stroke diesel engine with electrical loading test with pure diesel and blends of pure diesel and the following conclusions were made

- Brake power is high for B30.
- TFC is also high for B30.
- Volumetric efficiency of all blends are nearer to diesel .
- Brake thermal efficiency is high for pure diesel.
- Indicated thermal efficiency is high for B30.
- Mechanical efficiency is high for B10 and B20.

Reference

[1] Y.C.Sharma and bhaskar singh,"A Y.C.Sharma and bhaskar singh,"A hybrid feed stock for a very efficient preparation of biodiesel", fuel processing technology, vol.91,pp.1267-1273,2010.

[2] Cjlkilc s.ayden, r.behcet ,H.Aydin, "biodiesel fuel from safflower oil and its application in a diesel engine", fuel processing technology, vol.92,pp.356- 362,2011.

[3] Methanol", fuel, vol 80,pp.225- 231,2001Issn (0975-7384) JCPRC

[4] http://www.ijera.com/papers/Vol3_issue4/FA34936941.

[5] http://nopr.niscair.res.in/bitstream/123456789/4046/1/NPR%208(2)%20127-132.pdf.

[6] Guru Nanak Institute of Technology lab manuals

[7] International Journal of Modern Engineering Research (IJMER) www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1142-1149 ISSN: 2249-6645

[8] http://www.ijmerr.com/index.php?m=content&c=index&a=show&catid=126&id=177

[9] "Performance and Emission Characteristics of a Diesel Engine with Castor Oil", Indian Journal of Science & Technology, Vol. 2, No. 10.