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A comparative study an experimental investigation on performance and emission characteristics of diesel engine using bio-diesel as an alternate fuel

P.Lakshmanan[1] and G.Mariammal[2]

[1]Rvs School of Engineering and Technology, Dindigul, India.

[2]PSNA Colleges of Engineering and Technology, Dindigul, India.

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ABSTRACT

The utilization of liquid fuels such as biodiesel produced from various sources by trans_esterification process represents one of the most promising options for the use of conventional fossil fuels. The properties such as aniline point, density, fire point, flash point, viscosity, Cloud point and Pour point were found out for bio fuels. The same characteristics study was also carried out for the DF. Tests carried out to evaluate the performance, emission, and combustion characteristics diesel engine fuelled with 10%, 30%, 50% and 70% of alternative fuel (oil) Neem, Madhuca, Jatropa, Diesel, Laurel blended with diesel fuel (DF).

Introduction

Petroleum based fuels play a vital role in rapid depletion of conventional energy sources along with increasing demand and also major contributors of air pollutants. Petroleum based fuels play a vital role in rapid depletion of conventional energy sources along with increasing demand and also major contributors of air pollutants. Major portion of today's energy demand in India is being met with fossil fuels. Hence it is high time that alternate fuels for engines should be derived from indigenous sources. As India is an agricultural country, there is a wide scope for the production of vegetable oils (both edible and non-edible) from different oil seeds. The present work focused only on non-edible oils as fuel for engines, as the edible oils are in great demand and far too expensive. The past work revealed that uses of vegetable oils for engines in place of diesel were investigated by converting the non-edible oils into bio-fuels by trans-etherification process. Moreover the gases emitted by petrol, driven vehicles have an adverse effect on the environment and human health. Technical aspects of biodiesel are approached, such as the physical and chemical characteristics of methyl esters related to its performance in compression ignition engines [1]. Biodiesel has become more attractive recently because of its environmental benefits and the fact that it is made from renewable resources [2]. Although there are many ways and procedures to convert vegetable oil into a Diesel like fuel, the trans-esterification process was found to be the most viable oil modification process [3]. Biodiesel, defined as the mono-alkyl esters of fatty acids derived from vegetable oil or animal fat, in application as an extender for combustion in CIEs (Diesel), has demonstrated a number of promising characteristics, including reduction of exhaust emissions [4]. Vegetable oils have become more attractive recently because of their environmental benefits and the fact that it is made from renewable resources. More than 100 years ago, Rudolph Diesel tested vegetable oil as the fuel for his engine [5]. The Diesel boiling range material is of particular interest because it has been shown to reduce particulate emissions significantly relative to petroleum Diesel [6]. There are more than 350oil bearing crops identified, among which only sunflower, soybean, cottonseed, rapeseed and peanut oils are considered as potential alternative fuels for Diesel engines [7,8]. The transesterification can be dated back as early as 1846 when Rochieder described glycerol preparation through ethanolysis of castor oil [9]. The success of rapeseed ethyl ester production would mean that biodiesels two main raw materials would be agriculturally produced, renewable and environmentally friendly [12,16]. Since that time, alcoholysis has been studied in many parts of the world. Also, methyl esters have been prepared from palm oil by transesterification using methanol in the presence of a catalyst (KOH) in a batch reactor [21].

Bio Diesel:

Fuels derived from renewable biological resources for use in diesel engines are known as biodiesel. Biodiesel is environmentally friendly liquid fuel similar to petrol-diesel in combustion properties. Biodiesel is an oxygenated fuel; emissions of carbon monoxide and soot tend to reduce. Biodiesel is mostly obtained from renewable vegetable oils/animal fats and hence it may improve the fuel or energy security and thus leading to economy independence. Biodiesel obtained from vegetable sources does not contain any sulfur, aromatic hydrocarbons, metals or crude oil residues. Biodiesel is an oxygenated fuel; emissions of carbon monoxide and soot tend to reduce. Biodiesel is mostly obtained from renewable vegetable oils/animal fats and hence it may improve the fuel or energy security and thus leading to economy independence.

Methodology

Trans-Esterification Process:

Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. The process

Tele:

E-mail addresses: lakshkok@gmail.com

used to convert these oils to Biodiesel is called trans_esterification

Table. No .1 property of fuels

Property	Madhuca	Neem	Jatropa	Diesel	Laurel
Density(g/cc)	0.917	0.919	0.92	0.8	0.91
Viscosity(cst)	36	34	40.4	50	37
Flash point(0c)	273	300	315	57	317
Fire point(0c)	301	325	337	65	339
CalorificValues(KJ/kg)	39600	38500	38150	42000	37500
Cetane No	45	38	43	50	39

Experimental setup

The various components of experimental set up are described below. The important components of the system are the engine, Dynamometer, Smoke meter and Exhaust gas analyser.

Engine details

The engine we used is single cylinder diesel engine, its manufactured by Kirloskar company. The performance parameters such as Brake Power(BP), the emission parameters such as Carbon Monoxide(CO), Carbon dioxide(CO2),Un-burnt hydrocarbons(UHC), Nitrogen oxides(NOx) and Smoke Opacity(Smoke) are evaluated and analyzed from graphs

Table. No .2 Engine specifications

Number of cylinders	01
Number of Strokes	04
Fuel	Diesel
Rated Power	5.2 KW/7 hp @ 1500 RPM
Cylinder bore & Stroke	87.5 & 110 mm
Compression Ratio	17.5:1
Dynamometer arm length	185 mm
Dynamometer Type	Eddy current
Type of cooling	Water cooled

Result and discussion:

Table no.1.Aniline point

s. no	fuel	heterogeneous	homogeneous
1	Diesel	45^0c	75-80^0c
2	Jatropa	28-29^0c	60-65^0c
3	Laurel	3^0c	33^0c
4	Madhuca	21^0c	41^0c
5	Neem	2^0c	28^0c

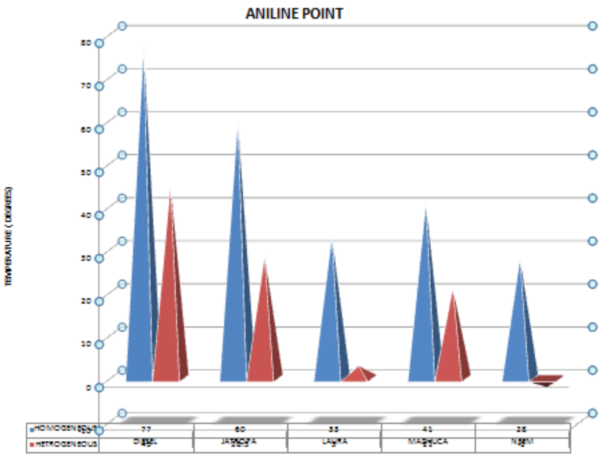

Fig no .1 Aniline point

Table no .2 Cloud point

s. no	fuel	Cloud point	Combined with diesel
1	Diesel	5^0c	
2	Jatropa	12^0c	10^0c
3	Laurel	10^0c	11^0c
4	Madhuca	18^0c	16^0c
5	Neem	14^0c	12^0c

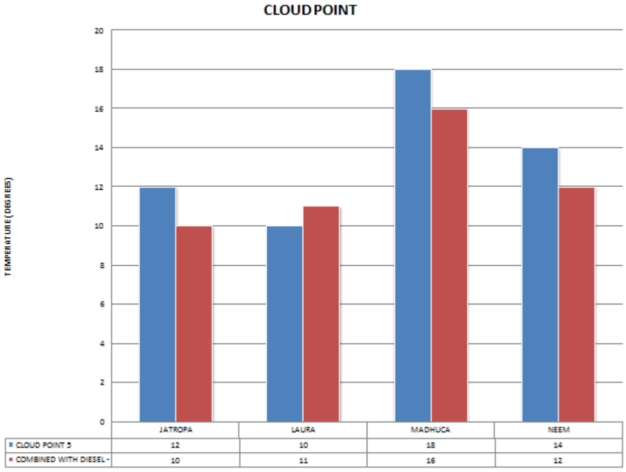

Fig no.2 Cloud point

Table.no.3 Pour point

s. no	fuel	heterogeneous	homogeneous
1	Diesel	-2^0c	-
2	Jatropa	6^0c	4^0c
3	Laurel	6^0c	5^0c
4	Madhuca	13^0c	10^0c
5	Neem	7^0c	4^0c

Fig no .3 Pour point

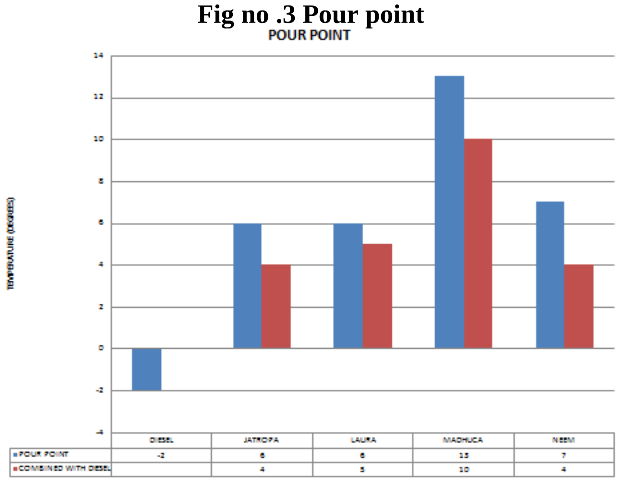

Table No.4 100% Diesel

Load (v)	C0 (%)	CO_2 (%)	HC (PPM)	O_2 (%)	NO_X (%)
0	0.071	3.95	0019	15.16	00385
500	0.073	4.05	0030	4.20	00655
1000	0.054	3.78	0027	17.38	00442
1500	0.025	1.59	0011	18.34	00310
2000	0.033	2.42	0007	16.95	00505

Table No. 5 70 % Diesel and 30% Neem (B30)

Load (v)	C0 (%)	CO_2 (%)	HC (PPM)	O_2 (%)	NO_X (%)
0	0.053	1.42	0006	18.80	00129
00	0.048	1.89	0006	18.06	00207
1000	0.036	1.54	0003	18.51	00205
1500	0.037	1.67	0005	18.41	00270
2000	0.034	1.87	0004	18.02	00388

Table No. 6 30 % Diesel and 70% Neem (B70)

Load (v)	C0 (%)	CO_2 (%)	HC (PPM)	O_2 (%)	NO_X (%)
0	0.044	1.74	0016	18.50	00119
500	0.052	1.88	0002	18.01	00176
1000	0.036	1.95	0003	17.85	00262
1500	0.035	2.03	0005	18.00	00302
2000	0.034	1.96	0007	18.33	00326

Table No. 7 10% Diesel and 90% Neem

Load	C0 (%)	CO_2	HC	O_2	NO_X

(v)		(%)	(PPM)	(%)	(%)
0	0.48	1.54	0001	18.76	00196
500	0.52	2.25	0011	17.34	00437
1000	0.048	2.355	0014	17.6	00657
1500	0.042	2.39	0018	18.29	00563
2000	0.043	2.87	0017	17.92	00909

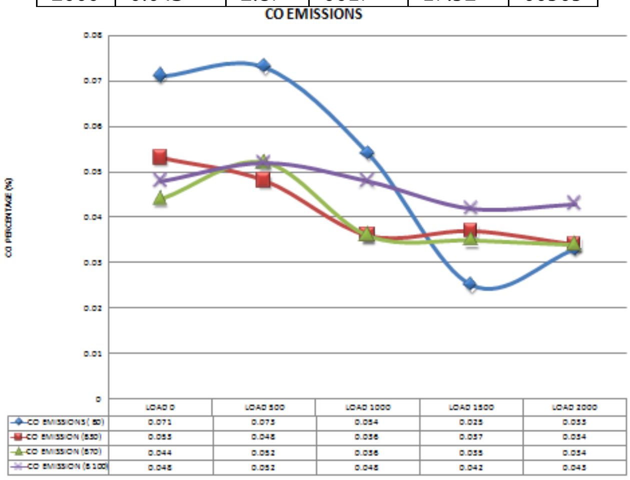

Fig.4 co emission

The fig.4 shows the variation of carbon monoxide emission from blends with respect to brake power. It is seen from the figure that the carbon monoxide emission increases with increase in load. It is further seen that for 10%, 20% of neem oil blends for entire operating range of loads CO emission.

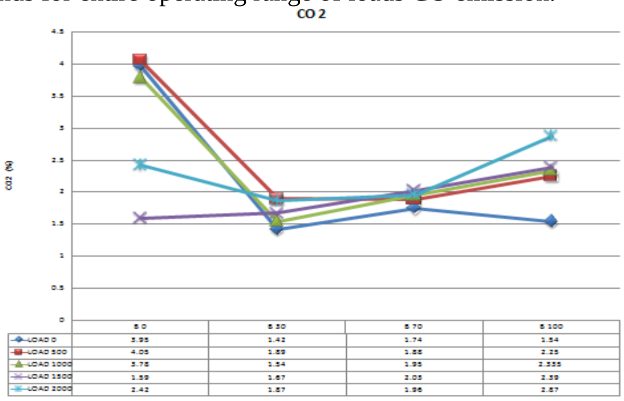

Fig.5 co$_2$ emission

Fig.5 shows the variations of CO_2 emission for blends with respects to break power. It is seen from the figure that the CO_2 emission increases with increase in load. Like previous discussion the emission of CO_2 emission the variation of CO_2 emission show 5% increase for 10% blend and 12.5% increase for 20% blend DF oil blends. It is further seen from the figure increase in CO_2 emission

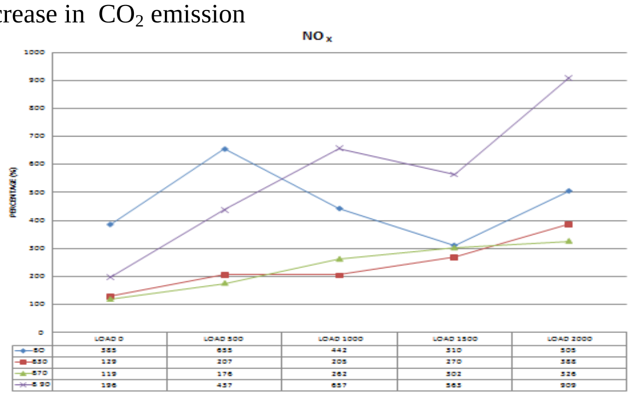

Fig.6 Oxides of Nitrogen

The oxides of Nitrogen emission depend on the engine type, engine operating conditions and fuel properties. The C.I engines normally produce higher NOx than diesel engines owing to their lower combustion temperature. The test result shows the NOx emission gets reduced with increase in vegetable oil content, because of the lower calorific value of the blended fuel the peak temperature attained in the combustion chamber is lower than the diesel. When the blend proportion increases the NOx formation is decreases at full load.

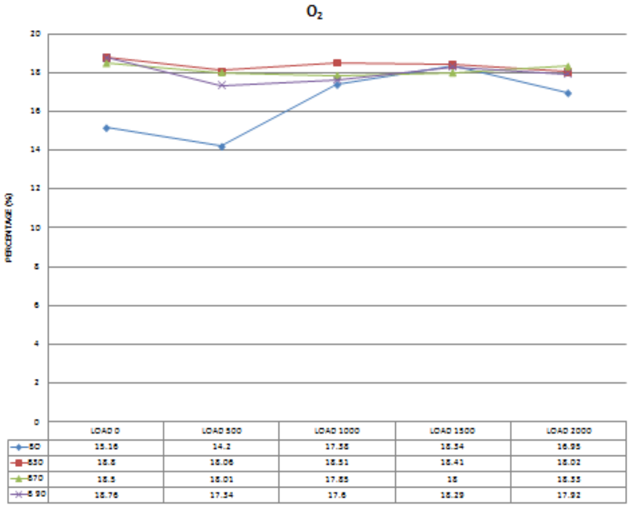

Fig.7 o$_2$ emission

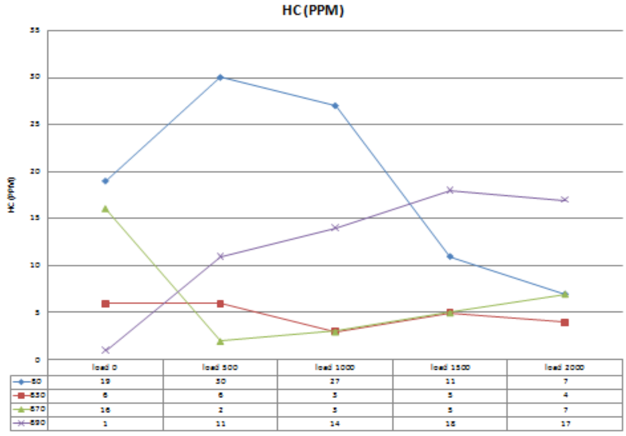

Fig.8 HC emission

Fig.8 shows the variations of HC emission for blends with respects to break power. It is seen from the figure that the HC emission increases with increase in load. Like previous discussion the emission of HC emission the variation of HC emission show 5% increase for 10% blend and 12.5% increase for 20% blend DF oil blends. It is further seen from the figure increase in HC emission

Mechanical Efficiency

B(0)	B(30)	B(70)	B(100)
56.021	54.979	54.979	57.323
54.93	55.02	54.976	57.32
54.95	55.11	54.97	57.32
54.95	54.97	54.975	57.327
54.86	54.974	54.92	54.972

Table no. 8 Mechanical Efficiency Vs fuel property

Brake Power (KW)

B(0)	B(30)	B(70)	B(100)
0.02689	0.02689	0.02444	0.02689
0.488	0.4888	0.49622	0.4889
0.977	0.97289	0.98	0.97778
1.48	1.47156	1.474	1.467
1.98	1.975	1.92	1.782

Table no.9 Brake power Vs fuel property

The fig.1 shows the variation of brake power for the blends of Diesel with Madhuca lural, neeem oil with respect to load. It is seen from the figure that the BP increases with increase in load. It is also seen that the BP decreases with increase in percentage of the MI oil in DF oil blend. It is seen that the BTE of DF oil blends are performing very closer to diesel such as 26.5% and 25% respectively.

Indicated Power (KW)

B(0)	B(30)	B(70)	B(100)
0.048	0.04891	0.04891	0.04691
0.8884	0.8884	0.90262	0.8529
1.7778	1.76569	1.7828	1.70578
2.69321	2.67676	2.68121	2.559
3.609	3.59262	3.49557	3.24164

Table no.10 Indicated power Vs fuel property

Conclusion

Considering the need for alternate fuels, the experimental investigations are carried out in the present work in order to run the existing diesel engines with non-edible oils. For these purpose four different non-edible oils and their blend madhuca oil, neem oil, jatropa oil and laurel oil are tried. All the oils are esterified. Properties of the above mentioned oils were determined. The result obtained for the properties of neem oil are more over equal to the conventional diesel fuel. Thus their suitability as an alternative fuel is examined. The performance and Emission parameters of Bio-diesels are evaluated and compared to those of Diesel. Performance parameters of engine such as mechanical efficiency, IP, BP, FP are calculated. Emission parameters of engine such as CO, CO2, HC, NO_X, and PM are decreased for all neem oils and their blends compared to Diesel. The results of mechanical efficiency is higher at the (90% Neem and 10% Diesel) and the emissions are much lower at the different combinations of the bio-fuels with diesel. However with the use of neem oils at various blends of the diesel, the emissions from the engine are highly reduced. Due to that the neem bio fuel is acts as the best alternate fuel for the future for reducing the emissions and increasing the mechanical efficiency

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