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PERFORMANCE AND EMISSIONS CHARACTERISTICS OF SINGLE CYLINDER 4 STROKE WATER COOLED DIESEL ENGINE FROM JATROPHA METHYL ESTER AND DIESEL BLENDS

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ABSTRACT

This paper deals with the study of the potential substitution of jatropha methyl ester blends for diesel as fuel for automobiles and other industrial purposes. The objective of this study is the analysis of the performance and emission characteristics of the jatropha methyl esters and comparing with petroleum diesel. The tests were carried out on a 3.7 KW, single cylinder, direct injection, water-cooled diesel engine. The fuels used were neat jatropha methyl ester, diesel and different blends of the methyl ester with diesel. The experimental result shows that 20% of blend shows better performance with reduced pollution. This analysis shows that jatropha methyl ester and its blends are a potential substitute for diesel.

INTRODUCTION

Unlike soybeans, pongamia, canola and many other agricultural sources of biodiesel, Jatropha can be cultivated on arid and semi arid non-agricultural land. This means growing Jatropha never has to compete with growing food. Also, on a per acre basis, Jatropha can yield up to 10 times the amount of oil as other sources of biodiesel. Finally, Jatropha is a perennial, lasting up to 50 years without replanting. In fact the "cake" (portion of the seed left over after extraction of the seed's oil) is full of nitrogen compounds making it an excellent organic fertilizer. After 4 or 5 years of treatment with this "cake" the soil of this originally non-agricultural land will be suitable for planting food crops or trees for reforestation.

Jatropha curcas grows almost anywhere, even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil. It can grow even in the crevices of rocks. The leaves shed during the winter months form mulch around the base of the plant. The organic matter from shed leaves enhance earth-worm activity in the soil around the root-zone of the plants, which improves the fertility of the soil. Regarding climate, Jatropha curcas is found in the tropics and subtropics and likes heat, although it does well even in lower temperatures and can withstand a light frost. Its water requirement is extremely low and it can stand long periods of drought by shedding most of its leaves to reduce transpiration loss. Jatropha is also suitable for preventing soil erosion and shifting of sand dunes.

Features of Jatropha

- Low cost seeds
- High oil content
- Small gestation period
- Growth on good and degraded soil
- Growth in low and high rainfall areas
- Seeds can be harvested in non rainy season
- Plant size is making collection of seeds more convenient

Fuel properties

The properties of methyl esters produced were measured using respective standard techniques. It was found that the properties of the methyl esters satisfy Indian standards for Biodiesel.. The Properties of oil, methyl esters, diesel and Indian Standards for biodiesel are listed in Table .1

Table 1 Properties of Methyl Esters

FUEL		Property			
		Specific gravity	Calorific value (KJ/kg)	Kinematic Viscosity (mm^2/sec)	Flash Point ℃
Jatropha oil		0.878	32430	49.9	240
	Diesel	0.85	42800	3.05	56
JTME	B20	0.8582	42156	4.96	64
	B40	0.8593	42072	5.03	76
	B60	0.8616	41139	5.14	98
	B80	0.8635	40174	5.26	109
	B100	0.8682	39200	5.27	174

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EXPERIMENTAL PROCEDURE
SPECIFICATIONS OF CI ENGINE

MAX. BP	:	3.7 kW (5 H.P)
SPEED	:	1500 RPM
BORE	:	80mm
STROKE	:	110mm
ORIFICE DIA	:	20mm
COMPRESSION RATIO	:	16.5:1

Description

The engine is four stroke vertical single cylinder diesel engine. The Mechanical brake drum is fined to the engine flywheel and are mounted on a frame and futures mounted on anti-vibrations. The panel board is provided with 3 way cock, digital temperature indicator with selector switch, digital RPM indicator and U-tube manometer.

Procedure

- The fuel level and lubrications oil levels are checked and three way cock is opened so
- that the fuel flows to the engine.
- The cooling water is supplied to the engine cooling water jacket and to the brake
- drum.
- The electrical power is supplied to the panel instrumentation.
- The engine is de-compressed by decompression lever provided on the top of the
- engine head.
- The engine is unloaded by removing the weights from the hanger.
- The engine is started by cranking.
- The readings are noted are:
    1. Spring balance reading in kg-f (S).
    2. Time taken for 10cc fuel consumption in seconds (t).
    3. Manometer reading (hw).
- The experiment is repeated for different loads
- The above steps 7 & 8 are repeated for different blends of fuels

RESULTS AND DISCUSSIONS

Comparisons of bio diesel with diesel

- BTE slightly decreases
- SFC slightly increases
- HC reduces
- CO reduces
- NOx increases

PERFORMANCE ANALYSIS

Results of the experiments in the form of brake power, brake thermal efficiency, specific fuel consumption for different load conditions for various blends of jatropha methyl esters compare with the petroleum diesel in the form of graphs

Specific Fuel Consumption

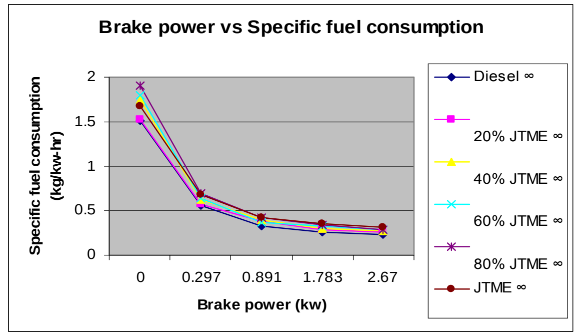

Fig. 1 Comparison of Specific Fuel Consumption for JTME/diesel blends

The comparison of variation of specific fuel consumption with brake power for diesel, with different blends of jatropha methyl esters are shown in Fig.1

From the fig1, it is observed that the methyl esters shows higher SFC compare to diesel as calorific value is less. It was observed that 20% blend is having comparable closer values with diesel. However SFC is higher for all the other blends. The SFC decreases with the increasing loads. It is inversly praportional to the thermal efficiency of the engine.

Brake Thermal Efficiency

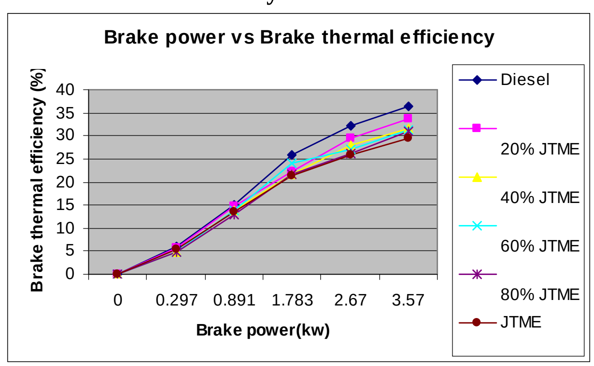

Fig 2 Comparison of brake thermal efficiency for JTME/diesel blends

The BTE variations with load for various blends of methyl esters were shown in fig.2.From the fig.2, it is observed that the BTE is slightly lower than the diesel for jatropha methyl ester and its blends. The BTE is less for jatropha methyl ester because of less calorific value.
From the Fig.2, it is observed that brake thermal efficiency is low at low values of BP and is increasing with increase of BP for all blends of fuel. For a blend of 20% the brake thermal efficiency is high at low BP values when compared with other blends of fuel and is very close to diesel at high values of BP. Hence at the blend of 20% of methyl ester the performance of the engine is good .

EMISSION ANALYSIS

Results of the experiments in the form of carbon monoxide (CO), Nitrogen oxides (NOx), Hydrocarbons (HC) for different load conditions for various blends of jatropha methyl esters compare with the petroleum diesel in the form of graphs.

CO_2 Emission

From Fig. 3, it is observed that CO_2 increases with increasing load for all the blends of Jatropha methyl esters. If percentage of blends of Jatropha methyl esters increases, CO_2 increases. The CO_2 emissions are directly proportional to the percentage of Jatropha in the fuel blend. Since Jatropha methyl esters is an oxygenated fuel, it improves the combustion efficiency and hence increases the concentration of CO_2 in the exhaust.

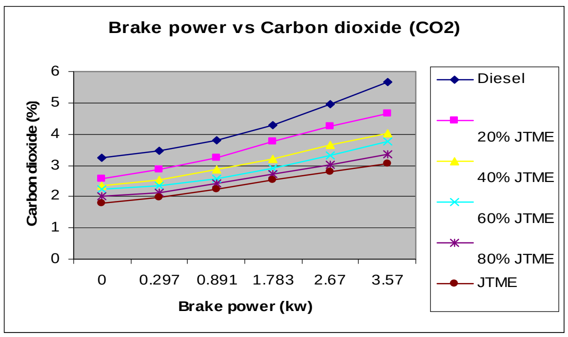

Fig.3 Comparison of CO for JTME/diesel blends

CO Emission

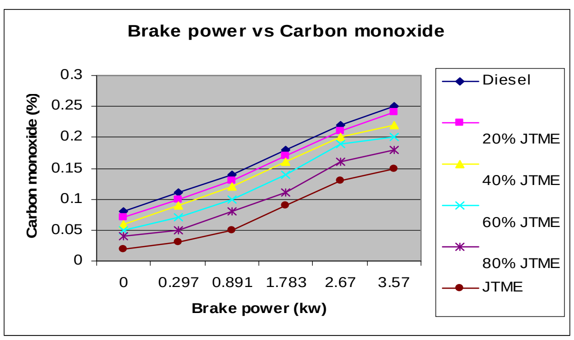

Fig.4 Comparison of CO for JTME/diesel blends

The comparison of variation of carbon monoxide(CO) emissions with break power for diesel, with different blends of jatropha methyl esters are shown in Fig. 4

From fig.4, it is observed that CO decreases with increasing load for all the blends of Jatropha methyl esters. If percentage of blends of Jatropha methyl esters increases, CO reduces. The concentration of CO decreases with the increase in percentage of JTME in the fuel. This may be attributed to the presence of O_2 in JTME, which provides sufficient oxygen for the conversion of carbon monoxide (CO) to carbon dioxide (CO_2). It can be observed that blending 20% JTME with diesel results in a slight reduction in CO emissions when compared to that of diesel.

HC Emission (in PPM)

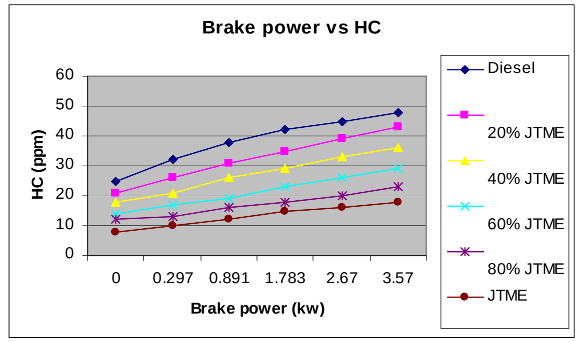

Fig.5 Comparison of HC for JTME/diesel blends

The comparison of hydrocarbons (HC) emissions for diesel, neat JTME and blends of them are presented in Fig. 5

From fig.5 it is observed that hydro carbon (HC) increases with increasing load for all the blends of Jatropha methyl esters. If percentage of blends of Jatropha methyl esters increases, HC reduces. The hydrocarbon emissions are inversely proportional to the percentage of JTME in the fuel blend. A significant difference between JTME and diesel operation can be inferred. The diesel oil operation showed the highest concentrations of HC in the exhaust at all loads. Since JTME is an oxygenated fuel, it improves the combustion efficiency and hence reduces the concentration of hydrocarbon emissions (HC) in the engine exhaust. Blending 20% JTME with diesel greatly reduces HC emissions especially at rated load condition.

NOx Emission

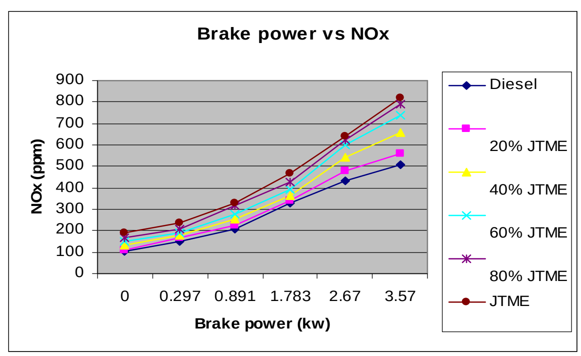

Fig. 6 Comparison of nitrogen oxides for JTME/diesel blends

The comparison of NOx emissions for diesel, neat JTME and blends are shown in Fig. 6

From fig.6, it is observed that NOx increases with increasing load for all the blends of jatropha methyl esters. If percentage of blends of jatropha methyl esters increases, NOx increases. It can be seen that NOx emissions increase with increase in percentage of JTME in the diesel-JTME fuel blend. The NOx increase for JTME may be associated with the oxygen content of the JTME, since the fuel oxygen may augment in supplying additional oxygen for NOx formation. Moreover, the higher value of peak cylinder temperature for JTME when compared to diesel may be another reason that might explain the increase in NO_X formation.

Smoke density

From fig.7, it is observed that smoke density increases with increasing load for all the blends of Jatropha methyl esters. If percentage of blends of Jatropha methyl esters increases, smoke density decreases. Because of increasing the load the fuel entering in to the cylinder increases in that proper oxygen is not allowed for that the smoke density is high for the diesel.

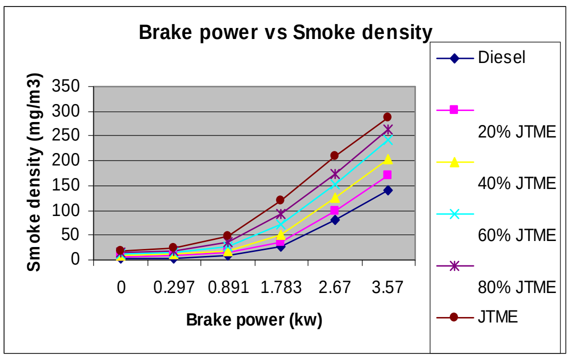

Fig. 7 Comparison of Smoke densiy for JTME/diesel blends

CONCLUSION

From the experiments conducted, it is concluded that biodiesel and its blends as a fuel for diesel engine have better emission characteristics compared with diesel.

It is clear that, at 20% blending of biodiesel the engine performance is found to be very appreciable. At this blending trial particularly at full load and half load conditions the specific fuel consumption and indicated thermal efficiency are very closer to the values obtained without blending. The NOx emissions are high due to presence of oxygen content in the fuel.The HC and CO emissions are less compared with diesel.

References

Y.C.Sharma ,B.Singh “Development of biodiesel from karanja , a tree found in rural India”Journal of Fuel, 1740–1742, 87 (2008).

Ganesan V. (2003), "Internal combustion Engines", Mcgraw Hill Publications, New Delhi.

Heywood J.B. (1998), "Internal combustion Engines Fundamentals", Mcgraw Hill, New York.

Sanjib Kumar Karmee,Anju Chadha “Preparation of biodiesel from crude oil pongamia pinnata”Journal of Bioresource Technology 96 (2005) 1425 -1429.

Vivek and A.K.Gupta “Biodiesel production from karanja oil” Journal of Scientific& Industrial Research,Vol 63 ,January 2004,pp 39-47.

L.C.Mehar ,S.N.Naik and L.M.Das “Methanolysis of Pongamia pinnata(karanja) oil for Production of biodiesel” Journal of Scientific& Industrial Research,Vol 63 ,November 2004,pp 913-918.

Sagar Pramodrao Kadu,Rajendra H.Sarda “Experimental Investigations on the use of Preheated neat karanja oil as fuel in a compression ignition engine” World academy of Science, Engineering and Technology, 72, 2010 pp 540-544.

P.K.Srivastava,Madhumita Verma “ Methyl Ester of karanja oil as an alternate renewable source energy” Journal of Fuel, 1673–1677, 87 (2008).

Sudipta choudhury and Dr. P.K.Bose “ Karanja oil-its potential and suitability as biodiesel.

H.Raheman,A.G.Phadatare “ Diesel engine emissions and performance from blends of karanja methyl ester and diesel” Journal of Biomass & Bioenergy 27 (2004) 393-397.

K.Sureshkumar,R.Velraj,R.Ganesan “Performance and exhaust emission characteristics of a CI engine fueled with pongamia pinnata methyl ester (PPME) and its blends with diesel” Journal of Renewable Energy 33 (2008) 2294-2302.

Magin Lapuerta, Octavio Armas , Jose Rodriguez-Fernandez “ Effect of biodiesel fuels on diesel engine emissions” Journal of progress in energy and combustion science 34 (2008) 198-223.

Thaim Leng Chew,Subhash Bhatia “ Catalytic processes towards the production of biofuels in a palm oil and oil palm biomass- based biorefinery”Journal of Bioresource Technology 99(2008) 7911-7922.

Mustafa Canakci,Ahmet Erdil,Erol Arcaklioglu”Performance and exhaust emissions of a biodiesel engine” Journal of Applied energy (2006) 594-605.

Tamilvendhan.D,Ilangovan.V “ Performance,emission and combustion characteristics of a methyl ester sunflower oil-eucalyptus oil in a single cylinder air cooled and direct injection diesel engine” International journal of engineering science and technology (IJEST) vVol.3 No.3 March 2011 pp 1977-1985.

Avinash kumar agarwal “ Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines” Journal of progress in energy and combustion science 33 (2007) 233-271.

C.V.Sudhir,N.Y.Sharma and P.Mohanan “Potential of waste cooking oils as biodiesel feed stock” Emirates journal for engineering research ,12(3),69-75 (2007).

Yong wang, Shiyi ou, Pengzhan liu, Feng xue, Shuze tang “ Comparison of two dfferent proceses to synthesize biodiesel by waste cooking oil” Journal of molecular catalysis A:Chemical 252 (2006) 107-112.

Pedro Felizardo, M.Joana neiva correia, Idalina raposo, Joao F.Mendes, Rui Berkemeier, Joao Moura bourdado “ Production of biodiesel from waste frying oils” Jornal of waste management 26(2006) 487 -494.

Magin lapuerta , Jose M.Herreros, Lisbeth L.Lyons, Reyes Garcia-contreras, Yolanda briceno "Effect of the alcohol type used in the production of waste cooking oil biodiesel on diesel performance and emissions" Journal of Fuel 87 (2008) 3161-3169.

S.Chongkhong,C.Tongurai,P.Chetpattananondh,C.Bunyakan " Biodiesel production by esterification of palm fatty acid distillate" Journal Biomass and Bioenergy 31(2007) 563-568.

Pedro Benjumea, John Agudelo, Andres Agudelo "Basic properties of palm oil biodiesel-diesel blends" Journal of Fuel 87 (2008) 2069-2075.

M.Pugazhvadivu, K.Jeyachandran " Investigations on the performance and exhaust emissions of a diesel engine using preheated waste frying oil as fuel" Journal of Renewable energy 30 (2005) 2189-2202.

Y.C.Sharma, B.Singh, S.N.Upadhyay " Advancements in development and characterization of biodiesel: A review" Journal of Fuel 87 (2008) 2355-2373.

Fangrui Ma,Milford A.Hanna " Biodiesel production : A review 1 Journal of Bioresource Technolgy 70(1999) 1-15.

Onkar S.Tyagi,Neeraj Atray,Basant Kumar and Arunabha Datta "Production, Characterization and development of standards for biodiesel- A review" Journal of metrology society of India ,Vol.25,No.3,2010 ,pp 197-218.

K.Khalisanni,K.Khalizani,M.S.Rohani and P.O.Khalid " Analysis of waste cooking oil as raw material for biofuel production" Global journal of environmental research 2 (2):81-83,2008.

Arjun B.Chhetri,K.Chris watts and M.Rafiqul Islam " Waste cooking oil as an alternate feedstock for biodiesel production" Jornal of energies 2008.1,3-18.

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