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"Performance Of Ic Engine By Using Mahua Oil *(Madhuca indica)* BIODIESEL"

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Abstract
The increasing industrialization and motorization of the world has led to a steep rise for the demand of petroleum-based fuels. Petroleum-based fuels are obtained from limited reserves. These finite reserves are highly concentrated in certain regions of the world. Therefore, those countries not having these resources are facing energy/foreign exchange crisis, mainly due to the import of crude petroleum. Hence, it is necessary to look for alternative fuels which can be produced from resources available locally within the country such as alcohol, biodiesel, vegetable oils etc. This paper reviews the production, characterization and current statuses of vegetable oil and biodiesel as well as the experimental research work carried out in various countries. This paper touches upon well-to-wheel greenhouse gas emissions, well-to-wheel efficiencies, fuel versatility, infrastructure, availability, economics, engine performance and emissions, effect on wear, lubricating oil etc. Ethanol is also an attractive alternative fuel because it is a renewable bio-based resource and it is oxygenated, thereby providing the potential to reduce particulate emissions in compression-ignition engines. In this review, the properties and specifications of ethanol blended with diesel and gasoline fuel are also discussed. Special emphasis is placed on the factors critical to the potential commercial use of these blends. The effect of the fuel on engine performance and emissions (SI as well as compression ignition (CI) engines), and material compatibility is also considered. Biodiesel is methyl or ethyl ester of fatty acid made from virgin or used vegetable oils (both edible and non-edible) and animal fat. The main resources for biodiesel production can be non-edible oils obtained from plant species such as Jatropha curcas (Ratanjyot), Pongamia pinnata (Karanj), Calophyllum inophyllum (Nagchampa), Hevca brasiliensis (Rubber) etc. Biodiesel can be blended in any proportion with mineral diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, biodiesel operates in compression ignition (diesel) engine, and essentially require very little or no engine modifications because biodiesel has properties similar to mineral diesel. It can be stored just like mineral diesel and hence does not require separate infrastructure. The use of biodiesel in conventional diesel engines results in substantial reduction in emission of unburned hydrocarbons, carbon monoxide and particulate. This review focuses on performance and emission of biodiesel in CI engines, combustion analysis, wear performance on long-term engine usage, and economic feasibility.
Keywords: *Biofuels; Alcohol; Biodiesel; Performance and emissions; Combustion analysis; Tribology; Wear analysis*

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I. INTRODUCTION

1.11 AN OVERVIEW OF DIESEL ENGINE

The diesel internal combustion engine differs from the gasoline powered Otto cycle by using highly compressed, hot air to ignite the fuel rather than using a spark plug (compression ignition rather than spark ignition).

In the diesel engine, only air is initially introduced into the combustion chamber. The air is then compressed with a compression ratio typically between 15:1 and 22:1 resulting in 40-bar (4.0 MPa; 580 psi) pressure compared to 8 to 14 bars (0.80 to 1.4 MPa) (about 200 psi) in the petrol engine. This high compression heats the air to 550 °C (1,022 °F). At about the top of the compression stroke, fuel is injected directly into the compressed air in the combustion chamber. This may be into a void in the top of the piston or a *pre-chamber* depending upon the design of the engine. The fuel injector ensures that the fuel is broken down into small droplets, and that the fuel is distributed evenly. The heat of the compressed air vaporizes fuel from the surface of the droplets vapour is then ignited by the heat from the compressed air in the combustion chamber, the droplets continue to vaporize from their surfaces and burn, getting smaller, until all the fuel in the droplets has been burnt. The start of vaporization causes a delay period during ignition, and the characteristic diesel knocking sound as the vapor reaches ignition temperature and causes an abrupt increase in pressure above the piston. The rapid expansion of combustion gases then drives the piston downward, supplying power to the crankshaft. Model airplane engines use a variant of the Diesel principle but premix fuel and air via a carburetion system external to the combustion chambers.

The high level of compression allowing combustion to take place without a separate ignition system, a high compression ratio greatly increases the engine's efficiency. Increasing the compression ratio in a spark-ignition engine where fuel and air are mixed before entry to the cylinder is limited by the need to prevent damaging pre-ignition. Since only air is compressed in a diesel engine, and fuel is not introduced into the cylinder until shortly before top dead centre (TDC), premature detonation is not an issue and compression ratios are much higher.

1.12 COMBUSTION IN C.I. ENGINE

The process of combustion in C.I. engine is fundamentally different from that in a S.I. engine. In the S.I. engine a homogeneous carbureted mixture of petrol vapor and air, in nearly stoichiometric or chemically correct ratio, is compressed in the compression stroke through a small compression ratio (6:1 to 11:1) and the mixture is ignited at one place before the end of the compression stroke (say before 30° before TDC) by means of an electric spark.

In C.I. engine, air alone is compressed through a large compression ratio (12:1 to 24:1) during the compression stroke raising highly its temperature and pressure. In the highly compressed and highly heated air in the combustion chamber (well above ignition point of fuel) one or more jets of fuel are injected in the liquid state, compressed to high pressure of 110 to 200 bar by means of a fuel pump. Each minute droplet as it enters the hot air (temperature 450-500°C and pressure 30-40 bar) is quickly surrounded by an envelope of its own vapor and this, in turn and after an appreciable interval, is inflamed at the surface of the envelope.

1.13 MAHUA OIL *(Madhuca indica)*

The two major species of genus Madhuca found in India are Madhuca Indica (syn. Bassia latifolia) and Madhuca longifolia (syn. Brassica longifolia). Mahua is the widely accepted as local name for the fat from both these species. This plant is common in deciduous forests. The seed and oil potential of this tree in the country is 5.00 lakh and 1.8 lakh M. tons.

Fig.1: Mahua (Madhuca Indica)

a. Botanical Name : Madhuca indica
b. Family : Sapotaceae
c. Common Names

Sanskrit	:	Madhuka
A.P	:	Ippe, Yappa
Gujarat	:	Mahuda
Hindi	:	Mahua, Mohwa,
Karnataka	:	Hippe
Kerla	:	Ponnam, Ilupa
Maharashtra	:	Mahwa,Mohwra
Orissa	:	Mahula, Moha,
Tamil Nadu	:	Illupei, elupa

West Bengal : Mahwa, Maul,
English : Butter tree

1.13.1. Botanical Features

M. Latijolia is a deciduous tree white M.Congijolia is ever green or semi ever green tree. Attains height upto 70 ft. The tree matures and starts bearing 8 to 15 years, and fruits upto 60 years. The two species are not differentiated in Trade. The kernels are 70% of seed by weight, are seed contains two kernels, having 2.5 cm x 1.75 cm size oil content in latifolia is 46% and 52% in long folia. In seeds oil content is 35% and protein in 16%.

1.13.2. Flowering

The flowering season extends from February to April. The copious fall of succulent, corollas weave a cream colored carpet on the ground. It is rich in sugar (73%) and next to cane molasses constitute the most important raw material for alcohol fermentation. The yield of 95% alcohol is 405 liters from one ton of dried flowers.

1.13.3. Fruiting

The matured fruits fall on the ground in May and July in the North and August and September in the South. The orange brown ripe fleshy berry is 2.5 to 5 cm long and contains one to four shining seeds. The seeds can be separated from the fruit wall by pressing. Drying and decortications yield 70% kernels on the weight of seeds.

1.13.4. Mahua Oil

Mahua seed contains 35% oil and 16% protein. The characteristics of fat are as under :

1.13.4a. Characteristics of Fat

Characters Characteristic/valve

1. Color Pole yellow
2. Consistency Plastic
3. Refractive index at 40 degree C1.452 to 1.462
4. Specific gravity at 15 degree C 0.856 to 0.870
5. Iodine valve 58.00 to 70.00
6. Specification valve 187 to 196
7. Sponification valve 1.00 to 3.00

II. EXPERIMENTAL PROCEDURE

1) Switch on the mains of the control panel and set the supply voltage from servo stabilizer to 220 volts.
2) The main gate valve is opened, the pump is switched ON and the water flow to the engine cylinder jacket (300 liters/hour), calorimeter (50 liters/hour), dynamometer and sensors are set.
3) Engine is started by hand cranking and allowed to run for a 20 minutes to reach steady state condition.
4) The engine software Lab view 7.1 optimized for engine analysis by Deepti Engineering Services, Bangalore is used for taking readings.

The engine has a compression ratio of 17.5 and a normal speed of 1500 rpm controlled by the governor. An injection pressure of 200 bar, 250 bar and 300 bar are used for the analysis. The engine is first run with neat diesel at loading conditions such as 6.5, 13, 19.5 and 26 N-m. Between two load trials the engine is allowed to become stable by running it for 3 minutes before taking the readings. At each loading condition performance parameters namely speed, exhaust gas temperature, brake power, peak pressure are measured under steady state conditions. The experiments are repeated for various load conditions for S10, S20 and S30 bio-fuel. With the above experimental results, the parameters such as total fuel consumption, brake specific fuel consumption, indicated specific fuel consumption, specific energy consumption, brake thermal efficiency, indicated thermal efficiency, mechanical efficiency are calculated. Finally graphs are plotted for these parameters against various load conditions for diesel and S10, diesel and S20, diesel and S30 bio-diesel. From these plots, performance characteristics of the engine are determined.

2.1 EXPERIMENTATION

The experiments were conducted on a direct injection compression ignition engine for various loads and blends of biodiesel & pure diesel. Analysis of combustion characteristics and performance parameters like peak pressure, specific fuel consumption (SFC) and Brake thermal efficiency are evaluated.

III. RESULTS AND DISCUSSIONS

EMISSION CHARACTERISTICS

3.1HYDROCARBON EMISSION

Fig 2. shows the variation of HC Emissions with load for Diesel and H20 blend for normal piston for CR=17.5. It is observed from the graph that the HC emissions for H20 blend is almost same as that of diesel at load of 6.5 N-m but gradually reduces and becomes lower than that of diesel at higher loads.

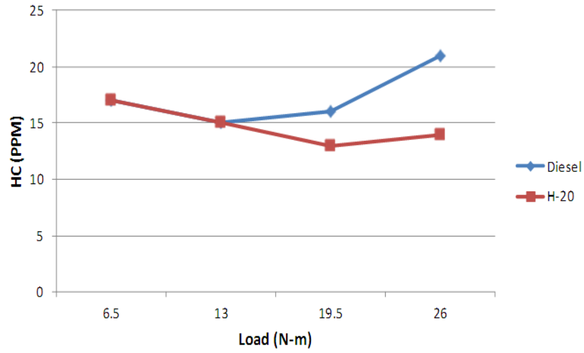

Fig .2 HC emissions for Diesel and H20 fuels for Normal piston

3.2 NITROGEN OXIDE EMISSION

Fig.2 shows the variation of NO_x with load of Diesel and H20 blend for normal piston for CR=17.5. It is observed from the graph that the emission of NO_x is increasing as the load increases.

The main reason for the emission of Nitrogen oxide is high temperature and availability of oxygen. In general high temperature in cylinder results in higher level of NO_x. In the modified piston NO_x emission is very less for H20 blend when compared to diesel fuel.

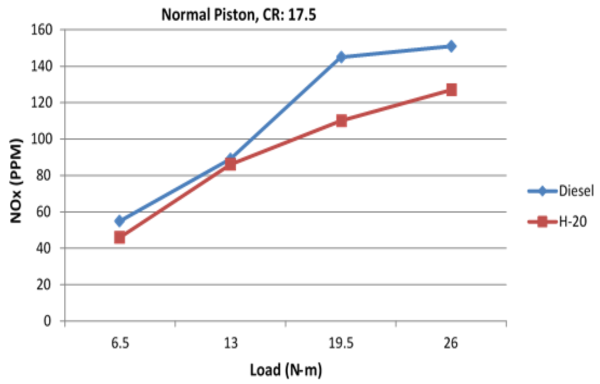

Fig 3. NOx emissions for Diesel and H20 fuels for modified piston

3.3 CARBON MONOXIDE EMISSION

Fig 3 shows the variation of CO with load for Normal piston for Diesel and H20 blend for CR=17.5.
In the figure it is observed that emission of CO is very high for H20 than diesel. Further it is observed that CO emissions increase for higher load of 26 N-m.

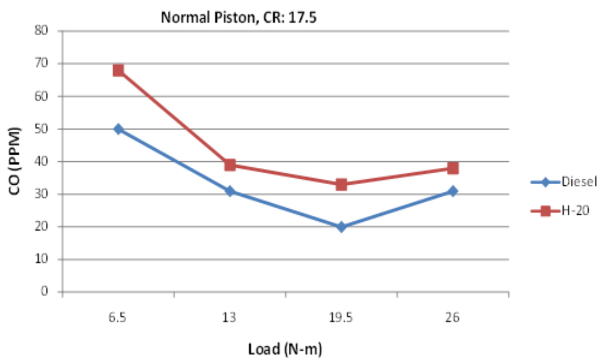

Fig.3 CO emissions for Diesel and H20 fuels for Normal piston

IV. Conclusions

In the present work the performance evaluation of single cylinder four stroke DI diesel engine using neat diesel and Mahua oil for different blends and compression ratios are carried out.

- Performance of the 20% Mahua oil -biodiesel blend was only marginally poorer at part loads compared to the neat diesel performance.
- At higher loads engine suffers from nearly 1 to 1.5% brake thermal efficiency loss for 20% and 30% blends.
- As the blend increases that is for 30% and 40% at full load engine suffers nearly 3 to 4.5% of the break thermal efficiency loss due the lower heating value of the biodiesel and incomplete combustion.
- The decrease in compression ratio the break thermal efficiency also decreased because of decrease in airflow leads to incomplete combustion.

REFERENCES

[1]. S.L.V. Prasad et al. / International Journal of Engineering Science and Technology (IJEST) Experimental study of the effect of air swirl in cylinder on diesel engine performance

[2]. Wu Zhijun, Huang Zhen In-cylinder swirl formation process in a four-valve diesel engine Experiments in Fluids 31 (2001) 467 – 473 Springer-Verlag 2001

[3]. K. Suresh Kumar and R. Velra "Performance and Characteristics Study of the Use of Environment Friendly Pongamia Pinnata Methyl Ester in C. I. Engines" Journal of Energy & Environment, Vol. 5, May 2007

[4]. Zhang Y, Dube MA, McLean DD, Kates M. Biodiesel production from waste cooking oil 2. Economic assessment and sensitivity analysis. Bio resource Technology 2003; 90:229–40.

[5]. Kusdiana D, Saka S. Kinetics of trans esterification in rapeseed oil to biodiesel

a. Fuels as treated in supercritical methanol. Fuel 2001; 80:693–8.

[6]. Xueliang H; ShuSong L, (1990); "Combustion in an internal combustion engine". Mechanical Industry Press, Peking Shaoxi S; Wanhua S (1990) "Some new advances in engine combustion research". Trans CSICE 8: 95-104

[7]. B. Murali Krishna and J. M. Mallikarjuna "Tumble Flow Analysis in an Unfired Engine Using Particle Image Velocimetry" World Academy of Science, Engineering and Technology 54 2009.

[8]. Z.H.Huang, H.W.Wang, H.Y.Chen, L.B.Zhou & D.M.Jiang Study of combustion characteristics of a compression ignition engine fuelled with dimethyl ether, , Xi'an Jiao tong University Institute of Internal Combustion Engines, School of Energy and Power Engineering Xi'an, People's Republic of China v.

[9]. M. Pugazhvadivu and S. Rajagopan Dept. of Mechanical Engineering, Investigations on a diesel engine fuelled with biodiesel blends and diethyl ether as an additive Dept. of Chemistry, Pondicherry Engineering College, Pondicherry, India-605 014 ,Vol. 2 No 5 (May 2009) ISSN: 0974- 6846.

[10]. Yi Ren, Zuohua Huang , Deming Jiang, Liangxin Liu, KeZeng, Bing Liu, Xibin Wang, Combustion characteristics of a compression-ignition engine fuelled with diesel di-methoxy methane blends under various fuel injection advance angles, State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, People's Republic of China.

[11]. Lu "Xingcai", Hou Yuchun, Zu Linlin, Huang Zhen Experimental study on the auto-ignition and combustion characteristics in the homogeneous charge compression ignition (HCCI) combustion operation with ethanol/n-heptanes blend fuels by port injection School of Mechanic and Power Engineering, Shanghai Jiaotong University, Shanghai, People's Republic of China. Received 2 August 2005; received in revised form 23 April 2006.

[12]. Kidoguchiyoshiyuki (Univ. Of Tokushima) Miwakei (Univ. Of Tokushima) yang c (zexel corp., jpn) Katoryoji (Isuzu Motor Ltd.) "Effect of High Squish Combustion Chamber on Smoke and NO_x Emissions of a Direct-Injection Diesel Engine" ISSN: VOL. 2000; NO.Vol. 4; PAGE 335-336 (2000).

[13]. John B. Heywood "Internal combustion Engine fundamentals". McGraw-Hill International Edition, Automotive technology series.

[14]. F. Halek, A. Kavousi, and M. Banifatemi, "Biodiesel as an alternative fuel for Diesel Engines," World Academy of Science, Engineering and Technology,

[15]. Mr. Paresh, K. Kasundra, Prof. Ashish, V. Gohil, "Performance Test of CI Engine with Different Vegetable Oil as a Fuel" International Journal of Engineering Trends and Technology- Volume 2, Issue 3 – 2011

[16]. K. Suresh Kumar and R. Velra "Performance and Characteristics Study of the Use of Environment Friendly Pongamia Pinnata Methyl Ester in C. I. Engines" Journal of Energy & Environment, Vol. 5, May 2007

Biographies and Photographs

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