EXPERIMENTAL ANALYSIS OF MAHUA OIL BLEND – AN SUSTAINABLE ENERGY

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ABSTRACT

In recent years due to depletion of fossil fuels, high oil prices and emission problems with conventional fuels such as gasoline and diesel ,there has arisen a need for alternate fuels. Biodiesel is an important alternate fuel and that has been used here. Source of biodiesel is mahua oil and its blended with diesel and experimental analysis is carried out.Performance characteristics of biodiesel are compared with that of diesel to validate the program developed for the performance characteristics of biodiesel fuelled engine.

INTRODUCTION

Due to shortage of petroleum, diesel fuel and its increasing cost an alternate source of fuel for diesel is very much needed. It has been found that vegetable oils hold special promise in this regard, since they can be produced from the plants grown in rural areas. Biodiesel can be used directly in compression ignition engines with no substantial modifications in the engine. Biodiesel contains no sulphur and therefore this is the important point in terms of future European regulations. A single cylinder, 4 stroke, direct injection diesel engine has been used to measure the general performance of biodiesel and traditional Diesel. The increased lubricate nature of biodiesel is a benefit to fuel pumps and overall engine wear. The uncertainty lies with the formation of hard deposits that may form on fuel injector tips and piston rings. This phenomenon has been noted in several studies, and is highly dependent on the engine, biodiesel feedstock, and production method. Biodiesel used here is mahua oil, which is edible oil. Performance test has been conducted on it .Simulation has also been done and the experimental results has been evaluated, compared and validated.

STUDY ABOUT FUEL PROPERTIES

Madhuca longifolia, commonly known as mahua, is an Indian tropical tree found largely in the central and north Indian plains and forests. 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 Jharkhand, Uttar Pradesh, Bihar, Madhya Pradesh, Kerala, Gujarat and Orissa.

USES

It is cultivated in warm and humid regions for its oleaginous seeds, its flowers and its wood; producing between 20 and 200 kg of seeds annually per tree, depending on maturity. This oil (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 a fuel oil. The product is often used in sweets and chocolates under the name "illipe". The seed cakes obtained after extraction of oil constitute very good fertilizer. The flowers are used to produce an alcoholic drink in tropical India. 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.

PROPERTIES OF VEGETABLE OIL BEFORE TRANSESTERIFICATION COMPARED WITH DIESEL FUEL

Properties	Diesel	Mahua oil
Density at 15^0C, kg/m^3	840	917
Cetane number	50	45
Kinematic viscosity at 40^0C, mm^2/s	2.6	34
Surface tension at 20^0C, N/m	0.023	0.037
Lower calorific value, MJ/kg	43	38
Specific heat capacity J/kg ^{0}C	1850	2040
10% Distillation point, ^{0}C	220	380

90% Distillation point, ^{0}C	300	420
Oxygen , % weight	0	10
Latent heat of evaporation, kJ/kg	250	200
Bulk modulus of elasticity, bar	16,000	19150
Stoichiometric air to fuel ratio	15.0	13.5
Molecular weight	170	810

PROPERTIES OF VEGETABLE OIL AFTER TRANSESTERIFICATION COMPARED WITH DIESEL FUEL

Properties	**Diesel**	**Mahua oil ester**
Density at 15^{0}C,kg/m^3	840	860
Cetane number	50	53
Kinematic viscosity at 40^{0}C, mm^2/s	2.6	3.1
Surface tension at 20^{0}C, N/m	0.023	0.025
Higher calorific value, MJ/kg	43	40.0
Specific heat capacity J/kg0C	1850	19360
10% Distillation point, 0C	220	241
90% Distillation point, 0C	300	320
Oxygen , % weight	0	10
Latent heat of evaporation,kJ/kg	250	240
Bulk modulus of elasticity, bar	16,000	16840
Stoichiometric air to fuel ratio	15.0	13.5
Molecular weight	170	200

EXPERIMENTAL SETUP

The present work is carried out to study the performance characteristics of a small direct injection (DI) type compression ignition engine using the mahua oil. An eddy current

dynamometer is connected with this engine to determine the engine performance with varying engine speed.

EXPERIMENTAL SETUP OVERVIEW

The engine is fully equipped with measurements of all operating parameters. The arrangement requires the following systems and apparatus for carrying out the desired experiment.

(1) Diesel engine

(2) Eddy current dynamometer

The test rig used for the present study has been developed in the dynamometer laboratory of the Madras Institute of Technology, Chennai. The test engine and eddy current dynamometer are mounted on channels which are embedded on concrete foundation.

SPECIFICATIONS OF THE APPARATUSES

In the test rig there are several instruments/equipments have been used for the purpose of the experiment. Brief Specification, the calibration procedure and working principle of all the instruments used for conducting the experiment are given below.

DIESEL ENGINE

The engine used in test rig is a Kirloskar Model SV1, single cylinder, four stroke, water-cooled, direct injection type, diesel engine.To reduce the temperature of the cylinders and the lubricant, the cooling system of the engine is connected to a cooling-water tower by means of a cooling-water pipe line. The specifications of the engine are listed.

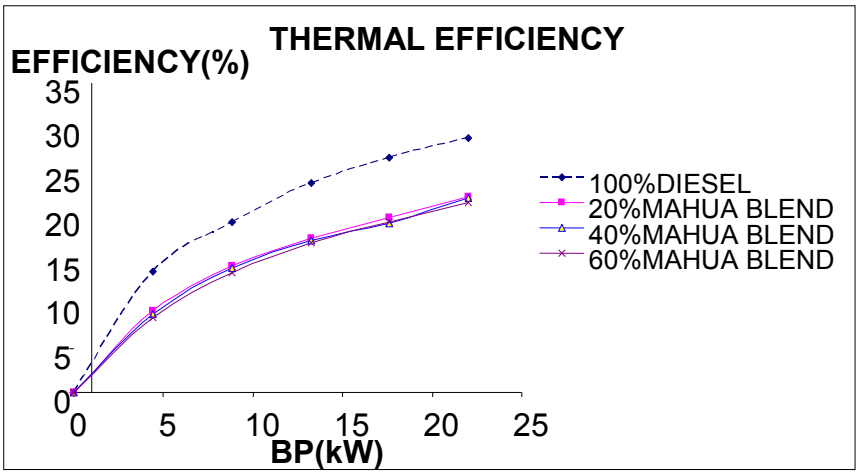
ENGINE SPECIFICATION

- Engine used : Single Cylinder , Kirloskar Engine
- Bore : 82 mm
- Stroke : 110 mm
- Cooling : Water Cooling
- Rated Speed : 1800 rpm
- POWER : 8 BHP
- SFC : 245 g/ kw.hr
- Compression Ratio : 16.5 : 1

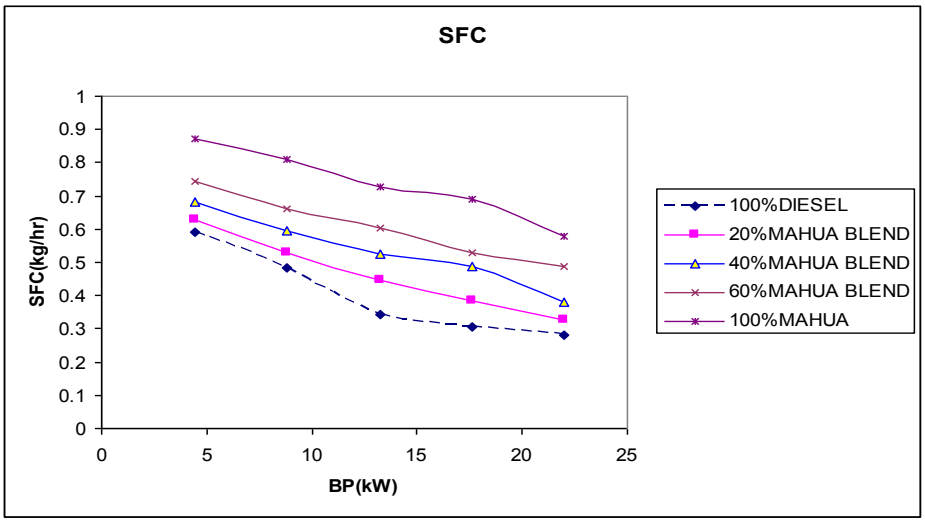
- Lubrication Oil : HD type 3 as per IS:496-1982
- Rating at 1500 rpm : 3.7 Kw.

RESULT OF ENGINE PERFORMANCE TEST

PERFORMANCE CHARACTERIRSTICS GRAPHS:

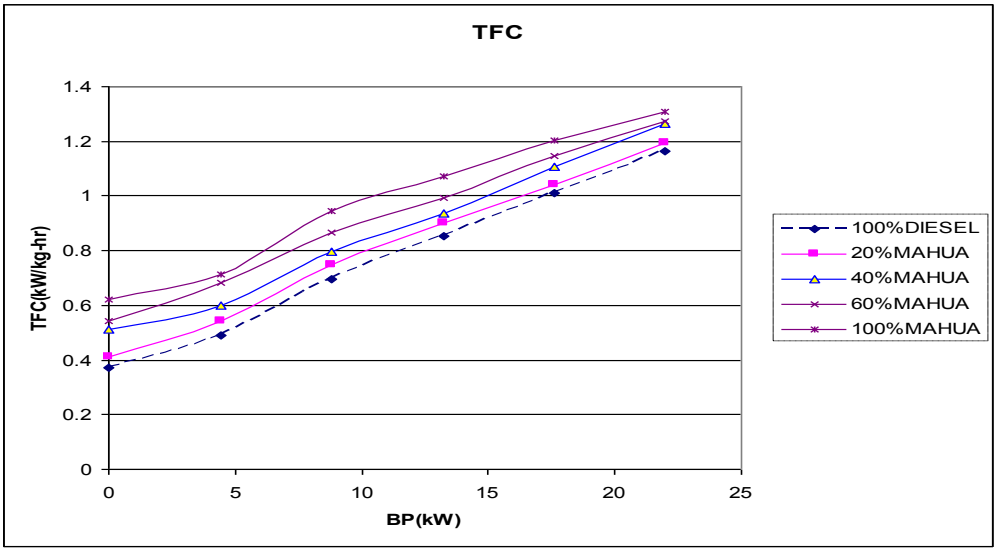


It is noted from the graph, as the brake power increases, combustion efficiency increases. The delay period decrease with increasing load because the operating temperature of the engine increases, leading to better combustion.



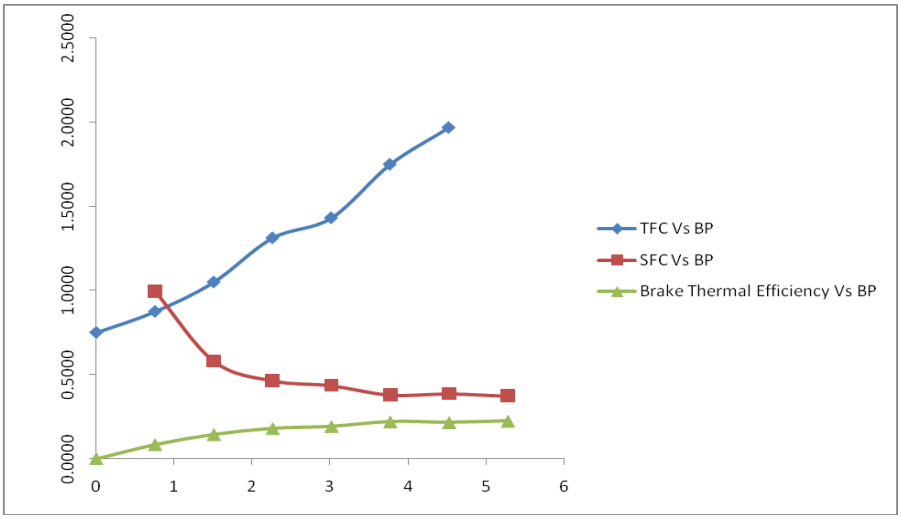
It can be noted from the graph, the SFC decreases with an increase in brake power. It is also absorbed from the graph that SFC for diesel is the least of all other Esterified mahua

oil blends. It is because the lower calorific value will lead to increase in specific fuel consumption.



It can be observed from the graph, as the brake power increases the TFC is increasing. But diesel has the least of all the other biodiesel blend when compared.

PERFORMANCE GRAPH OF DIESEL FUEL:



CONCLUSION

Based on the results of this experiment, the following conclusions drawn:

1. After Esterification of mahua oil, the kinematic viscosity of oil reduced to 3.1 from 34 mm^2 /s. however the calorific value of mahua oil is increased to 40 from 38 MJ/kg.
2. Biodiesel blend B20 and B40 produced on an average of about same torque and power output while running the diesel engine under same conditions.
3. Blends of mahua oil up to 40% by volume have good performance characteristics.
4. Drop in brake thermal efficiency for mahua oil blend as compared with that of diesel. If necessary engine modifications are made then this can be rectified.

The experimental analysis was conducted on kirloskar diesel engine using various blends of mahua oil to determine their performance characteristics. Theoretical simulation was conducted and the performance characteristics so determined were compared with the experimental results and validated.

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