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Experimental Study of Mahua Oil-An Alternative for Diesel

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Abstract— With ever growing Stress on environmental pollution and future oil supplies, the global community is Abstract: In this work Mahua Oil was used as an alternative fuel for diesel engine. The properties of Mahua Oil were determined. The performance and emissions of a single cylinder, stationary diesel engine was evaluated using mahua oil and compared with standard diesel operation. In this paper, Mahua seed oil was transesterified with methanol using acid and alkaline catalyst process to obtain Mahua Methyl Ester. The physical properties of MME were tested. The performance and emission characteristics of various blends of Mahua oil is tested under different loads of an engine and it is concluded that Mahua Oil can be used as an alternative fuel.

Keywords: Diesel, Engine, Emission, Mahua Oil, Performance, Transesterification

I. INTRODUCTION

Biodiesel is a hot topic internationally as well as in India. Since the beginning of the 2000s, the Government of India and, to a greater extent, various state governments have promoted the production and consumption of biodiesel. Proponents of biodiesel point to the potential of oilseeds as a substitute for fossil fuels, underlining their ability to reduce India's energy dependency and bring down greenhouse gas emissions. At the same time, it may satisfy a significant part of the country's fuel demand, increasing India's energy security and saving foreign exchange. Shifting to biodiesel could also reduce greenhouse gas emissions and urban air pollution. And finally, as oil-bearing trees can be grown in semiarid regions, there is a potential to rehabilitate degraded lands, which are abundant in India

At the same time, biodiesel production has recently come under heavy criticism for two reasons. First, critics claim that fertile agricultural lands will be diverted to cultivation of fuel crops at the expense of food production. Food scarcity and rising prices would especially hit the poor. Second, it has been shown that biodiesel production in some countries in fact increase greenhouse gas emissions, because forests are cleared for their cultivation and high energy inputs are used to produce some of the fuel crops. Hence important debates about the development impacts of biodiesel remain unsettled, and the specific trade-offs in the case of India need to be explored. Mahua oil is obtained from the seeds of madhuca indica, a deciduous tree which can grow in semi-arid, tropical and sub-tropical areas. It grows even on rocky, sandy, dry shallow soils and tolerates water logging conditions. Mahua oil was procured from an oil mill. The oil was filtered to remove the impurities. Diesel fuel was used as baseline fuel. The properties of mahua oil used in the present investigation are presented in Table 1. The viscosity was determined at different temperatures using redwood viscometer to find the effect of temperature on the viscosity of mahua oil. The viscosity of mahua oil was found to be 9 times higher than that of diesel fuel. The Various Equipments used to measure/compare the properties of Diesel and Mahua Oil are

1) Viscometer

2) Flash and Fire Point Apparatus

3) Calorimeter

4) Carbon Residue Test

Table 1: Comparison of Diesel and Mahua Oil Properties

Property	Diesel	Mahua Oil (After transesterification)
Kinematic viscosity@ 40°C (cSt)	4.10	38.00
Density @ 30°C(kg/m3)	838	915
Net Calorific Value (KJ/kg)	42800	37000
Flash point (°C)	47	58
Flash point (°C)	50	65
Carbon residue(%)	0.3	0.45

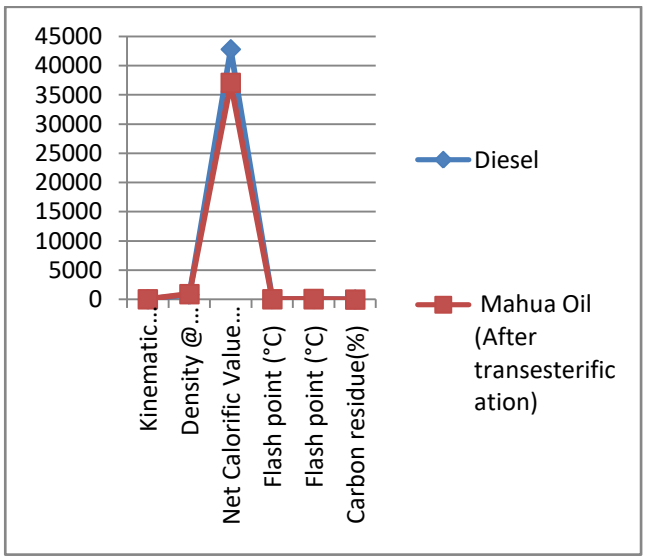

Fig 1.1: Properties comparison b/w Diesel and Mahua Oil

II. EXPERIMENTATION

1. Transesterification Process:

Transesterification process involves vegetable or animal fats and oils being reacted with short chain alcohols (methanol or ethanol). Methanol is used to get greater conversion of bio fuel. Transesterification can be classified as reaction with either with acid or base as a catalyst.

Free fatty acid (FFA) value of oil plays key role in the transesterification process. If free fatty acid content of the oil is lower than 3%, single stage process (alkali transesterification) is will be carried out. If it is greater than 3%, double stage process (acid esterification and alkali transesterification) will be carried out

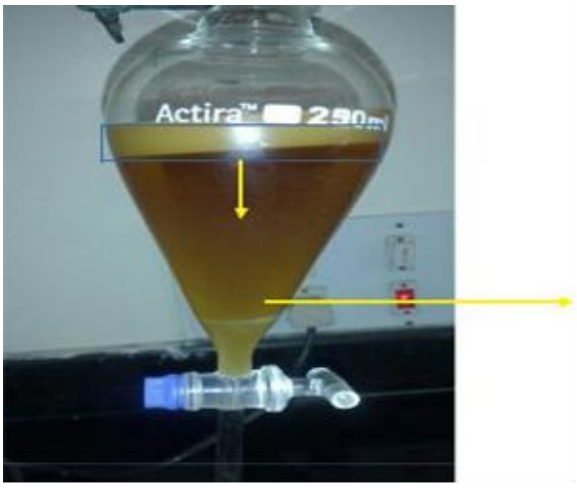

Fig 2.1: Transesterification Process

2. Identifying Various Properties of Mahua Oil:

i) Flash and Fire Point:

Flash and fire point of Diesel and Mahua oil is identified by Flash and fire point apparatus (Pensky Marten) where as Mahua Oil shows slightly greater value than Diesel

Fig 2.1: Pensky Marten Apparatus

ii) Viscosity:

One of the important property of fuels is Viscosity. In this work Saybolt viscometer is used to determine the viscosities of Diesel and Mahua Oil.

Fig 2.2: Saybolt Viscometer Apparatus

iii) Calorific Value:

CV of Mahua oil is not upto Diesel. CV of diesel is superior than Mahua as it is determined with a Digital Bomb Calorimeter.

Fig 2.3: Digital Bomb Calorimeter

3. Engine Setup:

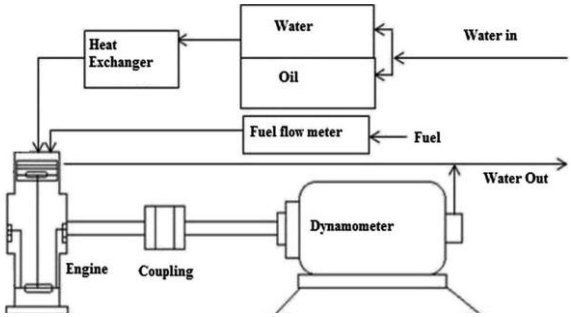

Fig 2.4: Engine Test Rig

The single cylinder diesel engine which is coupled with a dynamometer is as shown in fig. The performance and emissions are calculated for varying loads

Table: 2 : Engine Specification

MODEL	GL-400
Bore(mm)	86
Stroke(mm)	63
Displacement(cm^3)	395
Compression ratio	18:1
Oil sump capacity(lit)	1.2
Dry weight (kg)	45
Maximum torque(nm)	1.7
RPM	3600

III. RESULTS AND DISCUSSION

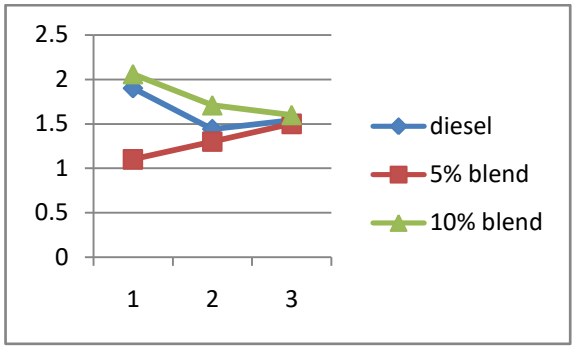

Fig. 3.1 Brake specific fuel consumption vs Load

As the load increases 5% Blend increases wrt BSFC, Where as diesel & 10% Blend gradually decreases

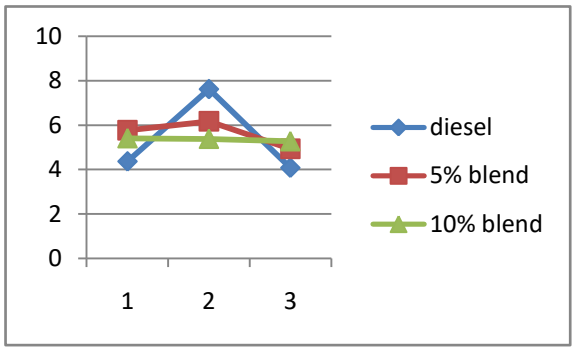

Fig. 3.2 Brake thermal efficiency vs Load

As the load increases, 10% Blend doesn't have much variation wrt brake thermal efficiency,Where as diesel & 5% Blend gradually varies

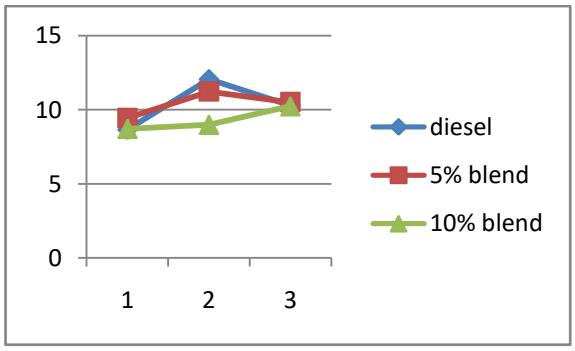

Fig. 3.3 Indicated thermal efficiency vs Load

Diesel, 5% and 10% blend all indicated thermal efficiency varies wrt load.

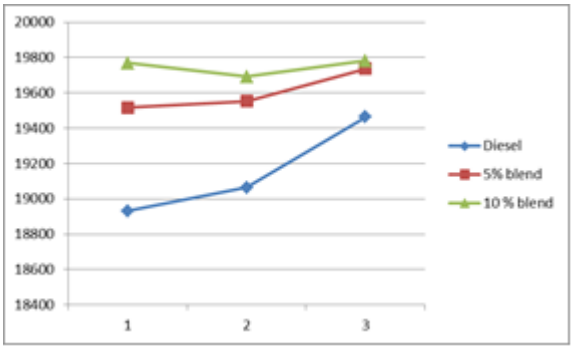

Fig. 3.3 HC Emissions vs Load

Diesel, 5% and 10% blend all HC Emissions varies wrt load, diesel being the least.

IV. CONCLUSION

Even after the transesterification the properties of diesel and Mahua Oil is not the same and even the performance test and emission results also varies. Finally it can be concluded that Mahua oil blend with diesel can be used as an alternative for diesel.

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