Analysis of Performance Characteristics of Various Alternate Fuels (Bio- Diesel) and its Blends in a 4 Stroke Diesel Engine

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Abstract— Bio Diesel is a renewable fuel derived from biological sources such as waste cooking oils, animal fat, virgin oils, etc. Bio diesel is a replacement fuel for conventional diesel with the advantages of reducing exhaust emissions of carbon monoxide and hydrocarbons. This paper discuss about the production of Bio Diesel from waste cooking coconut oil and waste cooking palm oil. Single step Transesterification process is followed for producing the Bio Diesel from both the oils.Two set of samples with Molar ratios 7:1 and 8:1 are prepared from both coconut oil and palm oil at 45^{o}C reaction temperature and 2 hours reaction time in the presence of KOH catalyst. Various blends (BD25, BD20, BD15, and BD10) are prepared and the comparison of different properties of the blends is discussed in this paper. Load test on a single cylinder diesel engine is carried out and a comparison of the performance of engine with the various blends is also studied in this work. A study on emission characteristics of the different blends to the conventional diesel is also carried out.

Index Terms — *Biodiesel; Waste cooking oil; Transesterification;Calorific Value; Indicated Thermal Efficiency; Brake Thermal Efficiency; Mechanical Efficiency*

1 INTRODUCTION

Alternative and renewable sources of energy have become more attractive in recent years due to many reasons like depletion of world petroleum reserves, increasing energy demand and increasing environmental concerns due to rising green house gas emissions. Owing to the increasing price of crude oil and environmental concerns, bio diesel fuel which chemically constitutes methyl esters of long chain fatty acids has attracted considerable attention over recent decades. Biodiesel is a non- petroleum based fuel that consists of fatty acid alkyl esters derived from either the transesterification of triglycerides or the esterification of free fatty acids with low molecular weight alcohols.

A biodiesel source does not contain significant amounts of nitrogen and sulpher compounds. Compared to petroleum diesel, biodiesel production price is high particularly for virgin oil which is one of the major hurdles to commercialize it. The production cost can be significantly reduced by using low cost feed stock such as waste cooking oil or animal fat.

In this present study low cost feedstock waste cooking coconut oil and waste cooking palm oil were used to produce biodiesel using single step transesterification process in the presence of Potassium Hydroxide (KOH) as the base catalyst. The process parameters such as catalyst loading, feed molar ratio, temperature of the transesterification reaction, reaction time were studied. The transesterified oil was characterized using different techniques to check the quality of produced biodiesel as per the ASTM standards.

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2 METHODOLOGY OF BIO-DIESEL PREPARATION

The aim and objective of the present work is to produce biodiesel using waste cooking coconut and palm oil and compare the properties, performance and emission analysis with the conventional diesel.

2.1 Methods Used for Sample Preparation

Steps Bio-Diesel Production

- Titration
- Esterification
- Transesterification
- Washing/ Cleaning and Drying

Types of Samples Prepared

Types	Waste Oil Used	Molar Ratio
1	Coconut oil	8:1
2	Coconut oil	7:1
3	Palm Oil	8:1
4	Palm Oil	7:1

Table1: Samples of Waste Oil

2.2 Characteristics of Bio-Diesel

Properties	Apparatus used
Viscosity	Redwood viscometer
Calorific Value	Bomb Calorimeter
Mechanical and Thermal efficiencies	4- Stroke Diesel Engine Test Rig
Emission Properties	Exhaust Gas Analyser

Table 2: Properties and Apparatus used

3 Results and Discussions

The results of the different tests conducted to investigate the comparison of properties, performance charateristics and emission on a 4 stroke diesel engine with petroleum diesel and biodiesel as fuel as per the ASTM standards. The results obtained are discussed. below.

3.1 Viscosity Investigation

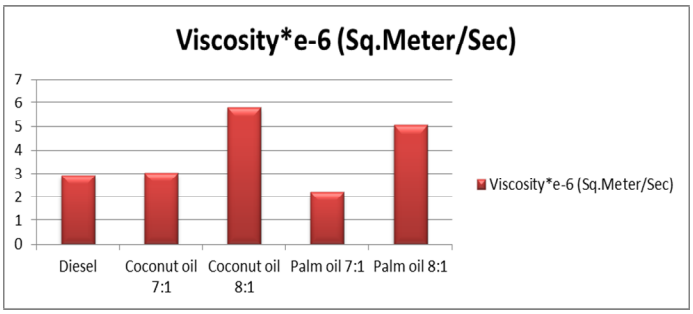

Table 3: Viscosity comparison

It is clearly seen that the viscosity of diesel (2.92x 10^{-6}) lies in between the viscosities of coconut oil blend 7:1 and Palm oil blend 7:1. The viscosity of biodiesel made from waste cooking coconut oil is higher than that of palm oil in all blends.

3.2 Calorific Value Investigation

It is clearly seen that the calorific value of diesel (45498.6 KJ /Kg) is higher than any other blends of biodiesel. The calorific value of biodiesel made from waste cooking coconut oil is higher than that of palm oil in all blends.

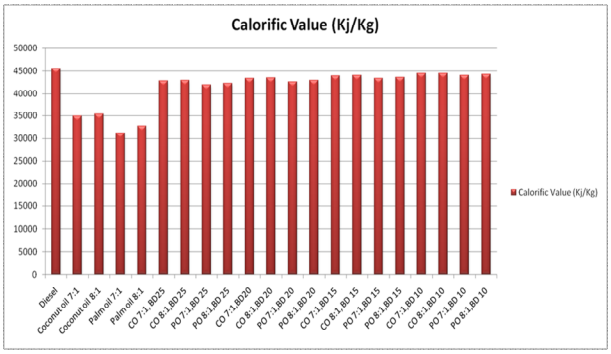

Table 3.1: Comparison of Calorific Values

3.3 Mechanical and Thermal Efiiciencies

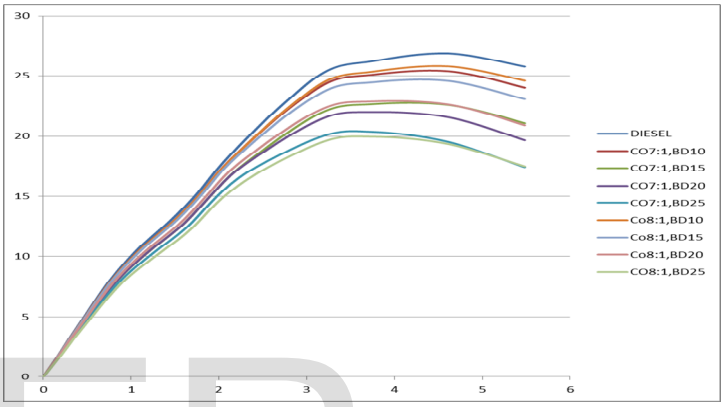

Fig3.1 Comparison of Brake Thermal Efficiencies of diesel and biodiesel prepared from waste cooking coconut oil in different molar ratios

It is clearly seen from the above graph that the brake thermal efficiency of diesel is higher than any other bio diesel blends prepared from waste cooking coconut oil in the molar ratio 7:1 & 8:1. This is may be due to the higher calorific value of diesel compared to the different blends. It is also seen that the brake thermal efficiency is slightly higher for the molar ratio 8:1 than 7:1.

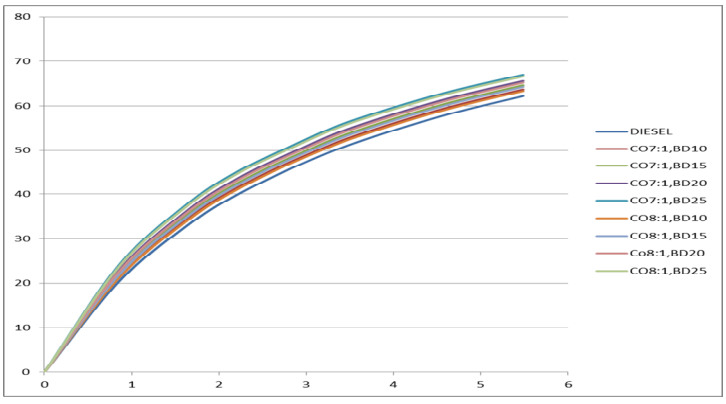

Fig3.2. Comparison of Mechanical efficiencies of diesel and biodiesel prepared from waste cooking coconut oil in different molar ratios

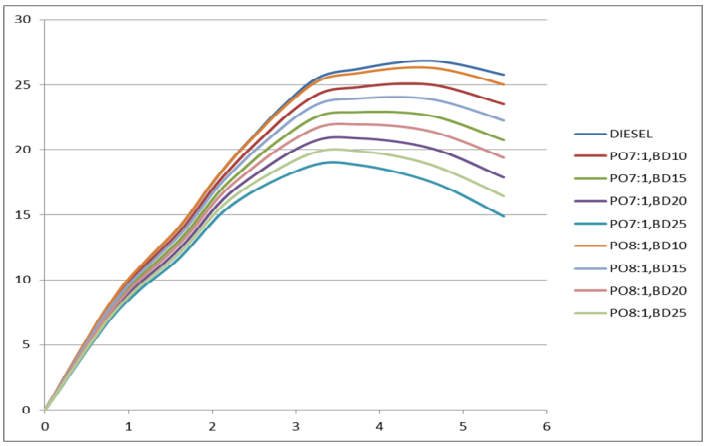

Fig 3.3 Comparison of Brake thermal efficiencies of diesel and biodiesel prepared from waste cooking Palm oil in different molar ratios.

It is clearly seen from the above graph that the brake thermal efficiency of diesel is higher than any other bio diesel blends prepared from waste cooking Palm oil in the molar ratio 7:1 & 8:1. This is may be due to the higher calorific value of diesel compared to the different blends. It is also seen that the brake thermal efficiency is slightly higher for the molar ratio 8:1 than 7:1.

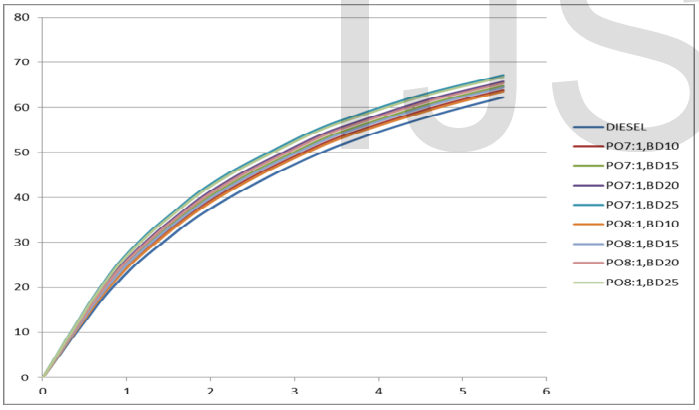

Fig 3.4 Comparison of Mechanical efficiencies of diesel and biodiesel prepared from waste cooking Palm oil in different molar ratios.

It is seen from the above graph that the mechanical efficiency of diesel is lower than any other bio diesel blends prepared from waste cooking palm oil in the molar ratio 7:1 & 8:1. This is may be due to the higher calorific value of diesel compared to the different blends. It is also seen that the indicated thermal efficiency is slightly higher for the molar ratio 7:1 than 8:1.

3.4 Exhaust Gas Analysis

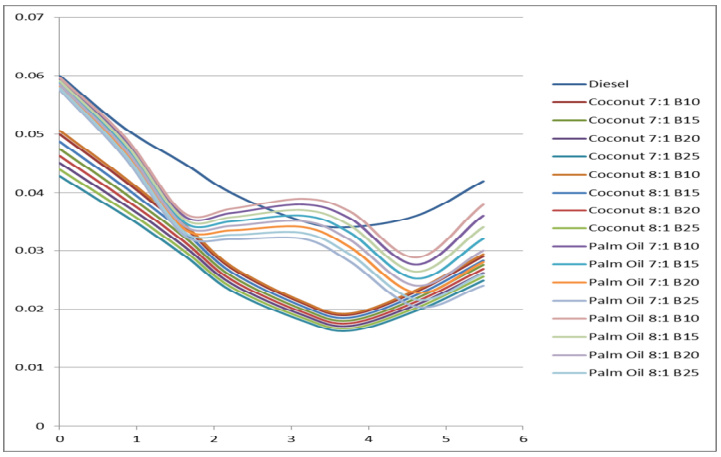

Fig 3.5. Comparison of Carbon Monoxide emission with diesel, coconut oil and palm oil

It is seen that the hydrocarbon emission is less in all blends compared to that of the diesel. It is also seen that the hydrocarbon emission is low for the biodiesel prepared from coconut oil compared to palm oil.

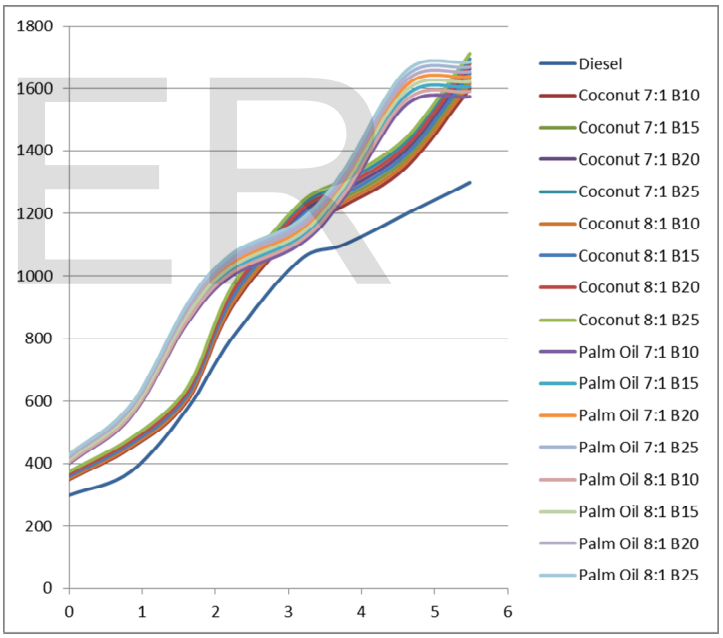

Fig 3.6. Comparison of NOx with diesel, coconut oil and palm oil

It is seen that the Nitrogen oxide emission is less in diesel compared to all blends. It is also seen that the hydrocarbon emission is low for the biodiesel prepared from palm oil compared to coconut oil.

CONCLUSION

The mechanical efficiency of bio diesel prepared from waste cooking oil higher than that of the petroleum diesel, therefore the above said bio diesel can be used as an alter-

native for the petroleum diesel. As far as the emission is concerned, bio diesel produces less carbon monoxide and hydrocarbon emission than the petroleum diesel. Therefore it can be used as an environmental free fuel for the future. In large scale production, the cost connected with the production of bio diesel from waste cooking oil will be less; therefore it can be used widely as a fuel in future.

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