A characterization of Waste Cooking Oil Biodiesel and its Blends in Single Cylinder Diesel Engine

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ABSTRACT

Conventional energy sources such as oil, coal and natural gas have limited reserves that are expected not to lose for an extended period. Biodiesel is receiving increasing attention each passing day because of its same diesel-like fuel properties and compatibility with petroleum-based diesel fueled engines. transeterification process is used to convert the vegetable oil , animal fatts oil into biodiesel.. wco oil and wco oil are considered for the study, After transesterification different properties are improved and that helps in improving the engine performance and emission performace of both oil physical and chemical properties such as calorific value, fire point, flash point, kinematic viscocity ,density are improved.The comparision of engine performance characteristics such as brake thermal efficiency,fuel consumption, exhust gas temperature etc and of emission characteristics such as carbon monoxide, hydrocarbon, nitrogen oxide on diesel engine for both wco oil are studied.the best blend can be used in future as good alternative fuel.

Keyword- *Fatty Acid Methyl Ester, Free Fatty Acid, Waste Cooking Oil, Waste Vegetable Oil, Waste Frying oil. Etc*

1. INTRODUCTION

21st century has been facing many problems like energy sustainability, environmental problems and rising fuel prices. Conventional fuels are known for polluting air by emissions of sulphur dioxides, carbon dioxides, particulate matter and other gases. This has resulted to increased research in alternate fuels and renewable source of energy. Moreover, energy consumption of the world is ever increasing, this has caused the fuel resources dwindle. The transport sector worldwide has considerably increased the fuel consumption reaching 61.5% of the total, especially in the last decade. Recent research expects that the amount of petrol in the world can be used merely for next 46 years. Hence, interest in research for an effective substitute for petroleum diesel is increasing. Currently, India produces only 30% of the total petroleum fuels required for its consumption and the remaining 70% is imported, which costs about Rs 80,0000 million per year. It is evident that mixing of 5% of biodiesel fuel to the present diesel fuel can save Rs.40, 000 million per year. Over last few years, Biodiesel (fatty acid methyl esters) has become the part of the equation in the 1990’s as the effects of global warming began to get political acknowledgement, because of its benefits over petroleum diesel like significant reduction in greenhouse gas emissions, non-sulfur emissions and non-particulate matter pollutants, low toxicity, biodegradable and is obtained from renewable source like vegetable oils, animal fat etc. Biodiesel is superior to fossil diesel fuel in terms of exhaust emissions, cetane number , flash point and lubricity characteristics, without any significant difference in heat of combustion of these fuels. Moreover, biodiesel returns about 90% more energy than the energy that is utilized to produce it.

2. Problem Statement

The problem was to determine the extent to which the sodium methoxide (NaOCH3) as the catalyst and the effect of batch transesterification process on various parameters where WCO and palm oil are used as a raw material in production of biodiesel. In today’s world, alternative fuels are needed more than ever. Conventional fuels, such as coal, natural gas, and fossil fuel, are constantly being depleted; however, the world’s dependency on these fuels is still growing. Additionally, the price on foreign fuels is ever increasing. For these reasons, the US and the world are pursuing alternative fuel sources to lessen the dependency on conventional fuels. One alternative fuel is biodiesel; biodiesel can be produced from vegetable oil or animal fat and thus can be used to alleviate the foreign fuel dependency. In order for biodiesel to be a viable alternative fuel source, an industrial-scale biodiesel production process needs to be improved. Compared to current designs and fossil fuel, the process must be cost competitive

3. Objectives

1. To get an better alternative source of fuel.
2. To conserve nonrenewable natural resources.
3. To obtain less pollutant biodiesel to reduce the emission of toxic gases.
4. To control the global warming and green house effects.
5. To increase the engine performance using bio-fuels.

4. Scope

In comparison with individual biodiesel, the performance of hybrid biodiesel that is mixture of all oils was better. But in its performance was found slightly poor than diesel fuel at higher loads while its gives optimum outputs. The performance was comparatively lower due to the higher viscosities and masses of biodiesels as well as its respective blends. The further research work was planned to reduce these physical parameters with the help of chemical additives such as n-butane and ethanol. They can be blended with biodiesel and diesel fuel in some extent. To study the effect of catalyst concentration on yield and purity of biodiesel using batch transesterification . To study the combustion characteristic of biodiesel from both RBD palm oil and WCO using batch transesterification process and analyze the product using Gas Chromatography. In this project we conduct, we used the concentration of 0.25 to 1.5wt%. While the temperature range used is fixed at 40°C and the time that be conducted is between 20 to 50 minutes.

5. Organization of dissertation

Chapter 1: This chapter deals with introduction of alternative fuels for internal combustion engine, non-edible oil resources in India and non-edible oils with their potential in India, Bio diesel sector in India, Supply chain of bio diesel and Government Policies also this chapter includes statement of problem, objective and justification of the study.
Chapter 2: This chapter deals with the review of literature, which includes. Brief description of research works on bio diesels with reference to properties and its performance.
Chapter 3: This chapter explains the fuels preparation like transesterification process for biodiesel preparation and blending methodology of the biodiesel. At final properties determination of different blended fuels used for the present work.
Chapter 4: This chapter deals with experimental setup for the operation of blended biodiesel fuels as well as specifications of different apparatus used for determination of performance and emission characteristics of engine.
Chapter 5: This chapter deals with the Results and discussions for the engine operation with different fuels and techniques used.
Chapter 6: Finally the conclusions have been mentioned for different fuels and techniques for engine operation. References also mentioned at last.

6. **Simulation of WCO**

Rudolf Diesel invented the diesel engine in the 1890s. From the beginning, this engine could1 run on a variety of fuels, including vegetable oil. In 1900, one of the new diesel engines featured at the Paris Exposition was powered by peanut oil. However, because cheap petroleum fuels were easily available, few people were interested in alternatives (Pal, 2005, pp. 18-22). As early as the 1930s, there was interest in splitting the fatty acids from the glycerine in vegetable oil in order to create a thinner product similar to petroleum diesel. In 1937, G. Chavannes was granted a Belgian patent for an ethyl ester of palm oil (which today we would call biodiesel). In 1938, a passenger bus fuelled with palm oil ethyl ester plied the route between Brussels and Louvain (Knot he, 2005, p. 10). During World War II (1939 to 1945), when petroleum fuel supplies were interrupted, vegetable oil was used as fuel by several countries, including Brazil, Argentina, China, India, and Japan. However, when the war ended and petroleum supplies were again cheap and plentiful, vegetable oil fuel was forgotten.

6.1 Trans esterification Process

Trans esterification is a chemical reaction used for the conversion of vegetable oil to biodiesel. In this process vegetable oil is chemically reacted with an alcohol like methanol or ethanol in presence of a catalyst like lye. After the chemical reaction, various components of vegetable oil break down to form new compounds. The triglycerides are converted into alkyl esters, which is the chemical name of biodiesel. If methanol is used in the chemical reaction, methyl esters are formed, but if ethanol is used, then ethyl esters are formed. Both these compounds are biodiesel fuels with different chemical combinations

Blend type	Composition of WVO biodiesel (in vol.)	Composition of Diesel fuel (in vol.)
B00	0%	100%
B6	6%	94%
B12	12%	88%

6.2 Procedure for Taking reading on Engine

1. To set load on computer engine software like 0, 8, 15
2. Set the compression ratio like 16, 17, & 18
3. Then set the load on engine first taking load 0.
4. Similarly setting the load 8, and 15.
5. Taking reading for compression ratio16. Like CR16B0L0 and CR16B6L0 Similarly for compression ratio 18 like CR18B0L0, CR18B6L4.
6. After the taking a reading generating the graph in engine software to Microsoft office in word file.

7. Observations and Calculations

7.1 Sample calculation

Given,

a. Speed, N=800rpm
b. Brake drum radius, R = 0.18
c. Load = 18Kg
d. Density of fuel = 0.840 Kg/m^3

1. Brake power

$$BP = \frac{2\pi NT}{60} = \frac{2\pi NWR}{60} \text{ KW}$$

$$= \frac{2*\pi*9.81*18*0.18}{60} \text{ KW}$$

=2.6627 KW.

2. Brake specific Fuel consumption

$$\text{Fuel consumption} = \frac{\text{Fuel consumption}}{\textit{Brake power}} \text{ Kg/sec}$$

$$= \frac{1.4*10^{\wedge}-4}{2.6627}$$

= $5.257*10^{-5}$ Kg/KWs

3. Brake thermal efficiency = $\frac{BP}{HS}$

$= \frac{1.4138}{4.9010} = 28.84\ \%$

4. Indicated power = FP + BP

= 6.4 + 1.4138

= 7.7148 KW

5. Mechanical Efficiency = $\frac{FP}{IP}$

$= \frac{1.4138}{7.7148}$

= 18.32%

7.2 Observation Table

- **Brake Thermal Efficiency VS load**

Load	B0	B6	B12	B18	B24	B30	B36
0	0.29	-0.26	-0.31	0.036	0.37	13.94	0
8	21.8	22.88	22.99	21.5	21.63	20.32	21.74
15	21.06	20.96	20.96	20.75	19.23	19.44	20.18

- **Brake Power**

LOAD	B0%	B6%	B12%	B18%	B24%	B30%	B36%
0	0.01	0.01	0.01	0.01	0.02	1.13	0.02
8	2.28	2.26	2.27	2.25	2.26	2.24	2.27
15	4.28	4.26	4.22	4.32	4.13	4.18	4.22

- **Mechanical Efficiency**

LOAD	B0%	B6%	B12%	B18%	B24%	B30%	B36%
0	0.64	0.49	0.72	0.78	0.78	28.18	0.81
8	48.06	48.81	49.34	47.33	46.95	45.8	46.89
15	65.67	64.83	65.74	65.74	60.38	63.03	62.84

8. Result and Discussion

8.1 Brake thermal efficiency (BTE)

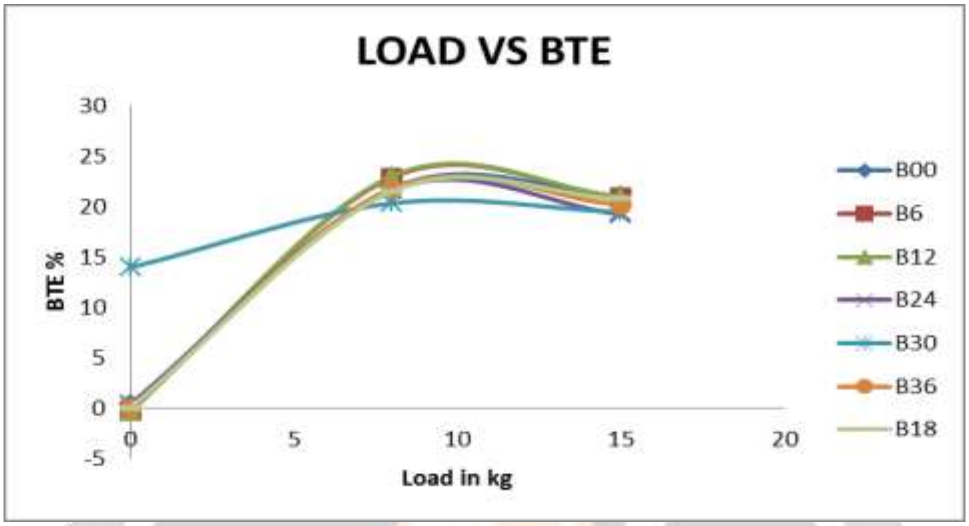

Fig 8.1 Brake Thermal Efficiency graph

BTE is the ratio of BP to fuel supplied that indicates the amount of fuel required to produce 1 kW of power. Figure 7.1 shows variation of loads with BTE. It is observed that in comparison with the diesel fuel, it is very close to diesel fuel. The lower BTE by biodiesel were due to its higher BP, ignition delay, reduction in friction loss and equivalent findings were reported in literature.

8.2 Brake Power (BP)

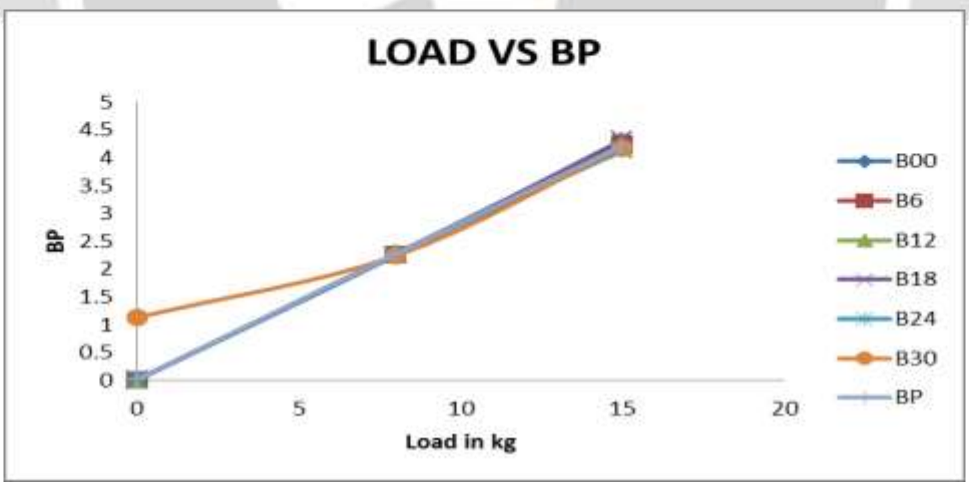

Fig 8.2 Brake Power graph

Figure 7.2 shows the variation of BP with respect to various loads for all fuel samples. It was noticed that BP of all biodiesel blends were very close to that of diesel fuel and it was improved with rise in load In comparison with diesel fuel the synthesized biodiesel was just 2.3 %, 1.29% less than diesel fuel. The results were supported by literature.

8.3 Mechanical Efficiency

Fig no 8.3 Mechanical efficiency graph

It is explained as the ratio of friction power to indicated power. The figure 7.3 shows the variation of loads with ME for all blend samples. It was observed that initially (at 0 kg load), ME were observed to be lower then after it was increased with loads. In comparison with diesel fuel b30% shows best ME. The higher density and viscosity of fuel may be the reason to increase VE of blended fuels as reported by researchers .

9. CONCLUSIONS

Biodiesel produced by trans esterification process from Waste vegetable oil has resulted good quality and in acceptable range as per ASTM D6751-9B international standards. The blended fuels shown its chemical properties very close to diesel fuel. Following conclusions were made on practical study of hybrid biodiesel. The density of biodiesel is slightly higher in the range of 0.832 to 0.854 for all blends, for B00 it is 0.830. The calorific value of all biodiesel blends is in the range of 41 - 42 MJ/Kg, whereas for B00 it is 42.5 MJ/Kg Brake Power of all the blended fuels get improved with CR. Pure diesel has given highest BP than pure biodiesel and its blends too.The Brake thermal efficiency of all blended fuels get increased due to its higher BP, ignition delay and friction losses. In comparison of other blends B30% has given optimum results for BTHE.

10. Future Scope:

In comparison with individual biodiesel, the performance of hybrid biodiesel that is mixture of all oils was better. But in its performance was found slightly poor than diesel fuel at higher loads while its gives optimum outputs. The performance was comparatively lower due to the higher viscosities and masses of biodiesels as well as its respective blends. The further research work was planned to reduce these physical parameters with the help of chemical additives such as n-butanol and ethanol

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