

## Evaluation of Properties of Biodiesel and Performance Analysis of Blended Pongamia Biodiesel

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### Abstract:

In the view of fast depletion of fossil fuel, the search for alternative fuels has become inevitable making biodiesel as a substitute of diesel. Biodiesel is a renewable fuel derived from vegetable oils used in diesel engines, in any proportion with petroleum diesel, or pure. Chemical processes produce it, usually by transesterification.

The aim of the present work is to focus on the work done in the area of production of biodiesel from Pongamia and characterization of properties of various blends of Pongamia biodiesel. The work also includes the impact analysis of Pongamia oil and its biodiesel on engine performance. The fuel properties like density, flash point, viscosity and calorific value are very similar to diesel. It was observed that BSFC for Pongamia (0.44416 Kg/Kwhr) is higher than Mahua (0.4306 Kg/Kwhr) and Spent oil (0.3834 Kg/Kwhr). The BTE for Pongamia (23%), Mahua (24%) and spent oil (26%) were almost same. Hence, diesel may be well replaced by biodiesel in near future.

**Keywords:** Biodiesel, Brake specific fuel consumption, Brake thermal efficiency, Fossil fuel

### I. Introduction:

An update on the advances production technique can reinforce the biodiesel as an alternative fuel to combat against global warming. The interest in renewable fuels has increased dramatically in recent years due to high demand of energy and the limitation of Fossil fuel [1]. It could offer the opportunities to develop domestic resources in a cost effective manner. Supplementing the petroleum consumption with renewable biomass resources might be one of the components of strategic approach to reduce dependence on petroleum-based fuels [2]. Nowadays, the search for alternatives of biofuel is a major environmental and political challenge worldwide. These biofuels can be derived from renewable carbon sources to mitigate greenhouse gas emissions, and the products can be employed as drop in replacements for petroleum fuels. Furthermore, usage of biodiesel has almost zero emissions of sulfates, a small net contribution of carbon dioxide (CO<sub>2</sub>) when whole lifecycle is considered, and biodiesel is about 10% oxygen by weight [3], [4].

The main biodiesel production challenge in commercialization is high cost of production compared to fossil fuel diesel. This is due to that the cost in producing biodiesel is heavily depending on feedstock cost or raw materials [5]. Biodiesel has a very high flash point (300°F) making it one of the safest of all alternative fuels, from a combustibility point of view. It has a closed carbon cycle 3.2:1 production value, which is highly efficient [6]. It is noted that biodiesel has a cetane number of over 51, which will make the vehicle perform better in term of fuels ignition with a low idle noise [7]. Hulwan and Joshi reported the performance, emission, and combustion characteristics of a multi-cylinder diesel engine running on diesel-ethanol-biodiesel blends of high ethanol content [8]. However, there is lack of detailed data on combustion and emission of diesel blended with biodiesel produced from castor seed oil [9].

In IC engine, the thermal energy is released by burning fuel in engine cylinder. The combustion of fuel in IC engine is quite fast but to get proper air/fuel mixture, it depends on nature of fuel and method of its introduction into combustion chamber. The combustion process in cylinder should take little time with the release of maximum heat energy during its operation [10]. Longer operation results in formation of deposits which in combustion with other combustion products may cause excessive wear and corrosion of cylinder, piston and piston rings. The combustion should not be toxic when released to atmosphere. The biodiesel from non-edible sources like Jatropha, Pongamia, Mahua, Neem etc., meet the above engine performance requirement and can offer perfect viable alternative to diesel. The experiments on diesel engine are performed and found that there is an increase in BSFC using various blends of biodiesel from various resources including diesel [11]. It is found that there is no significant change in the thermal efficiency while using Biodiesel upto B<sub>20</sub> but there is slight decrease in thermal efficiency when B<sub>100</sub> was used. When biodiesel is used as fuel in existing engines, there is decrease in power, drop in thermal efficiency, increase in specific fuel consumption, and higher emissions [12] & [13]. In order to overcome these problems various modifications in engine operating parameters are suggested. The various modifications suggested are varying the compression ratio [14] & [15] injection pressure [16], use of multiple injections, oil preheating, and so forth. Thus, aim of the study is to investigate engine performance of a diesel engine using biodiesel produced from Pongamia.

**II. Materials and Methods:** Pongamia, Spent and Mahua oil are used for the present study and tested for various properties such as Acidic value, Density Test, Catalyst, Flash point, Fire point & Kinematic viscosity etc

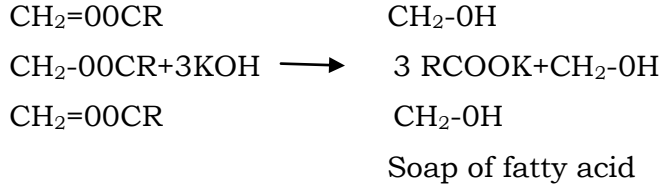
<b>Sl. No</b>	<b>Particulars</b>	<b>Diesel</b>	<b>Biodiesel</b>
1	Kinematic Viscosity in stokes	0.07-0.1	0.102
2	Cetane Number	40-55	48.60
3	Flash Point °C	50-60	150-170
4	Boiling Point °C	188-343	182-338
5	Carbon wt%	87	77
6	Hydrogen wt%	13	12
7	Sulphur wt%	0.5	0

<b>Catalyst</b>	<b>Concentration</b>	<b>Amount (gms)</b>
NaOH	96%	3.5
KOH	99%	4.9
KOH	92%	5.2
KOH	85%	5.8

The schematic diagram of production of Biodiesel is shown in figure 1. Experimental set up of A typical 4-stroke, single cylinder diesel engine at 1500 rpm was used for research work shown in figure 2.

### **2.1 Acidic Value of Oil**

The acidic value of oil is the number of milligrams of KOH required to neutralize free acid present in 1 gm of oil sample. A known weight sample is dissolved in suitable solvent and free fatty acid is titrated with KOH using phenolphthalein indicator. The set up is shown in figure 3.



## 2.2 Density Test

A hydrometer is an instrument used to measure relative density of biodiesel. A simple set up is shown in figure 4

## 2.3 Flash and Fire Point Test

Cleveland's open cup apparatus is used to determine flash and fire point of fuels, lubricating oils and suspension of solids. The set up is shown in figure 5

## 2.4 Kinematic Viscosity Test at 40°C

This test is carried out by filling 40°C, which is maintained for 20-30 mins. The set up is shown in figure 6. The fuel property of Diesel and Biodiesel with suitable parameters is shown in Table 1.

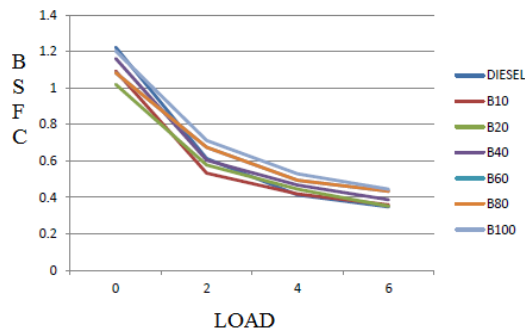
## 2.5 Catalyst Requirement

Refined oil contains 0.1% of free fatty acids. To neutralize them, amount of catalyst required is shown in Table 2.

## III. Results and Discussions

### 3.1 Brake specific fuel consumption (BSFC) of Biodiesel from Pongamia

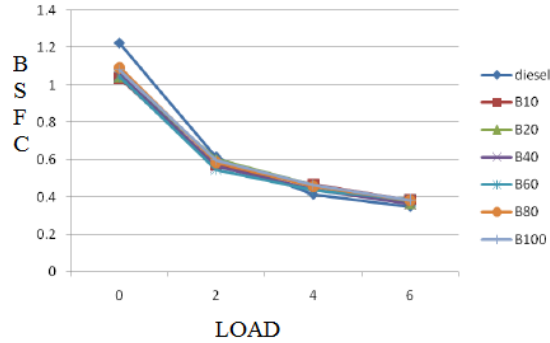
The graph reports the result of BSFC, which states that as load, decreases the fuel consumption for different blends increases. The trend of BSFC for different blends for biodiesel from Karanja B10 upto B100 is shown in fig 7 which indicates that the highest BSFC for B100 (0.44416 Kg/Kwhr) at full load is about 30% higher than diesel (0.3485Kg/Kwhr).



“Figure 7” Variation in BSFC with load for different Blends of Biodiesel from Pongamia

### 3.2 BSFC of Biodiesel from Spent Oil

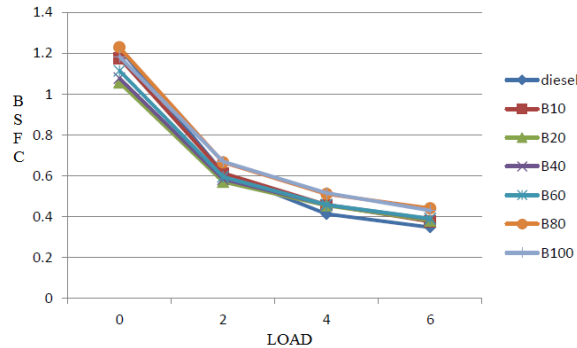
The variation of BSFC for different blends for biodiesel from Spent oil B10 up to B100 is shown in figure 8 which indicates that the highest BSFC for B100 (0.3834 Kg/Kwhr) at full load is about 10% higher than diesel (0.3845Kg/Kwhr).



“Figure” 8 Variation in BSFC with load for different Blends of Biodiesel from Spent Oil

**3.3 BSFC of Biodiesel from Mahua**

The variation of BSFC for different blends for biodiesel from Spent oil B10 upto B100 is shown in figure 9 which indicates that the highest BSFC for B100 (0.4306 Kg/Kwhr) at full load is about 20% higher than diesel (0.3485Kg/Kwhr)

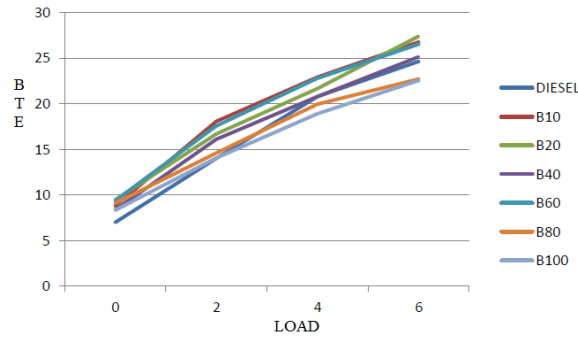


“Figure 9” Variation in BSFC with load for different Blends of Biodiesel from Mahua

**3.4 Brake Thermal Efficiency (BTE) of Biodiesel from Pongamia**

The variation of brake thermal efficiency is shown in figure 10, indicates that BTE of Pongamia biodiesel is about 26% almost similar to that of diesel at full load condition.

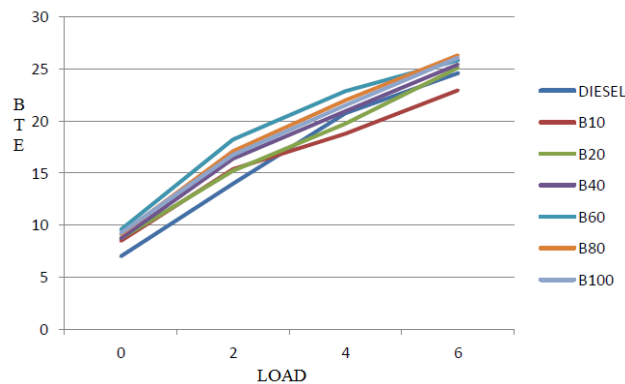
The BTE for B10 (26.75%), B20 (27.35%), B40 (25.12%), B60 (26.49%), B80 (22.68%) and B100 (22.51%) was found about nearly equal to diesel (25%) respectively. The low efficiency may be due to low volatility, slightly higher viscosity and higher density of the biodiesel of Pongamia oil, and due to presence of higher un-saturation in Pongamia biodiesel, which affects mixture formation of the fuel and thus leads to slow combustion.



“Figure 10” Variation in BTE with Load for different Blend Biodiesel from Pongamia

### 3.5 Brake Thermal Efficiency (BTE) of Biodiesel from Spent Oil

The variation of BTE is shown in figure 11 indicating that BTE of Spent oil Biodiesel is about 26% almost same as that of diesel at full load.

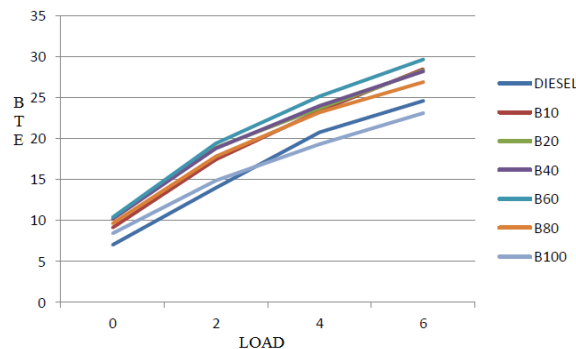


“Figure 11” Variation in BTE with Load for different Blend Biodiesel from Spent oil

The BTE for B10 (23.68%), B20 (25.09%), B40 (25.43%), B60 (25.8%), B80 (26.29%) and B100 (26.07%) was found about nearly equal to diesel (25%) respectively. The low efficiency is due to low volatility and higher un-saturation leading to low combustion.

### 3.6 Brake Thermal Efficiency (BTE) of Biodiesel from Mahua

The variation of BTE is shown in figure 12 indicating that BTE of Spent oil Biodiesel is about 24% almost same as that of diesel at full load.



“Figure 12” Variation in BTE with Load for different Blend Biodiesel from Mahua

The BTE for B10 (28.45%), B20 (28.3%), B40 (28.17%), B60 (29.6%), B80 (26.86%) and B100 (23.07%) was found about nearly equal to diesel (25%) respectively. The low efficiency is due to low volatility and higher unsaturation leading to low combustion.

At lower loads, significant induction of fuel inducted through intake does not burn completely due to lower quantity of pilot fuel, low cylinder gas temperature and lean fuel air mixture, also at higher load, the cylinder wall temperature is increased, reducing ignition delay and hence reduction in fuel consumption. [10] observed the BTE for biodiesel for all blends range (B10 to B100) was found almost comparable to that of diesel. Perhaps due to higher cetane number and inherent presence of oxygen in the biodiesel produced better combustion. The reduction in viscosity of Pongamia leads to improved atomization, fuel vaporization and combustion.

#### **IV. Conclusions**

The present study has dealt with the production of biodiesel from Pongamia, Spent oil and Mahua oil, measurement of properties and performance evaluation on blends of biodiesel at various loads. The following conclusions can be drawn. The fuel properties like density, flash point, viscosity and calorific value of B10, B20 are very similar to diesel and therefore diesel may be well replaced by biodiesel in near future. Use of mixed biodiesel (Pongamia, Mahua and Spent oil) blended with diesel in a conventional diesel engine indicates that performances characteristics of engine with mixed biodiesel operation are comparable to those with diesel operation. The low efficiency may be due to low volatility, slightly higher viscosity and higher density of the biodiesel, which affects mixture formation of the fuel and thus leads to slow combustion.

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