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Blended fuel from sal oil (*Shorea Robusta*) and its characterization

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ABSTRACT

Blended fuel is one of the desirable and significant alternative options in the present world due to the scarcity of conventional fuel. Many vegetable oils are used for the conversion of alternative fuel (biodiesel) and its utilisation. For the preparation of blended fuel, initially, sal (*Shorea Robusta*) oil is used in the present research investigation and after that it was blended with diesel fuel in different ratios. Transesterification process was adopted for biodiesel preparation with methanol in the presence of enzyme Novozyme 40013 (*Candida antarctica*) as catalyst maintaining other required reaction parameters. Blended fuel was prepared by mixing it with diesel fuel as B20, B40, B60 and B80 maintaining 20%, 40%, 60% and 80% diesel respectively. The characterization of blended fuel along with biodiesel (B100) was done w.r.t. density, kinematic viscosity, cetane no and flash point. Acceptable results were obtained during the characterization process. So the blended fuel from sal oil can be a major alternative fuel in diesel engines in near future.

Keywords: Biodiesel, Blended fuel, *Candida antarctica, Shorea Robusta.*

INTRODUCTION

Blended fuel or mixture of diesel fuel with biodiesel creates a lot of attention regarding alternative fuel in the present world. Due to depleting nature of conventional fuel along with the undesirable degradation of the environment over the last few decades compel to think about alternative sources of energy. Researchers and academicians contribute different process technology for the alternative sources of energy which may help to save our mother earth. Blended fuel is one of the important options among semi-conventional energy sources. Blended fuel is prepared by mixing with diesel fuel with biodiesel in different ratios. So, initially, biodiesel is prepared using different sources like edible or non-edible oils, fatty acid distillates, deodorizer distillates and acid oils etc. After that, it is mixed with diesel fuel for the preparation of blended fuel.

Researchers prepared blended fuel from different sources depending on the availability of resource materials. Nandi et al (1) prepared blended fuel utilising mahua oil (*MadhucaIndica*) and characterized the properties. Liaquat et al (2) studied the application of blend fuels in a diesel engine and identified successful results. Ali and Jaafar (3) also successfully derived physical properties of waste cooking oil- diesel blends. Blended fuel from waste cooking oil (4) and palm fatty acid distillate (5) was also studied by Nandi et al. Properties of biodiesel- diesel blends using different mathematical techniques were studied by different researchers (6-9) and showed good similarities with laboratory results. Properties like cetane number, calorific value, emission characteristics, density, viscosity, flash point etc of blended fuel were analysed by different researchers (10-17) and desired outcomes were obtained.

Different edible and non-edible vegetable oils are used for the preparation of biodiesel and blended fuel. Utilisation of non-edible oils for this purpose is more rational as it does not create any unwanted pressure on edible oil consumption. Different non-edible oils (18-25) like jatrophacurcus oil, karanja oil, mahua oil, neem oil, castor oil, waste cooking oil etc are used for this purpose along with by-products of vegetable oil industries like fatty acid distillates, deodorizer distillates and acid oils etc. But very few research was done utilisingsal fat for this purpose. There is a huge opportunity for utilisingsal fat for this purpose in India because India has 10 million hectors Sal (Shorea Robusta) forest which produced 180 million kg non-edible seeds annually. Due to this tremendous sources, sal seeds may be an option to fulfil the biodiesel mission of India due to its low acid value (26). Present study is based on blended fuel from sal fat and its characterisation. It has been analysed in the present study that there are analogous properties of blended fuel from sal oil and diesel fuel. So, sal fat is one of the great sources for the preparation of blended fuel which shows a ray of light for the solution of scarcity of conventional fuels.

MATERIALS

Sal oil was collected from Angura Oils Pvt Ltd, Kolkata, West Bengal. Novozyme 40013, an immobilized nonspecific lipase from *Candida antarctica* was used as catalyst in the reaction with ester synthesis activity of 10000 propyl laurate unit/g and it was a kind gift of Novozyme South Asia Pvt. Ltd. Bangalore, India.The chemicals monoglycerides and diglycerides were purchased from Scientific and Laboratory Instrument Co., Kolkata. Diesel was collected from local petrol pump. Except otherwise specified all other chemicals were A.R. Grade.

METHODS

A. Transesterification of sal oil

For the preparation of biodiesel, initially, 500 mL of sal oil was filtered and taken in an Erlenmeyer flask and heated up to 80°C to drive off moisture by continuous stirring for about 1 h. After that, methanol was added through stepwise manner in an appropriate proportion (6:1::methanol:sal oil) using solvent hexane at a temperature of 63^0C for 9 hours in the presence of 7.5% biocatalyst with a mixing intensity of 550 rpm. After completion of reaction, biodiesel was separated and dried for blending purpose. Biodiesel characterization was done according to the American Standard Testing Method (ASTM). Values are reported as mean ± s.d., where n = 3 (n = no of observations).

B. Preparation of blended fuel

Sal biodiesel was added to diesel at low stirring rate. The mixture was stirred for 30 min and left to reach equilibrium before analysis. Sal biodiesel was added to diesel fuel in volume percentages of 20%, 40%, 60% and 80%. The properties which were compared are density, kinematic viscosity, flash point and cloud point.

RESULTS AND DISCUSSIONS

C. Analysis of sal oil

The physicochemical properties of saloil are shown in Table 1. It has been observed from Table 1 thatsal oil has a calorific value of nearly 38.79 MJ/Kg with higher flash point at nearly 249°C. Lower iodine value shows the presence of higher percentage of saturated part of this oil.

Table 1: Physicochemical properties of sal oil

Properties	Values	Test methods
Iodine Value (g I_2/100 g)	41.27 ±0.227	ASTMD 5554
Peroxide Value (Eq. O2/kg)	18.34 ±0.029	----------
Acid Value (mg KOH/g)	16.39 ±0.052	----------
Saponification Value (mg KOH/g)	192.43 ±0.186	----------
Kinematic Viscosity at 40^oC (mm^2/s)	57.45 ±0.201	ASTM-D445
Refractive Index	1.452 ±0.023	----------
Density at 15^oC(Kg/m3)	903 ±0.852	ASTMD 5002
Calorific value (MJ/Kg)	38.79±0.103	ASTMD-4868
Flash point (^oC)	249±0.107	ASTMD-93

D. Blending of biodesel with diesel fuel

For the analysis of blended fuel prepared from sal oil, initially, sal oil has been converted to biodiesel through transesterification reaction and the sal oil biodiesel and diesel fuel have been blended in different proportions (v/v) by moderate stirring. After half an hour of mixing, the blended fuel was kept for again 30 minutes for stabilization. The blending composition of sal oil biodiesel and diesel fuel is shown in Table 2**.** In the blended compositions, the percentage of sal biodiesel has been considered as 20, 40, 60 and 80% (v/v). The properties like density, kinematic viscosity, flash point and cloud point of the blends were analysed. The testing was repeated three times and was carefully recorded.

Table 2: Blending composition of sal oil biodiesel and diesel fuel

Sample	Sal oil biodiesel (%)	Diesel fuel (%)
Diesel	0	100
B 20	20	80
B 40	40	60
B 60	60	40
B 80	80	20
B 100	0	0

E. Analysis of density of sal biodiesel – diesel fuel blends

Density of a fuel determines the spray characteristics and fuel injection property which are considered very important regarding fuel efficacy. So the analysis of density has been studied with the blended fuel as compared to diesel fuel as shown in Fig 1. It has been observed from the figure that density of diesel fuel is less compared to blended fuel. Almost a linear proportional relationship has been observed for the increasing amount of biodiesel in blended fuel. Maximum density for blended fuel is observed for B 80 (879 Kg/m3) and lowest density is observed for B20 (848 Kg/m3). Pure diesel fuel shows lowest density as expected.

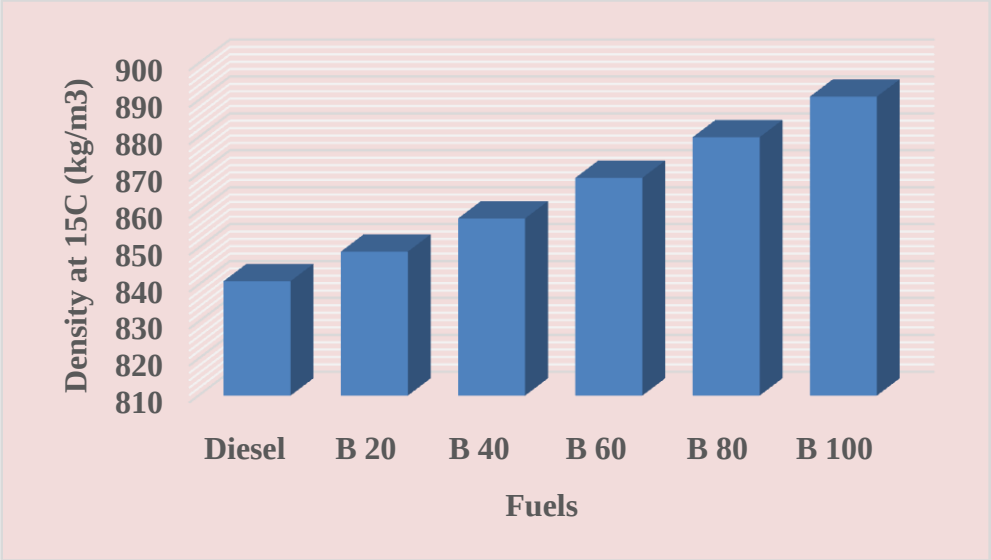

Figure 1.Analysis of density at 15^0C (Kg/m^3) of diesel fuel and blended fuels

F. Analysis of kinematic viscosity of sal biodiesel – diesel fuel blends

Viscosity of fuel plays a vital role for the efficiency of engine as fuel atomization upon injection into a combustion chamber is controlled by fuel viscosity and cause formation of engine deposits. The mixing of biodiesel with diesel fuel changes the kinematic viscosity of blended fuel as shown in Fig. 2 at a temperature of 40^0C. It has been observed from Fig. 2 that enhancing the amount of sal biodiesel in the diesel fuel increases the viscosity of the blended fuel. Transesterification reaction is needed for the sal oil due to its higher viscosity. This reaction helps to lower the viscosity of the original oil and after that blending is done as per requirement.

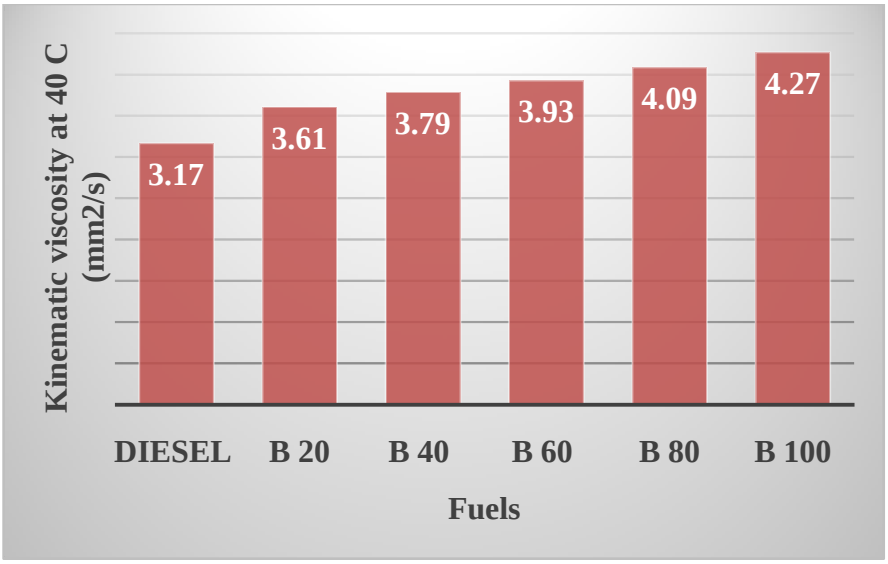

Figure 2. Analysis of kinematic viscosity at 40^0C (mm^2/s) of diesel fuel and blended fuels

G. Analysis of cetane number and flash point of sal biodiesel – diesel fuel blends

Cetane number is a measure of fuel's ignition delay. This is the time period between the injection and combustion of the fuel. Higher the cetane number, better the fuel burns within the engine. Flash point of fuel indicates the safety measures as it is related to volatility and flammability. Higher flash point specifies safe fuel. So fuels with higher flash

point and higher cetane number are favourable. In our study, cetane number and flash point of the blended fuel are analysed as shown in Fig. 3. It has been observed from Fig. 3 that biodiesel shows higher flash point (201^0C) than diesel fuel (51^0C) and hence it can be used safely in the diesel engine. Blended fuel also shows much higher flash point which indicates its safe use. Regarding cetane number, blended fuel shows higher in side than diesel fuel indicating use of it in efficient manner.

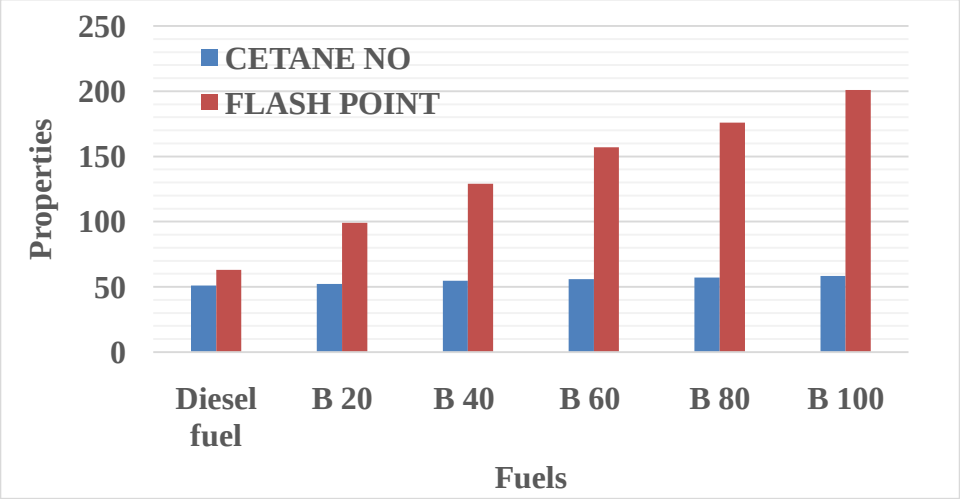

Figure 3. Analysis of cetane number and flash point of diesel fuel and blended fuels

CONCLUSION

Blended fuel from sal fat is prepared after converting it to biodiesel. The characteristics like density, kinematic viscosity, cetane number and flash point of the sal biodiesel-diesel blends have been analysed and found acceptable results. Based on the availability of sal fat in India, the present process technology for the preparation of blended fuel may be a good option for the alternative source of semi-conventional fuel in the near future.

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