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Characterisation of Biodiesel Derived From Waste Cotton Seed Oil and Waste Mustard Oil

Sandeep Singh[1*], Sumeet Sharma[1], S.K. Mohapatra[1] and K. Kundu[2]

[1]*Department of Mechanical Engineering, Thapar University, Patiala - 147 004, India*

[2]*Mechanical Engineering Research and Development Organization, Ludhiana - 141 006, India*

Email: ss18856@gmail.com

***Abstract* - Biodiesel, an alternative fuel is derived from the fats of animals and plants. As energy demand increases and fossil fuels are limited, research is directed towards alternative renewable fuels. Properties of waste oil (cotton seed oil and mustard oil) have been compared with the properties of petro-diesel, showing a comparable regime for satisfactory optimized blend which is to be selected for the better performance of a C.I. engine with biodiesel. The work presented in this paper is the study of characteristics of biodiesel prepared from vegetable oils (waste cotton seed oil and waste mustard oil). The characteristics of biodiesel are to be checked at different blends(B10, B15, B20) and select the optimum blend based on these characteristics. The characteristics include free fatty acid value, density, viscosity, flash point and fire point, cloud point and pour point, carbon residue content and ash residue content.**

***Keywords:* Waste cotton seed oil, Waste mustard oil, Transesterification, Characterisation**

I. Introduction

Bio-diesel is an alternative to petroleum-based fuels derived from vegetable oils, animal fats, and used waste cooking oil including triglycerides. Vegetable oils are widely available from various sources, and the glycerides present in the oils can be considered as a viable alternative for diesel fuel. Due to the increase in price of petroleum products and environmental concern about pollution coming from automobile emission, biodiesel is emerging as a developing area of interest. The world is confronted with the twin crises of fossil fuel depletion and environmental degradation. [1][2][4][6].

The world is confronted with the twin crises of fossil fuel depletion and environmental degradation. [3] Alternative fuels, promise to harmonize sustainable development, energy conversion, management, efficiency and environmental preservation. [5]. Vegetable oil is a promising alternative to petroleum products. The economic feasibility of biodiesel depends on the price of crude petroleum and the cost of transporting diesel over long distances.[2] Vegetable oils have high viscosity; transesterification process is to be used to reduce the viscosity of the waste oil. [14]. Biodiesel from waste cotton seed oil and waste mustard oil is to be prepared. Biodiesel prepared from both the waste oils blended with diesel at three different levels i.e. B10, B15 and B20. The properties of these three blends were analyzed and optimum blend from both the biodiesels were selected. Biodiesel was prepared from both the waste oil by alkali catalyzed transesterification process. KOH was used as the catalyst amounting 1.5% on mass basis. 20% methanol was used for treating both the oils. [7][11][15][16].

II. Materials and Methods

A. Materials

The waste cotton seed and waste mustard oil used in this study were collected from a local snack shops in Patiala, Punjab, India. The biodiesel from the both the oils was extracted at Mechanical Engineering Research and Development Organization, Ludhiana.

Properties of the biodiesel were determined on different apparatus. Table I shows the list of the apparatus on which properties were tested and determined.

Table I Apparatus used for Determination The Properties

Properties	Apparatus
Density	Weighing balance
Kinematic Viscosity	Redwood Viscometer
Flash point and fire point	Closed cup flash and fire point
Ash Content	Muffle furnace
Cloud point and pour point	Cloud and pour point apparatus
Carbon Residues	Carbon residue apparatus
Calorific Value	Bomb calorimeter

III. Results and Discussions

A.Characterization of Blends of Cotton Seed Methyl Ester(CSME)

1. Density

The relative density of B10, B15, B20 blends of cotton seed oil with diesel were observed to be 8.5, 8.0, 7.0 and 9.6 percent higher than that of diesel respectively. The experimental results indicated that the relative density of cotton seed methyl ester is higher than that of diesel.

2. Free Fatty Acid Content

The FFA content of B10, B15, B20 blends and cotton seed methyl ester were observed 0.090%, 0.10%, 0.109% and 0.112%. FFA content was determined by following formula: Weight of sample = Volume × density.

$$(28.2 \times V \times N)/(\text{weight of sample}) \quad [1]$$

Where V = volume of NaOH consumed in the titration

N = Normality of NaOH

3. Kinematic Viscosity

The kinematic viscosity of of B10, B15, B20 blends and cotton seed methyl ester were found as 2.19, 2.38, 2.28 and 3.6 centistokes at 40^0C. Cotton seed methyl ester had the kinematic viscosity 7.692 percent less than that of diesel.

4. Flash and Fire Point

The blends B10, B15, B20 have higher flash and fire point as compared to diesel. The flash and fire point of cotton seed methyl ester was found higher than that of diesel respectively. The results indicated that the blend B 15 was observed to have the flash and fire point 16.66 percent higher than that of diesel.

5. Cloud and Pour Point

The blends B10, B15, B20 have higher cloud and pour point as compared to diesel. The cloud and pour point of cotton seed methyl ester was also higher as compared of diesel respectively. The results indicated that the blend B10 had the cloud point nearly equal to that of diesel.

6. Ash Content

The experimental results indicated that ash content of cotton seed methyl ester and their blends were higher than that of diesel.

7. Carbon Residue Content

The experimental results indicated that the ester of cotton seed and and their blends were lower carbon residue content than that of diesel which is better for engine performance and it also prevents carbon deposition inside the combustion chamber. The blend B20 has lowest carbon residue content as compare to B10 and B15 because biodiesel has more oxygen content as compared to diesel, so carbon content of the fuel takes oxygen from biodiesel and hence combustion takes place completely. Due to this reason carbon residue content reduces as we increase the amount of value of biodiesel.

Table II Fuel Properties of Cotton Seed Methyl Ester And Their Blends Compared to Diesel [18]

Sr.No	Properties	Units	B100C.S.E	B10	B15	B20	Diesel	ASTM D6751
1	Density	kg/m^3	910	838	842	846	830	0.84-0.92
2	FFA value	%	0.112	0.090	0.10	0.109	-	<0.2
3	Viscosity	cSt	3.6	2.19	2.38	2.82	3.9	1.9-6.0
4	Flash point	^{0}C	160	65	70	70	60	>130
5	Fire point	^{0}C	165	70	75	75	65	-
6	Cloud point	^{0}C	-3	-9	-7	-4	-12	-10
7	Pour point	^{0}C	-8	-14	-12	-9	-16	-15
8	Ash content	%	0.0180	0.010	0.012	0.014	<0.02	<0.02
9	Carbon Residue	%	0.0112	0.02038	0.0198	0.01324	-	0.05 max
10	Calorific value	kJ/kg	40000	42700	42550	42400	43000	-

8. Calorific Value

The calorific value of diesel, cotton seed methyl ester and blend B10 were found as 43,000, 40,000 and 40,300 kJ/kg respectively. The calorific value of blend B10 decreased by 6.27% than that of diesel whereas the calorific value of cotton seed methyl ester decreased by 6.97% than that of diesel. The result shows that the calorific value of B10 blend is lower than that of diesel fuel.

B. Characterization of Blends of Mustard Methyl ester (MME)

1. Density

The relative density of B10, B15, B20 blends and mustard methyl ester were observed 4.3, 4.0, 3.8 and 4.8 percent higher than that of diesel respectively. The experimental results indicated that the relative density of mustard methyl ester is slightly higher than that of diesel.

2. Free Fatty Acid Content

The FFA content of B10, B15, B20 blends and mustard methyl ester were observed to be 0.072%, 0.084%, 0.095% and 0.126%.

3. Kinematic Viscosity

The kinematic viscosity of B10, B15, B20 blends and mustard methyl ester were found as 2.35, 2.54, 2.95 and 3.7 centistokes at 40^0C. Mustard methyl ester had the kinematic viscosity 5.12 percent less than that of diesel. The results indicated that the blend B10 has kinematic viscosity 40.05 percent less than that of diesel.

4. Flash and Fire Points

The blends B10, B15 have higher flash and fire point as compared to diesel. The flash and fire points of mustard methyl ester was found to be higher than that of diesel respectively. The results indicated that the blend B20 was observed the lower flash and fire point as compare to blend B10 and B15 due to experimental error.

Table III Fuel Properties Of Mustard Methyl Ester and Their Blends Compared To Diesel [18]

Sr.No	Properties	Units	B100M.E	B10	B15	B20	Diesel	ASTM D6751
1	Density	kg/m^3	870	834	836	838	830	0.84-0.92
2	FFA value	%	0.126	0.072	0.084	0.095	-	<0.2
3	Viscosity	cSt	3.7	2.35	2.54	2.95	3.9	1.9-6.0
4	Flash point	^{0}C	145	70	75	65	60	>130
5	Fire point	^{0}C	150	75	80	70	65	-
6	Cloud point	^{0}C	4	-9	-5	-2	-12	-10
7	Pour point	^{0}C	-12	-14	-10	-7	-16	-15
8	Ash content	%	0.0189	0.0105	0.0128	0.0149	<0.02	<0.02
9	Carbon Residue	%	0.0138	0.02064	0.02026	0.0198	-	0.05 max
10	Calorific value	kJ/kg	39542.98	41754	41631	41508	43000	-

5. ***Cloud and Pour Point***

The blends B10, B15, B20 have higher cloud and pour point as compared to diesel. The cloud and pour point of mustard methyl ester was also higher as compared to that of diesel respectively. The results indicated that the blend B10 was observed the cloud point nearly to that of diesel.

6. Ash Content

It is clear from the experimental results that the mustard methyl ester and their blends have higher ash content than that of diesel respectively.

7. Carbon Residue Content

The experimental results indicated that the ester of mustard and and their blends have lower carbon residue content than that of diesel which is better for engine performance as it prevents carbon deposition inside the combustion chamber. The blend B 20 has lowest carbon residue content as compared to B10 and B15.

8. Calorific Value

The calorific value of diesel, mustard methyl ester and blend B20 were found as 43,000, 39,542 and 41,508 kJ/kg respectively. The calorific value of blend B20 decreased by 3.46% than that of diesel whereas the calorific value of mustard methyl ester is decreased by 8.86% than that of diesel. The result shows that the calorific value of B10 blend is lower than diesel fuel.

C. Comparison of Blends of Cotton Seed Methyl Ester And Mustard Methyl Ester

1. Density

The relative densities of B10 blends of cotton seed and mustard methyl ester were observed to be less as compared to blends B15 and B20 of both esters. The experimental results indicated that the relative density of B10 blend of mustard methyl ester is slightly less than that of diesel.

2. Free Fatty Acid content

The FFA content of B10, B15, B20 blends of mustard methyl ester were observed to be less than the blends of cotton seed methyl esters.

3. Kinematic Viscosity

The kinematic viscosity of of B10, B15, B20 blends of cotton seed methyl ester were found as 2.19, 2.38, 2.28 centistokes at 40^0C. Mustard methyl ester blends have higher kinematic viscosity as compared to cotton seed ester.

4. Flash and Fire Point

The blend B15 of cotton seed methyl ester and mustard methyl ester have higher flash and fire point as compare to blends B10 and B15 of both the esters

5. Cloud and Pour Point

The B10 blend of both esters had lower cloud and pour point as compared to B15 and B20 blends of both esters.

6. Ash Content

It is clear from the results that blends of mustard methyl ester has higher ash content as compared to blends of cotton seed methyl ester.

Table IV Comparison of Properties of Different Blends

Sr.No	Properties	Units	BLENDS (C.S.E with diesel)			BLENDS (M.E with diesel)		
			B10	B15	B20	B10	B15	B20
1.	Density	kg/m^3	838	842	846	834	836	838
2.	FFA value	%	0.084	0.107	0.118	0.072	0.084	0.095
3.	Viscosity	cSt	2.19	2.38	2.28	2.35	2.54	2.95
4.	Flash Point	^{0}C	65	70	70	70	75	65
5.	Fire point	^{0}C	70	75	75	75	70	65
6.	Cloud point	^{0}C	-9	-7	-4	-9	-5	-2
7.	Pour Point	^{0}C	-14	-12	-9	-14	-10	-7
8	Ash content	%	0.010	0.012	0.014	0.0105	0.0128	0.0149
9.	Carbon Residue	%	0.02038	0.0198	0.01324	0.02064	0.02026	0.0196
10.	Calorific value	kJ/kg	42700	42550	42400	41754	41631	41508

7. Calorific Value

The blends B10, B15 and B20 of cotton seed methyl were found experimentally to have higher calorific value than that of blends of mustard methyl ester. The blend B20 of both esters has lowest calorific value as compared to B10 and B15 blends of both esters.

IV. Conclusions

The density, FFA content, flash point and fire point, ash content, carbon residue content and calorific value of B10 blends of cotton seed and mustard methyl ester were observed to be less as compared to blends B15 and B 20 of both esters. The results indicate that characteristics of B10 blend of cotton seed methyl ester and mustard methyl ester was more optimized as compared to B15 and B20 blends.

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