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Research Article

Experimental Investigation on the Fuel Properties of Soybean Oil and Groundnut Oil Biodiesels and its Blends with Acetone

Kailas M. Talkit[Ȧ*], D.T. Mahajan[Ḃ]

[Ȧ]Department of Engineering chemistry, DESS COET Dhamangaon Rly, Maharashtra, India
[Ḃ]Department of chemistry, V.B.M.V. Amravati, Maharashtra, India

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Abstract

An experimental investigation was performed to find out the fuel properties including kinematic viscosity, acid value and density of convectional diesel fuel, biodiesels (100% methyl ester of soybean oil, 100% methyl ester of groundnut oil) and their blends with acetone having blending ratio 95%, 85%, 75% and 65%. In the present research work, reduces the kinematic viscosity of biodiesels by two approaches. The first approach is heating of the fuel to five elevated temperature 35^0c, 40^0c, 45^0c, 50^0c and 55^0c and second approach is adding the one chemical in different proportions and heating it to same temperatures as compared to the base ambient temperature and to diesel fuel too. Acetone used for this purpose which improves the fuels ability to vaporize completely by reducing the surface tension and considered as a renewable and alternative fuel. The kinematic viscosity has been reduced by both methods for close to diesel values. From results obtained, it's found that the kinematic viscosity of test fuels and its blends decreases linearly with increasing temperature and increasing blending ratio of acetone. The density and acid value of test biodiesels also decreases with increasing blending ratio of acetone.

Keywords: *Biodiesels, blends, surface tension, viscosity, temperature.*

1. Introduction

Biodiesel fuel obtained from vegetable oils which are used as substitute for nonrenewable petroleum fuel in diesel engine have recently received increase attention. This increase in interest is based on number of vital properties of biodiesels such as high biodegrability and most important fact that it is produced from a renewable resource. For emission reduction these feature of biodiesels lead its greatest advantage. Number of worker have been studied the fuel properties of biodiesels, used as substitute for petroleum fuels.

Rafat A.A. et al. investigated the production optimization and quality assessment of biodiesel from waste vegetable oils. From this study it was clear that the produced biodiesel fuel, whether from waste vegetable oil or pure vegetable oil was fuel properties compatible with diesel fuel. Effect of mixture of biodiesel- diesel – ethanol as fuel on diesel engine emission was investigated by *Altun s. et al*. The research was find out a reduction in carbon monoxide emission for blended fuel while emission of nitrogen oxide were slightly higher for B20 and lower for BDE compared with diesel fuel. *Patil Milind S. et al*. investigated performance test for I.C. engine using blends of ethanol and kerosene with diesel. From the results obtained, it observed that for 20% mixture of ethanol blend with diesel has a very good efficiency compared with pure diesel and ethanol blend. Also it was observed that the 20% ethanol blend is having higher volumetric efficiency compare with diesel and kerosene blends. *Singh sudhakar et al.* was demonstrated utilization of ethanol and rice bran methyl ester in a single cylinder CI diesel engine. This shown that, the co-emission of biodiesel and all the other fuel blends were lower than that of the diesel fuel and NO_X emission of the biodiesel were high as compared with diesel fuel. Sudrolhosseini *Reza Amir et al.* was investigated the physical properties of normal grade biodiesel and winter grade biodiesel. From this research it was proved that the higher palmitic acid $C_{16\cdot 0}$ content in normal grade than in winter grade palm oil of biodiesel. Physicochemical properties of biodiesels from jatropha and castor oil were demonstrated by *okullo aldo. et al*. From the results obtained showed that high amount of FFA in oil produced low quality biodiesel. The quality of biodiesel from jatropha and castor oil was improved greatly by neutralization the crude oils. *Khanahamadzadeh salah. et al*. was determined physicochemical properties of biodiesel produced from safflower oil. This proved that kinematic viscosity of the produced biodiesel from safflower oil was in appropriate range of D 6751 ASTM standard. Production of bio-ethanol and sunflower methyl ester and investigation of fuel blend properties was determined by *Ghobadian B. et al*. From this paper it was conclude that, addition of ethanol to diesel fuel greatly reduce the fuel blend cetane number extremely on the other hand biodiesel can

*Corresponding author: **Kailas M. Talkit**

increases the ethanol-diesel cetane number. *Subramanin R. et al*. studied on performance and emission characteristic of multicylinder diesel engine using hybrid fuel blend as fuel. This study compared performance and emission characteristic of hybrid fuel blend with diesel in multycylinder, naturally aspirated, direct injection diesel engine. The results obtained shown that smoke and oxides of nitrogen are found to be reduced simultaneously, while using hybrid fuel blends as a fuel. Recently, *Muthukumar A. et al*. investigated biodiesel production from marine microalgae chlorella marina and nannochloropsis salina. This study showed that 60.26% of biodiesel yielded from 0.752 gm/lit contains 30% oil content from N. Salina whereas 50% yielded from 0.752gm/lit contains 20% oil content. *Singh R.K. et al* demonstrated characterization of jatropha oil for the preparation of biodiesel. This study suggests that jatropha oil can be used as a source of triglyceride in manufacture of biodiesel by esterification process. *Bellown M.A. et al.* was studied physicochemical characteristic of oil and biodiesel from Indian and Nigerian jatropha curcas seeds. From this study it was conclude that jatropha curcas plant found in Nigeria has the potential of boosting the economy in terms of biodiesel production. Biodiesel production from algal species was studied by *shah et al* and *Abubakar L.U. et al*.

From the above literature review it was found that kinematic viscosity and other fuel properties of biodiesels are not similar to diesel fuel because biodiesels shows high viscosity, high density and high acid value relative to diesel fuel. The high viscosity and density of biodiesels tends to alter the injector spray pattern inside the engine causing fuel impingement on the piston and other combustion chamber surfaces. The result of this leads to formation of carbon deposit inside the engine, resulting in the problems such as subsequent engine failures, stuck piston rings in the cylinder, which would not otherwise occur using diesel fuel. The acid value denotes the concentration of hazardous bodies in the biodiesels sample and increasing concentration of acidic bodies in biodiesels undergoes oxidation and corrosion hazards. Higher the acid value of fuel it's should forms gum and sludge in diesel engines.

The undesirable properties of biodiesels can be substantially mitigated by reducing the viscosity of biodiesels. Viscosity of biodiesels can be reducing by two approaches. The first approach is heating of the biodiesel and second approach is adding such chemical which possesses lower viscosity than biodiesels. Many researchers used lighter molecule such as ethanol, methanol and diethyl ether etc. for reducing viscosity of biodiesels. In the present research work, acetone is use because a) it is readily available chemical added in biodiesels improves the fuel ability to vaporize completely by reducing the surface tension b) it increases the gas mileage, increases power, engine life and performance, less unburned fuel going past the rings keeps the rings and engine oil in far better condition c) it can stop the black smoke when the rack is all the way at full throttle c) it can reduces hydrocarbon emission 60% d) it can reduce the formation of water ice crystals in below zero weather which can damage the fuel filter e) it can easily soluble in biodiesel.

Hence the main objectives of this research work, is to investigate the effect of temperature and blending of acetone on the fuel properties of biodiesels in order to obtained correlation between neat biodiesels, biodiesels blends with acetone and diesel fuel so that its properties will be acceptable by fuel properties standard and is acceptable as a good fuel for diesel engines.

2. Experimental

2.1 Test fuels

In the measurements of fuel properties, test fuel used in this work were a convectional diesel fuel, biodiesels (100% methyl ester of soybean oil, 100% methyl ester of groundnut oil) and their blends with acetone having blending ratios 95%, 85%, 75% and 65%. Biodiesels blends are made on the basis of volume (volume %) and blending ratio range from 95% to 65% by the intervals of 5%. During the blending process, biodiesel and acetone stirred continuously to ensure proper and uniform mixing.

2.2 Viscosity measurement

Viscosity of neat biodiesels, biodiesel blends with acetone and diesel was measured by Redwood viscometer number 1. According to this method, level the instrument with the help of leveling screws on the tripod fill the water bath with water to the height corresponding tip of indicator up to which the oil is filled in the cylindrical cup. Keep the brass ball in position so as to seal the orifice. Then, pour the oil under test carefully into the oil cup up to the tip of indicator. Keep 50ml flask in position below the jet. Keep the oil and water well stirred and note their temperatures. When the temperature of oil and water are steady, raise the ball valve and suspend it from the thermometer bracket. Simultaneously start to stop watch. When the level of oil dropping in to the flask reaches the 50ml mark, stop the watch and note the time in seconds. Repeat the experiment at five elevated temperature and note the respected times of efflux as described above. The kinematic viscosity of the oil in centistokes can be calculated from the time taken by the oil to flow through the standard orifice of the instrument, with the help of following equation.

$$\upsilon = c\,t - \beta/t$$

Where,

υ = Kinematic viscosity in centistokes

c = Viscometer constant

t = Time of flow in second

β = Coefficient of kinematic energy which may be determined experimentally or eliminated by choosing long flow times. For redwood viscometer No.1, the values for the constant are as below

Time of flow	β	C
40 to 85 seconds	190	0.264
85 to 2000 seconds	65	0.247

2.3 Acid value measurement

Acid value of neat biodiesels, biodiesel blends with acetone and diesel was measured by ASTM method (ASTM – D 974(00). According to this method, weigh out accurately 0.2 to 0.5gm of the oil under test in to 250ml conical flask and add 50ml neutral alcohol. Heat the flask. Cool the flask and contents to room temperature and add a few drops of phenolphthalein indicator. Titrate with the standard N/10 KOH solution until a faint permanent pink colour appears at the end point.

Chemical reaction:

$C_{17}H_{35}COOH + KOH \rightarrow C_{17}H_{35}COOK + H_2O$

Calculations

The acid value of vegetable oils and their blends can be determined by using following formulae.

$$\text{Acid value}=\frac{Number\ of\ ml\ of\frac{N}{10}KOH\ run\ down}{Weight\ of\ oil\ taken\ in\ gm}\times 100$$

Where 5.6 represents the amount of KOH in mg present per each ml of N/10 KOH solution (1000 ml of 1N KOH= 56 gm of KOH).

2.4 Density measurement

The densities of neat biodiesels, biodiesel blends with acetone and diesel were determined by ASTM method D4052.

Table 1 Test fuels

Fuels	Abbreviation
Soybean oil methyl ester	SOME
Groundnut oil methyl ester	GOME

Table 2: Kinematic viscosity of pure fuel

Sr.No.	Temperature	SOME	GOMO	Diesel
1	30^0c	39.61	33.36	26.57
2	35^0c	39.11	31.61	25.82
3	40^0c	38.86	31.10	24.55
4	45^0c	38.61	30.35	24.30
5	50^0c	38.36	29.09	23.54
6	55^0c	37.86	28.59	23.03

Table 3: Kinematic viscosity of fuel blends

SOME + Acetone						
Mixture Ratio	Viscosity at different temperature					
	30^0c	35^0c	40^0c	45^0c	50^0c	55^0c
95 + 5	33.86	33.11	32.61	32.36	31.86	31.35
85 + 15	30.36	30.11	29.61	29.55	29.10	27.85
75 + 25	21.25	20.99	20.48	20.23	19.71	19.46
65 + 35	18.94	17.65	17.14	16.62	16.10	14.79
GOME + Acetone						
95 + 5	30.35	29.85	29.34	29.09	28.84	28.59
85 + 15	25.82	25.56	25.06	24.80	24.30	23.54
75 + 25	24.55	24.05	23.80	23.54	23.04	22.78
65 + 35	22.28	22.02	22.02	21.76	21.51	21.50

According to this method, take a fuel sample in measuring glass on flat place at room temperature, Stirr the fuel sample homogeneously after that measured temperature and record when reading are constant. Then enter hydrometer off the hydrometer if the equilibrium position then read hydrometer scale. This scale is the density obtained then converts it in to temperature by using the ASTM table 55B.

Table 4: Acid value and density of pure fuel

Sr.No.	Test fuels	Acid value (mg/liter)	Density(30°C) (g/cm^3)
1	SOME	1.42	0.853
2	GOME	0.78	0.836
3	Diesel	0.56	0.812

Table 5: Acid value and density of fuel blends

SOME + Acetone		
Mixture ratio	Acid value (mg / liter)	Density(g/cm^3)
95 + 5	1.39	0.830
85 + 15	1.34	0.819
75 + 25	1.32	0.791
65 + 35	0.97	0.758
GOME + Acetone		
95 + 5	0.42	0.853
85 + 15	0.33	0.839
75 + 25	0.27	0.835
65 + 35	0.20	0.820

3. Results and discussion

3.1 Kinematic viscosity

The effects of adding acetone to biodiesels as well as heating up the biodiesels on kinematic viscosity are shown in table 2, 3. The biodiesels are heated from 30^0c (atmospheric condition) to 35^0c, 40^0c, 45^0c, 50^0c and 55^0c and the kinematic viscosity has been measured. It may be seen from the table and that, heating the neat biodiesels and its blends with acetone from 30^0c to 55^0c decreases kinematic viscosity linearly with increases in temperature. Due to heating of biodiesels and its blends with acetone it has been becomes within the acceptable range for diesel engine fuel. The highest temperature such as 55^0c is easily achievable from the vehicles system.

3.2 Acid value

The acid values of neat biodiesels as well as effects of adding acetone to biodiesels on acid value are shown in table 4, 5. It may be seen from the table that, the acid value of biodiesels decreases linearly with increasing blending ratio of acetone. Lower acid value prevent corrosion hazards, gum and sludge formation in diesel engine. Thus, due to blending of acetone with biodiesels the acid value has been becomes within the acceptable range for diesel engine fuel.

3.3 Density

The density of neat biodiesels as well as effects of adding acetone to biodiesels on density is shown in table 4, 5. It may be seen from the table that, the density of biodiesels decreases linearly with increasing blending ratio of acetone. Thus, due to blending of acetone with biodiesels density has been becomes within the acceptable range for diesel engine fuel.

4. Conclusions

In order to investigate the effect of various temperatures condition on pure biodiesels fuel properties, blended fuel properties and diesel fuel properties such as kinematic viscosity were measured. Acid value, density of pure biodiesel, neat diesel and biodiesel blends with acetone (5-35%) wear measured. The kinematic viscosity wear measured in temperature range from 30^0c to 80^0c. On the basis of results obtained of fuel properties, the following conclusions were obtained.

1.The kinematic viscosity measured decreased proportionally with the increase in temperature and increase in blending ratio of acetone. The kinematic viscosity of pure biodiesels such as GOME at 55^0c is found very close to diesel fuel. Also, the kinematic viscosity of blended biodiesels such as 85% SOME + 15% acetone at 55^0c, 85% GOME + 15% acetone at 30^0c are found very close to diesel fuel. Hence, from the above data obtained it's should be conclude that these blends are directly use as fuel in diesel engine.

2. The acid value measured, decreased proportionally with increase in blending ratio of acetone. Acid values of pure biodiesels are higher than diesel fuel hence they cannot directly use in diesel engine. Acid value of fuels such as 95% GOME + 5% acetone is found very close to diesel fuel. Thus from above data it's should be conclude that, fuel property such as acid value of pure biodiesels should be improved by acetone blends.

3. The density measured, decreased linearly with increasing blending ratio of acetone. Density of fuels such as 85% SOME + 15% acetone, 65% GOME + 35% acetone are found very close to diesel fuel. Thus, from these data's, it's should be conclude that fuel property such as density should be improved by acetone blends.

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