STUDIES ON FUEL PROPERTIES OF NEEM OIL METHYL ESTER AND ITS CONVENTIONAL DIESEL AND KEROSENE BLENDS

V. R. Kattimani[1], R.T.Radhika[2] B. M. Venkatesha[3]*, S. Ananda[4]

1Department of Chemistry, Basaveshwar Engineering College, Bagalkot, India

2Department of Chemistry, Maharani's science College for Women, Mysore, India

3Department of Chemistry, Yuvaraja's College, University of Mysore, Manasagangothri,Mysore, India

4Department of Studies in Chemistry, University of Mysore, Mysore, India

Email: bmvenkatesha123@gmail.com

ABSTRACT

Fuel properties such as specific gravity, viscosity, gross calorific value, flash and fire point of Neem oil methyl ester and its blends with conventional diesel oil in the proportions of 20:80 (B20), 40:60 (B40), and 60:40 (B60), 80:20 (B80) have studied. It has found that the fuel properties were found to deviate more from those of diesel oil with the increasing in the percentage of methyl ester in the blend. It was also found that the properties of blend of B20 were found very close to those of conventional diesel oil.

An attempt has also made to study the fuel properties of Neem oil methyl ester blends with domestic kerosene oil and conventional diesel oil in the proportions (Methyl ester : Conventional diesel : Kerosene) of 20:75:5 (B20K5),40:50:10(B40K10),60:25:15(B60K15),and80:0:20(B80K20).

KEYWORDS: Neem oil methyl ester, conventional diesel oil, Neem oil, transesterification

INTRODUCTION

Crude oil prices have been increasing rapidly which increases the burden on foreign exchange reserves of oil importing countries like India. It has severe effect on the economy of oil importing countries. Efforts are going on all over the world to find alternative automotive fuel due to increase in the demand for petroleum products, global warming due to emission of harmful gases, degradation of air quality and fast depletion of supply of fossil fuel.

Noticeable research work has been made to use methyl ester (Bio-diesel) in place of conventional diesel oil. It has received attention all over the world as an alternative fuel to diesel oil because it has produced from renewable sources such as straight vegetable oil (edible and non –edible oil), animal fats and oil and waste cooking oil and fried oil [1]. It is eco-friendly [2, 3, 4] in nature and referred as green energy source.

Considerable research work has been done in past to study the fuel properties of methyl esters. It was reported that properties of methyl ester are close to diesel oil [5] and deviates more with the increase in the percentage of methyl ester in the blends because methyl ester contains nearly 10% lower calorific value than conventional diesel oil [6].

Viscosity is an important transport property of fuel and it strongly affects the flow behaviour at different temperatures [7]. In general, viscosity increases with the increase in un-saturation. So, vegetable oil containing low molecular weight tricylglycerol is slightly less viscous than the oil containing high molecular weight tricylglycerol.

It was reported that viscosity of soybean oil and beef tallow reduced from 28.08 cSt and 51.15 cSt to 4.06 cSt and 4.11cSt respectively after transesterification [6, 7]. It was reported that viscosity of linseed oil, sunflower oil, and jatropha oil reduced from 37.85cSt, 44.86cSt and 49.04 cSt respectively to 9.75cSt, 9.42 cSt, and 8.1 cSt respectively after transesterification [6, 7].

In this paper, an attempt has made to investigate the fuel properties such as viscosity specific gravity, viscosity, gross calorific value, flash and fire point of Neem oil methyl ester and its blends with conventional diesel oil in the proportions of 20:80 (B20), 40:60 (B40), and 60:40 (B60), 80:20 (B80).

An attempt has also made to study the fuel properties of Neem oil methyl ester blends with domestic kerosene oil and conventional diesel oil in the proportions (Methyl ester : Conventional diesel : Kerosene) of 20:75:5 (B20K5),40:50:10(B40K10),60:25:15(B60K15),and80:0:20(B80K20).

MATERIAL AND METHOD

Neem oil methyl ester was prepared by using two-stage transesterification process because their free fatty acids (FFA) level is greater than 1%. In the first stage, esterification reaction was carried out to minimize the FFA level. Minimum value of FFA was obtained by adding 15ml methanol and 1ml H_2SO_4 to 100ml of Neem oil. This reaction was carried at temperature range between 55^0C to 60^0C with a reaction period of 60 minutes using magnetic stirrer. In the second stage, maximum yield was obtained by adding 35ml methanol and 0.3 % NaOH to the sample (100ml) obtained from the first stage which has lowest FFA level. During this process, temperature range of 55^0C to 60^0C was maintained for a reaction period of 90 minutes.

Neem oil methyl ester-diesel oil blends were prepared by mixing 20% (B20), 40% (B40), 60% (B60) and 80% (B80) respective methyl ester with diesel oil on volume basis. In addition another four blends were prepared by replacing diesel oil proportion by 5% (B20K5), 10% (B40K10), 15% (B60K15) and 20% (B80K20) respectively in B20, B40, B60 and B80 with domestic kerosene oil on volume basis. The relative density of all test samples were determined in accordance with IS: 1448[P: 32]:1992. Redwood viscometer No 1 was used for measurement of kinematic viscosity in cSt was calculated from time units as per IS No. 1448[P: 25]:1976. Heating value was determined as per IS No 1448[P: 6]:1984 by using Isothermal bomb calorimeter. Pour point was determined as per IS NO, 1448 [P: 10]: 1970. Pensky –Martens closed cup) was used to find flash and fire point of test samples as per IS NO 1448 [P: 21]: 1992.

Properties of Neem oil methyl ester and its blends with diesel oil and kerosene

Table 1 shows characteristic fuel properties such as specific gravity, viscosity, gross calorific value, flash and fire point of diesel oil, Neem oil, Neem oil methyl ester and its blends with diesel oil and kerosene in different proportions. Table 1 indicates that density, viscosity, specific gravity and flash point of Neem oil are larger than Neem oil methyl ester and diesel oil.

Property	Neem oil	Diesel	B100	B20	B40	B60	B80	Kerosene	B20 K5	B40 K10	B60 K15	B80 K20
Density in kg/m^3	910	816	870	826.8	837.6	848.4	859.2	780	825	834	843	852
Specific gravity	0.91	0.816	0.87	0.8268	0.8376	0.8484	0.859	0.78	0.825	0.834	0.843	0.852
Viscosity at 40 ^{0}C in cSt	40.75	4.3	4.5	4.34	4.38	4.42	4.46	1.12	4.181	4.062	3.943	3.824
Flash point in ^{0}C	250	53	175	77.4	101.8	126.2	150.6	52	77.35	101.7	126.05	150.4
Heating value in MJ/kg	39.82	45.7	41.5	44.86	44.02	43.17	42.34	43	44.72	43.75	42.77	41.8

Table 1.1 Properties of Neem oil, Neem oil methyl ester (B100), and diesel oil and kerosene blends

Result and Discussion

Effect of specific gravity

The density of fuel is correlated with particulate emission. Figure 1.1 shows the specific gravity of Neem oil, diesel oil, and B20, B40, B60, and B100, B20K5, kerosene, B40K10, B60K15 and B80K20. Neem oil has highest specific gravity (0.910) which is reduced to 0.870 after transesterification. Specific gravity of B20 is very close to that of conventional diesel which is 1.032 times higher than conventional diesel oil. B100 has specific gravity of 0.870 which is 1.0661 times higher than the conventional diesel oil. Figure 1.1 indicates that specific gravity increases with the increase in percentage of methyl ester in the blend.

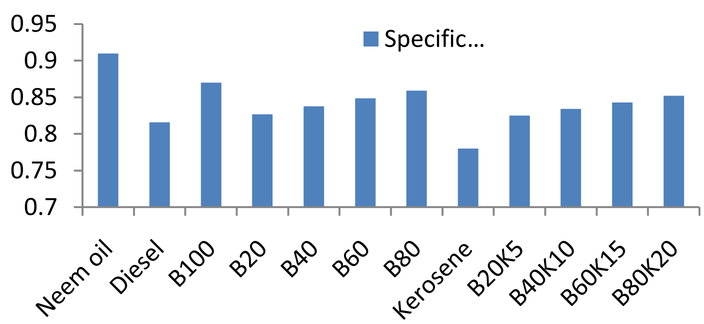
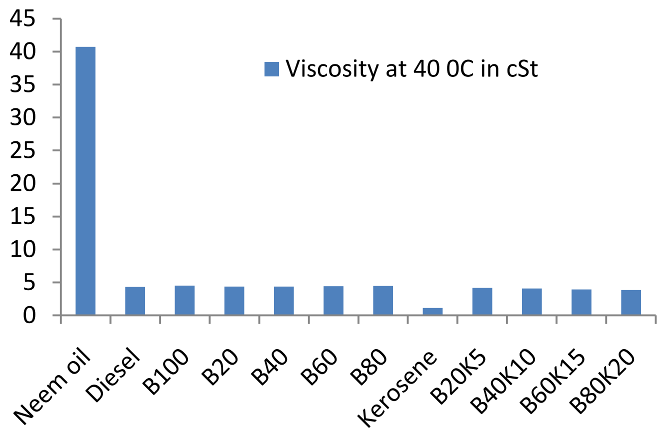


Figure 1.1 Specific gravity of Neem oil, biodiesel and its blends with conventional diesel oil and kerosene

From Figure1.1 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower specific gravity than biodiesel and conventional diesel oil blends. B20K5 has specific gravity of 0.825 which is very close to conventional diesel oil (0.816). Specific gravity of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

Effect of viscosity

Viscosity of fuel is an important fluid property because it determines flow characteristic when a liquid fuel flows through flow line, injector nozzle and orifices. Figure 1.2 shows the kinematic viscosity of Neem oil, diesel oil, and B20, B40, B60, and B100, kerosene, B20K5, B40K10, B60K15 and B80K20. Viscosity of B20 was observed 4.34 cSt which is 1.009 times higher than conventional diesel oil, Neem oil has highest viscosity (40.75 cSt at 40 ^{0}C) which is 9.477 times higher than conventional diesel oil after transesterification viscosity has decreased from 40.75 cSt to 4.5 which is 1.0465 times higher than diesel oil.



. Figure 1.2 Kinematic viscosity of Neem oil, biodiesel and its blends with conventional diesel oil and kerosene

Figure 1.2 also indicates that viscosity increases with the increase in percentage of methyl ester in the blends. Viscosity of Neem oil is higher than all other samples which is 9.056 times higher than B100 (4.5cSt).Viscosity of B20 (4.34 cSt) very close to that of conventional diesel oil which is 1.0093 times higher than conventional diesel oil. High viscosity of Neem oil and B100 attributed to molecular composition and structure, greater carbon chain length and reduced number of double bonds , high viscosity leads to pour atomisation of fuel spray which results in larger droplet size. This in turn leads to poor mixing of fuel and air, finally leads to incomplete combustion that results in loss of power and efficiency.

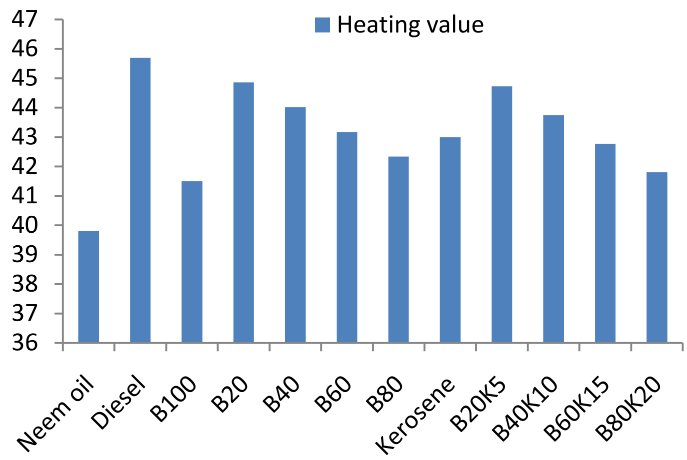
From Figure1.2 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower kinematic viscosity than biodiesel-conventional diesel oil blends. B20K5 has kinematic viscosity of 4.181 which is lower than conventional diesel oil (4.3). Kinematic viscosity of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

Effect of heating value

Table 1.1 indicates the heating values of Neem oil, diesel oil, and B20, B40, B60, and B100, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 1.3 indicates that Neem oil has heating value of 39.82MJ/kg which is 12.866% lower than the diesel oil. B100 has the heating value of 41.5 MJ/kg which is 9.19% lower than the diesel fuel. B20 has the heating value of 44.86 MJ/kg which is 1.838 % lower than the diesel. The lower heating value for all samples could be attributed to the presence of few hydrogen atoms and large number of oxygen atoms in the molecule. The lower heating value of methyl ester and their blends could result in loss of thermal efficiency as compared to conventional diesel oil.

From Figure1.3 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower heating value than biodiesel-conventional diesel oil blends. B20K5 has heating value of 44.725MJ/kg which is lower than conventional diesel oil (45.7 MJ/kg).

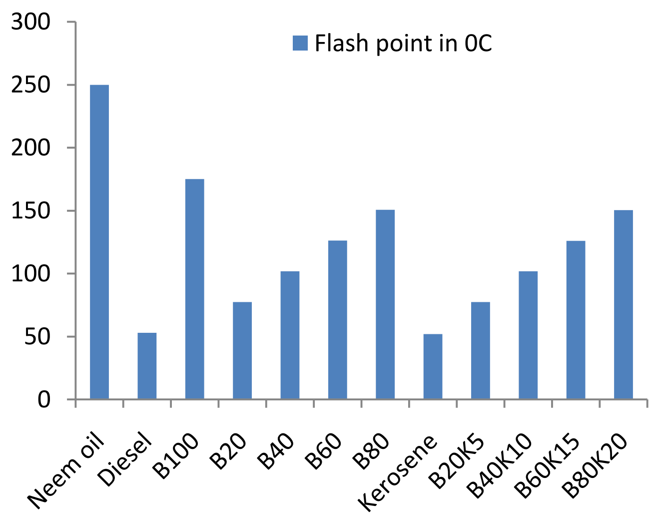
Heating value of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.



. Figure 1.3 Heating values of Neem oil, biodiesel and its blends with conventional diesel oil and kerosene

Flash point

Table 1.1 shows the flash point Neem oil, diesel oil, and B20, B40, B60, and B100, kerosene, B20K5, B40K10, B60K15 and B80K20.The flash point of B20 (77.4 ^{0}C) is 1.46 times higher than the conventional diesel oil. Figure 1.4 shows that flash point increases with the increase in percentage of methyl ester in the blend.



. Figure 1.4 Flash points of Neem oil, biodiesel and its blends with conventional diesel oil and kerosene

From Figure1.4 it is observed that, biodiesel, conventional diesel oil and kerosene blends have slightly lower flash point than biodiesel-conventional diesel oil blends. B20K5 has flash point of 77.35^{0}C which is higher than conventional diesel oil (53^{0}C). Flash point of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in the percentage of conventional diesel oil in the given percentage of biodiesel.

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