An Experimental Study On Physical Properties Of Jatropha As Biodiesel

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Abstract- *Developing industrialization and modernization of vehicles has led to the consumption of fossil fuels in large quantities. Usage of fossil fuels leads to the increase in global warming and causes environmental pollution, These fossil fuels certainly will get exhaust one or the other day. In recent days more studies have been carried out on various edible & non-edible plant oils. These plant oils are alternatives to fossil fuels used in engines. The physical properties of the biodiesel nearly match that of the fossil fuels as well as biodiesel is eco-friendly, economic with good performance characteristics. In this paper investigation is carried out on Jatropha oil as biodiesel in different blend ratios as J20, J40, J60, J80 & J100 in order to study the properties such as kinematic viscosity, density, flash point, fire point and calorific values. The results obtained represent viscosity, flashpoint and calorific values are within the limits of International standard for biodiesel.*

Keywords- Biodiesel, Jatropha oil, fuel properties

Nomenclature*:*

ASTM: American Society for Testing and Materials
NOx: Oxides of Nitrogen

I. INTRODUCTION

Rapid growth in civilization, transportation have led to the problems of global warming, harmful emissions causing damage to the earth because of high consumption of the petroleum based fuels. Biodiesel is an alternative fuel for diesel engine. The esters of vegetable oils and animal fats are collectively known as biodiesel. Biodiesel has an energy content of about 12% less than petroleum-based diesel fuel on a mass basis but it is domestic and renewable. It has higher molecular weight, viscosity, density and flash point than diesel fuel. Currently, biodiesel is becoming popular as an environment friendly fuel [1, 2]. The advantage of biodiesel over the conventional diesel fuel includes higher cetane number, low smoke and particulates, low emission of oxides of carbon and hydrocarbons. It is biodegradable and non toxic. Biodiesel comprises of monoalkyl esters of long chain fatty acids. It is produced using edible oil, non-edible oil and animal fats by acid or by base catalyzed transesterification with ethanol or methanol. The significant efforts have been made for obtaining biodiesel by transesterification of oil obtained from Jatropha curcas, soybean, sunflower, cotton seed, rapeseed and palm12. The ASTM-445 specification for viscosity at 40℃ of centistokes is generally met by biodiesel and biodiesel blends. The reported viscosity of soy methyl ester is ranging from 3.8 to 4.1 centistokes at 40°C. Addition of Glycerin will increase viscosity of biodiesel but it leads to many other problems. Estimation of surface tension of biodiesel suggests that it is two to three times as great as that of diesel. The major problem of using biodiesel in diesel engine is higher viscosity and cloud point. High viscosity of edible oil, non edible oil and animal fats tend to cause problem when directly used in diesel engines [3, 4]. The fuel droplet size during injection is affected by the above properties. Higher NOx emission may be due to larger droplets resulting from both viscosity and surface tension of Biodiesel. Transesterification of oil and fats using short chain alcohols, results in monoesters having viscosity that is closer to petroleum based diesel fuel [5, 6]. The physical and chemical properties such as viscosity, density, flash point, cloud point, cetane number, and acid value etc. affect the biodiesel engine performance and emission. In turn, these properties are derived from the fatty acid composition and the properties of the individual fatty esters in biodiesel. Increase in chain length and decrease in unsaturation of fatty acids result in increase in cetane number, heating value and viscosity.

Studies conducted by different researchers around the world revealed that biodiesel is proven as a substitute for mineral diesel and at the same time reducing the emission significantly [7-10]. Moreover, several authors have evaluated the performance characteristics of conventional diesel engine fuelled with biodiesel and their blend with mineral diesel with alcohol as an additive. In general, biodiesel that originated from palm oil has different properties as compared to other biodiesel obtained from other organic sources as well as mineral diesel. Palm oil has greater density and viscosity compared to mineral diesel. Therefore, a comprehensive data of biodiesel and their blend fuel physical properties is required to analyse the characteristics of biodiesel when operated with conventional diesel engines. The fuel physical properties are very critical parameters in the atomization process in compression ignition engines. Viscosity plays an important role in the atomization quality which in turn is affected by fuel injection inside the combustion chamber, distribution of fuel, droplet size and the uniformity of the mixture. In addition, larger surface tension affects the dissolution of a liquid jet into smaller fuel droplets.

In the present work, the physical properties of Jatropha seeds containing 35%-40% oil by weight is investigated. Glycerol is a by-product of transesterification process. The most important variables which influence the transesterification reaction are reaction temperature, ratio of alcohol to vegetable oil & catalyst mixing intensity. And the factors that affect biodiesel activity are molar ratio, moisture and water content. The objective of this study is to determine the properties of the Jatropha biodiesel of following blend J100, J80, J60, J40, J20 with diesel.

II. EXPERIMENTAL SET UP AND PROCEDURE

Jatropha biodiesel with diesel in six different types of blend are used for investigating kinematic viscosity, density, flash point, fire point and calorific values of J100 (100% Jatropha biodiesel with 0% diesel), J80(80% Jatropha biodiesel with 20% diesel), J60(60% Jatropha biodiesel with 40% diesel), J40(40% Jatropha biodiesel with 60% diesel), J20(20% Jatropha biodiesel with 80% diesel) & diesel (0% Jatropha biodiesel).

Figure 2.1 represents redwood viscometer. Viscosity is determined using Redwood viscometer which consists of a vertical cylinder with an orifice at the centre of the base of inner cylinder. The water bath surrounds the cylinder in which the temperature of biodiesel is evaluated to required temperature.

Figure 2.1 Redwood Viscometer

Figure 2.2 represents Cleveland's open cup apparataus. This apparatus is responsible for measuring the flash point & fire point of biodiesel blends.

Fig. 2.2 Cleveland's open cup apparataus

Figure 2.3 represents Bomb calorimeter. Bomb calorimeter is a device which is used to measure the calorific value of biodiesel blends.

Fig.2.3.Bomb Calorimeter

III. RESULTS AND DISCUSSION

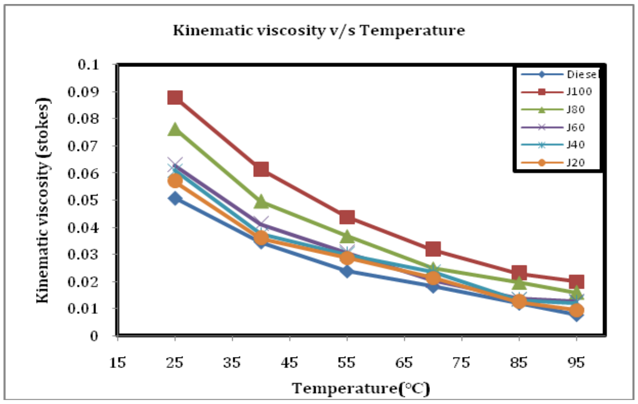

Fig 3.1 Kinematic viscosity v/s Temperature

Viscosity of a fluid is defined as a measure of its resistance to its deliberate deformation by shear stress or tensile stress. In the figure 3.1 it is observed that kinematic viscosity is a function of temperature. Kinematic viscosity decreases with increase in temperature. It is also seen that as the blend percentage increases from J20 to J100 so also the kinematic viscosity for blends from J20 to J100 varies. In the figure 3.1 it can be clearly seen that the kinematic viscosity for J20 blend matches nearly to that of diesel. Kinematic viscosity is calculated using the following formula.

$$X=At-\frac{B}{t}$$

where

X:kinematic viscosity of biodiesel.

t: time required in seconds to pass 50ml of biodiesel.

A=0.264 is constant for t in the range of 40 to 85.

B=190 is constant for t in the range of 40 to 85.

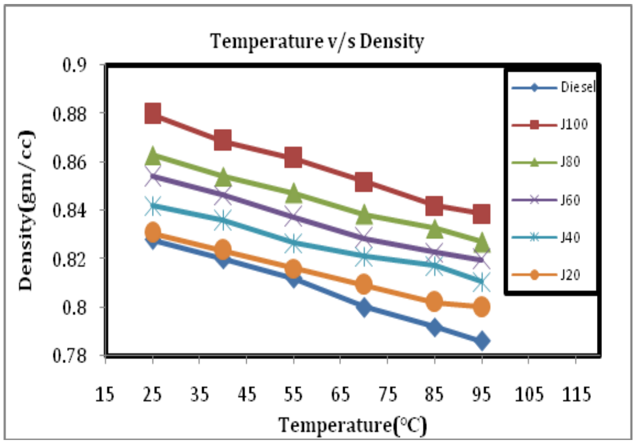

Fig.3.2 Density v/s Temperature

Density of fuel is defined as mass per unit volume. In the figure 3.2 it can be seen that density decreases with increase in temperature. Increase in percentage of blending concentration leads to increase in density of biodiesel blends. This is due to higher viscosity, poor atomization leads to increase in density for higher concentration biodiesel blends. In the figure 3.2 density of J20 blend follows the trend of diesel with sight variation at higher temperatures. Density is calculated using the equation.

$$\rho_f=\frac{(W3-W1)}{(W2-W1)}*\rho_{water}$$

ρ_f: Density of fuel(gm/cc).

ρ_{water}: Density of water (gm/cc)

W_1: weight of empty bottle (gm).

W_2: weight of bottle with water (gm).

W_3: Weight of bottle with fuel (gm).

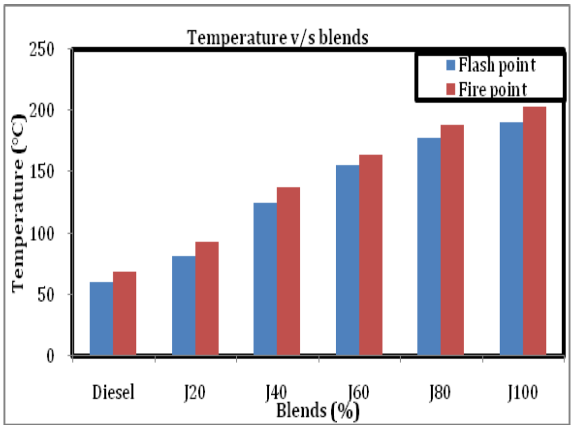

Fig.3.3 Temperature v/s Blends

Flash point of a fuel is essentially lowest temperature at which vapors from a test fraction combines with air to give a flammable and a flash when ignition source is supplied. Fire point is the lowest temperature at which test flame causes oil surface to ignite & burn continuously. In the figure 3.3 it is clearly observed that increase in biodiesel blend percentage results in increase of flash point fire point temperatures. This is due to increase in viscosity, density with increase in biodiesel percentage. In the figure J20 blend has the flash point, fire point which nearly matches to diesel.

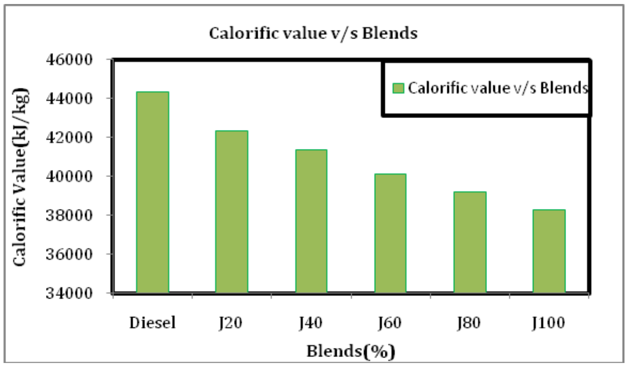

Fig.3.4 Calorific value v/s Blends

Calorific value of fuel is defined as the energy content present in the fuel useful for combustion to do work. In the figure 3.4 it is observed that calorific value of the fuel decreases with increase in biodiesel blend percentage. With increase in biodiesel blend percentage viscosity of biodiesel increases, resulting to have poor atomization decreasing energy content in the biodiesel blends to reduce the calorific value of the biodiesel blends at higher percentage. In the figure 3.4 calorific value of J20 blend is nearer to the calorific value of diesel.

IV. CONCLUSIONS

Different physical tests are conducted on Jatropha biodiesel blends and diesel. After certain test comparisons J20 biodiesel blend is decide to be the substitute fuel for diesel with the following conclusions.

1. Kinematic viscosity & density of J20 biodiesel blend are nearly to diesel.
2. Flash point & fire point of J20 blend are similar to diesel.
3. Calorific value of J20 biodiesel blend matches diesel.

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