VISCOSITY BEHAVIOR OF BIODIESEL AND DIESEL BLENDS

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Abstract. *Diesel-biodiesel blends are developed and tested using a rotational rheometer. Biodiesel of palm oil and beef tallow grease was blended with fuel oil no. 2. Pure substances was tested using an capillar viscosimeter Cannon Fenske and blendes of this in 5, 10, 15 and 20% in volume proportion was developed and tested in a rheometer. The pure fluids and yours blendes have a newtonian behavior, but the viscosities values of blends have not a classical behavior. This anomalous behavior can be explained by a miscible problem between esters and paraffinic hydrocarbons.*

Keywords*: biodiesel, viscosity, rheology*

1. INTRODUCTION

Most of the energy consumed worldwide comes from oil, coal and natural gas. With the depletion of energy sources, especially fossil fuels, particularly its inability to renew, there is a reason the development of technologies to use renewable energy sources (Ferrari *et al*., 2005).

Vegetable oils appear as an alternative source of fuel, its direct use in internal combustion engines is not a recent innovation. In 1900, Rudolph Diesel (1858 - 1913), inventor of the diesel engine cycle, used vegetable oil from peanuts to demonstrate his invention in Paris (Rabelo, 2001 and Demirbas, 2003).

The advantages of vegetable oil as fuel for the diesel are: liquid natural, renewable, high energy, low content of sulfur, low aromatic content and biodegradable (Fangrui *et al*., 1999). The transesterification of oil with alcohol, specifically methanol or ethanol, promotes the breakdown of the triglyceride molecule, generating a mixture of ethyl or methyl esters of fatty acids that are released as a co-product glycerine. The molecular weight of monoesters is close to that of diesel (Ramos, 1999). Methanol is the most used in the transesterification for reasons of physical and chemical nature (polarity and short chain). However, ethanol is more popular, because it is renewable and much less toxic than methanol (Kitakawa *et al*., 2007).

In Brazil, nowadays, an advantage of course is the supply of ethyl alcohol, disseminated throughout the national territory, under the environmental point of view, the use of ethanol takes advantage of the use of methanol, as the latter is usually obtained from derivatives oil. Some advantages of the use of ethanol, such as: Alcohol production in Brazil has already consolidated, biodiesel with a higher cetane number and lubricity increased as compared to methanol biodiesel if made from biomass (such as almost the entire of the Brazilian production), produces a 100% renewable fuel, is not as toxic as methanol and has a lower risk of fires.

Brazil has the second largest herd of cattle in the world, annually producing 200,000 tons of beef tallow. This waste is composed of fat, that has triglycerides as constituted principally palmitic acid (~ 30%), stearic (~ 20-25%) and oleic (~ 45%) (Aboissa, 2005). Considering its high yield and low cost of marketing, the tallow is presented as a choice of material for the production of biodiesel, an alternative fuel to diesel oil. Among the permanent crops, you can also highlight the palm, which can be an important source of vegetable oil, it shows the extraordinary productivity of more than 5,000 kg of oil per hectare per year. This value is about 25 times higher than that of soybean. However, this value is only reached 5 years after planting. The oil from palm oil contains equal proportions of saturated fatty acids (44% palmitic and stearic 4%) and unsaturated (40% oleic and linoleic acid 10%).

The use of biodiesel has a number of environmental benefits, economic and social. Studies show that the substitution of mineral diesel by biodiesel results in emission reductions of 20% sulfur, 9.8% carbon dioxide, 14.2% of unburned hydrocarbons, 26.8% of particulate matter and 4.6% of nitrogen oxides. Environmental benefits may also be generating economic benefits.

This work was carried out to evaluate the effect of the addition of biodiesel from palm oil and biodiesel from beef tallow, produced by ethyl route on the property of viscosity of diesel oil in the mineral mass fractions ranging from 0, 5, 10, 15, 20 and 100% biodiesel in diesel oil and also perform its characterization.

2. MATERIALS AND METHODS

2.1. Biodiesel production

The production of biodiesel derived from palm oil and beef tallow was performed by an ethanol esterificatio - transesterification reaction used acid catalyst, H_2SO_4, followed by transesterification reaction used a base catalyst, KOH. This process was realized in a stirred tank reactor by 3 hours and 75ºC. A mixture of ethyl esters, ethanol and glycerol was obtained. The esters are removed of this washing the mixture with heat water, 75ºC. Separation process is realized by decantation. Multiples cool water wash was realized for remove glycerin, soap alcohol and catalyst.

Diesel and biodiesel samples were characterized according to the ASTM standards and proprieties are showed in the table 1.

Table 1. Result characterizations of diesel/biodiesel.

Features	Diesel	Biodiesel of palm oil	Biodiesel of beef tallow
Density	0,8570	0,8696	0,8647
Viscosity 40°C (cSt)	4,689	5,402	5,027
Flash point (°C)	82	158	158
Cloud Point (°C)	2	13	15
Pour Point (°C)	-12	6	-11
Corrosivity	1a	1a	1a
Calorific value		41700,000	42365,000
Molecular weight	230,0	284,8	288,5

2.2. Splash-blending

Mixtures of diesel/biodiesel were prepared with volume fractions of 0, 5, 10, 15, 20 and 100% biodiesel.

The samples were mixed in a becker under continuous agitation to ensure uniformity of the mixture. All mixtures were stored in amber glass bottles. The mixtures were named according to the ASTM standard for biodiesel specified.

2.3. Fuel viscosity measurement

Kinematic viscosity tests of mixtures were measured by capillary method, using a Cannon Fenske Capillary 100, but the standards deviations of values were very large. To solve this problem Dynamic viscosity was measured using a Thermo Haake Rheometer RheoStress model RS50. A cylindrical sensor DG41 was used and the test temperature was 40ºC. A sample of 10.8 ml of mixture was utilized for each test. This test was developed using a linear shear stress application, from 0.05 to 15 Pa. Comparative test for 360 seconds and 3600 seconds for the stress application was realized without finding relevant influence of time of test in the dynamic viscosity measurement, as can be observed in the Fig. 1. For this test diesel fuel was used and its Newtonian behavior is comproved.

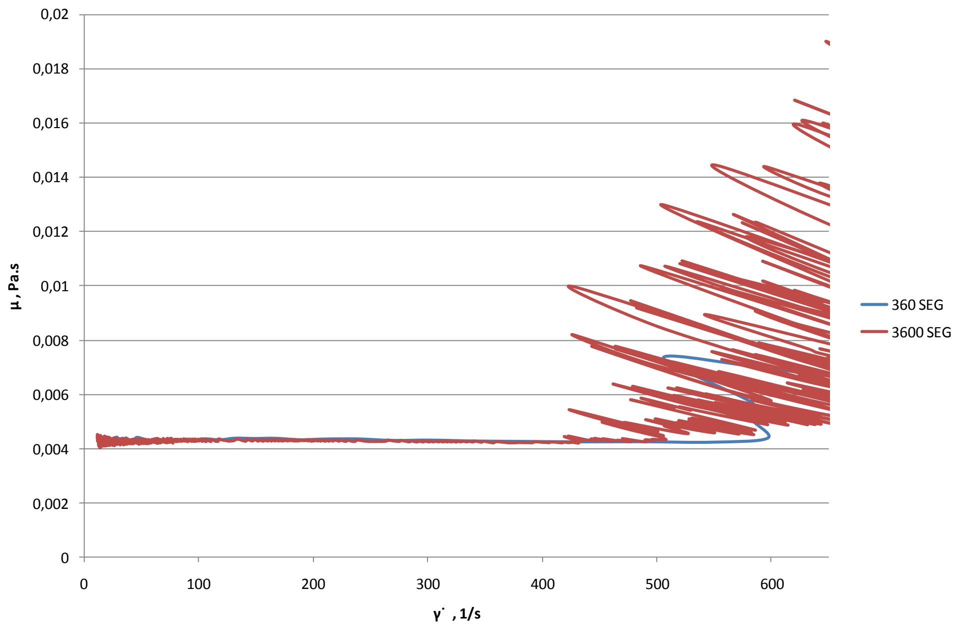

Figure 1. Comparative test of viscosity measurement for 360 seconds and 3600 seconds

Curves of dynamic viscosity behavior for diesel and ethylic palm oil biodiesel blendes are showed in the Fig. 2. In the Fig. 3 the viscosity behavior for tallow beef biodiesel blends are showed.

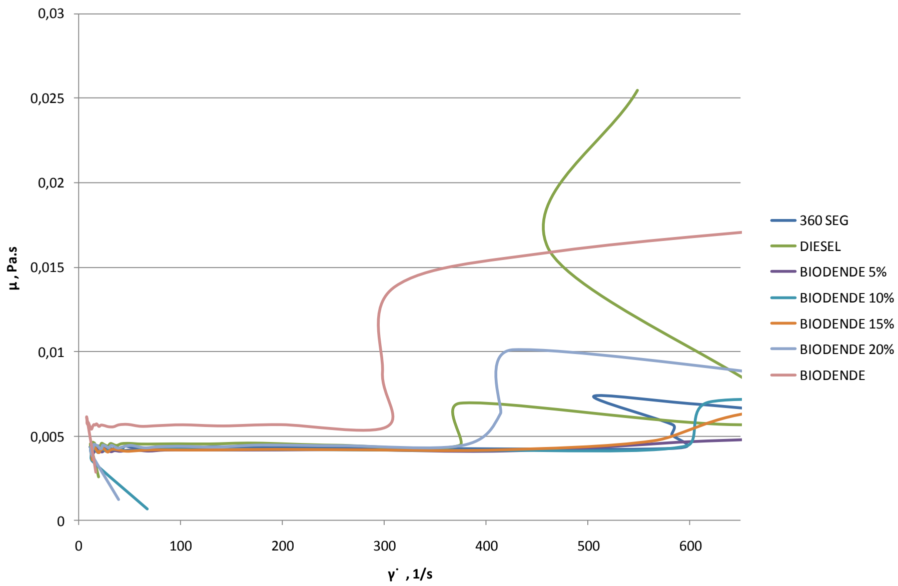

Figure 2. Dynamic viscosity for Diesel – Palm Oil Biodiesel Blend

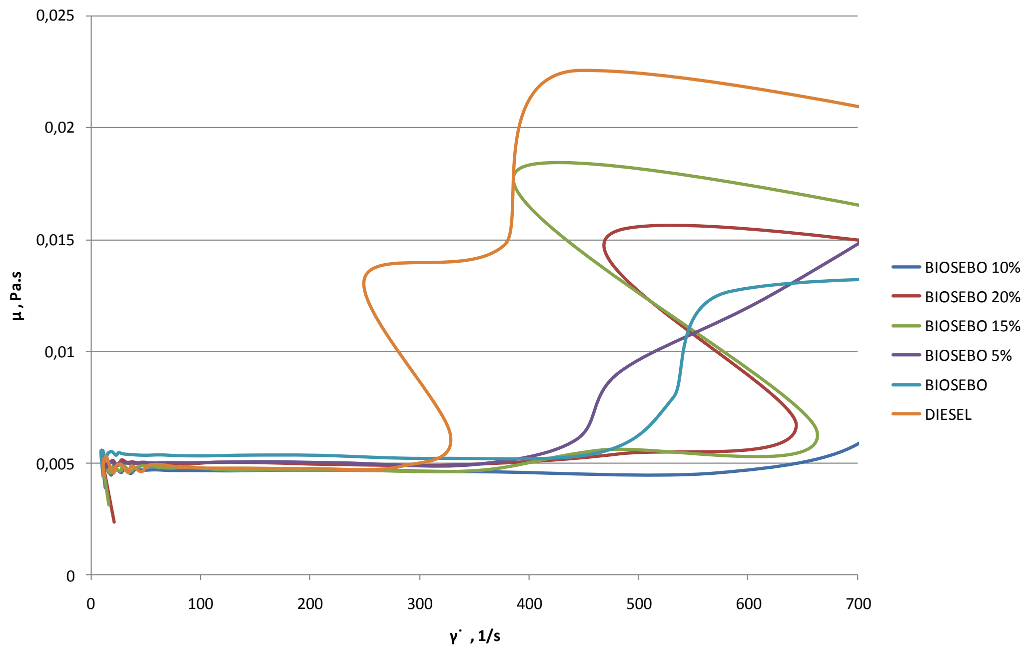

Figure 3. Dynamic viscosity for Diesel – Tallow Beef Biodiesel Blend

In the Figures 2 and 3 the Newtonian behavior of diesel, biodiesel and blendes is observed into the laminar limits for this cylindrical sensor. Kinematic viscosity was calculated from mead value of measured dynamic viscosity for Newtonian behavior and compared with the value obtained in the capillary Cannon-Fenske viscosimeter.

3. RESULTS AND DISCUSSION

The results of measurements kinematic viscosity for diesel, biodiesel and mixtures studied are shown in the graphs below.

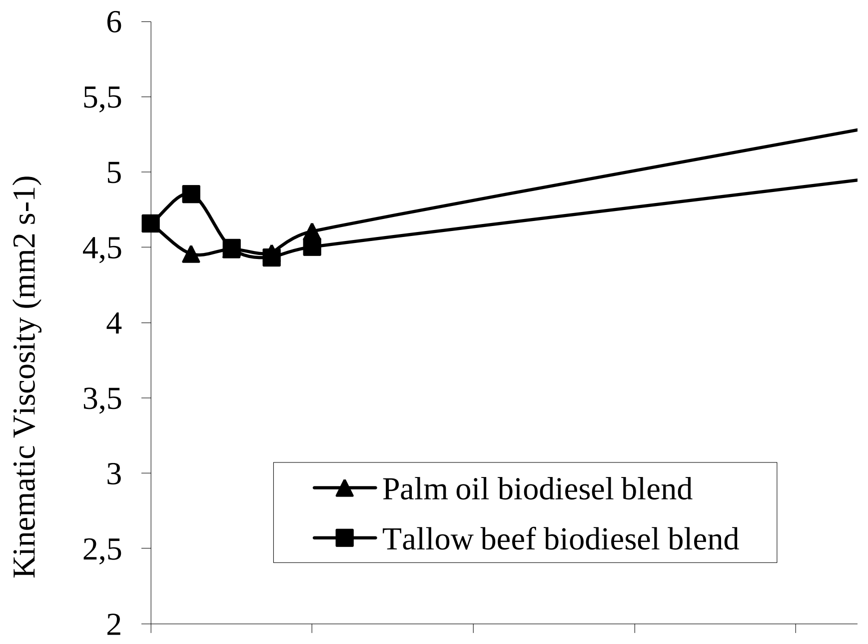

Figure 4. Kinematic viscosity versus Percent blend diesel-biodiesel

An anomalous viscosity behavior can be observed in the Fig. 4. Problems of dilution of biodiesel into the diesel were considered, and replicas were realized. However the viscosities obtained values were equals. This behavior can be explained as an effect of miscibility or molecular interaction of ethyl esters and paraffinic hydrocarbons. The blendes were detailed observed. Despite the orange coloration of palm oil biodiesel separation or phase difference cannot be observed for any mixture percentage.

4. CONCLUSION

Kinematics viscosities of biodiesels are very close to diesel viscosity and can be measures using a Cannons Fenske viscosimeter. Repeatability problems in the mixture test, bigger standard deviation, indicate the use of rotary rheometer for viscosity test development. The blends were tested, dynamic viscosities were measured and then cinematic viscosities were calculated. An anomalous behavior of viscosity was observed for the blends. Miscibility or molecular interaction can be source of this behavior. Composition test is recommended and new viscosity measures will be realized.

5. ACKNOWLEDGEMENTS

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