ORIGINAL PAPER

ASSESSMENT OF RHEOLOGICAL BEHAVIORS OF COCONUT OIL

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Abstract. *In this article we have presented the dependence of dynamic temperature vicinity at all shear rates for coconut vegetable oil used as biodegradable lubricant. Dynamic viscosity decreases exponentially with increasing temperature at all shear rates. At high temperatures the dynamic viscosity decreases less significantly. The shear speed increases linearly with the shear voltage at all temperatures studied. The dependence of dynamic temperature viscosity shows a polynomial decrease over the entire shear rate range.*
Keywords: *rheological, coconut oil, viscosity.*

1. INTRODUCTION

Viscosity is one of the important properties that strongly affect the lubricant behavior, being dependent on pressure, temperature, time and shear rate. Tests pointing out the simultaneous influence of these factors are rare because of synergic effects that occur. Due to newly designed equipment of measuring viscosity data and software that could approximate the experimental data, the mapping of this very important characteristic of fluid could be drawn and interpreted for a better design of the lubricating system [1-6]. Regression of the data showed that the relationship between viscosity and temperature had followed the modified Andrade equation [7]. Verduzco [8] studied the effect of molecular weight, the number of double bonds and temperature on the dynamic viscosity for different grades of biodiesel.

The empirical models correctly reproduced the behaviors of the physical properties of methyl ester compounds. The results suggested a relationship between molecular weight, fatty acid methyl ester type (saturated or unsaturated), and temperature, as independent variables; and each one of the density and dynamic viscosity. Mixing rules in conjunction with empirical models were used to successfully predict the density and viscosity of tested biodiesel grades. Based on this study, we can conclude that the mix of components is of great importance when studying fat acids or vegetable oils [5, 9].

Coconut fat is one of the major ingredients for food production in Southeast Asia and also famous in European countries in both food and non-food industries. Generally, coconut fats belong to the unique group of vegetable oils called lauric oil about 44 – 51 %. Lauric acid ($CH_3(CH_2)_{10}COOH$) is known as small molecule fatty acid (< 14:0) which contains a short or medium chain of saturated fatty acid. Other chemical compositions of coconut oil belong to myristic acid (16 – 19%), caprylic acid (9.0 – 9.5 %), palmitic acid (8.0 – 9.5 %), oleic acid (5 – 6 %), capric acid (5 – 10 %), stearic acid (3.0 – 3.5%) and linoleic acid (1.0 – 1.5 %), respectively [1,2]. More than 90 % of fatty acids of coconut oil are saturated.

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The objective of this research is to assess the rheological properties of coconut oil. The dependence of shear stress of coconut oil on shear rate will be studied. The dynamic viscosity and shear stress of coconut oil as a function of temperature will be measured. The relationship between the dynamic viscosity and shear stress of coconut oil with temperature will be found by fitting equations. In addition, the flow behavior of coconut oil will be determined whether Newtonian or non-Newtonian [9-14].

2. MATERIALS AND METHODS

Types of coconut oil used in this paper are produced in Romania. The coconut oil has been investigated using a Haake VT 550 Viscotester developing shear rates ranging between 3 and 120 s^{-1} and measuring viscosities from 10^4 to 10^6 mPa·s when the HV_1 viscosity sensor is used. The temperature ranged between 40 and 100°C and the measurements were made from 10 to 10°C. The accuracy of the temperature was ± 0.1°C.

3. RESULTS AND DISCUSSION

Fig. 1 shows the dependence of the dynamic shear velocity viscosity on the temperature range 40-100°C. As seen from the graph the viscosity decreases with increasing temperature, and at high shear rates, the viscosity remains almost constant for the oil studied. The viscosity of the oil decreases exponentially with increasing temperature and shear speeds.

Fig. 2 shows the dependence of the shear rate on the shear voltage over the entire temperature range. As can be seen from the graph, the shear rate increases linearly with the shear voltage at all temperatures studied.

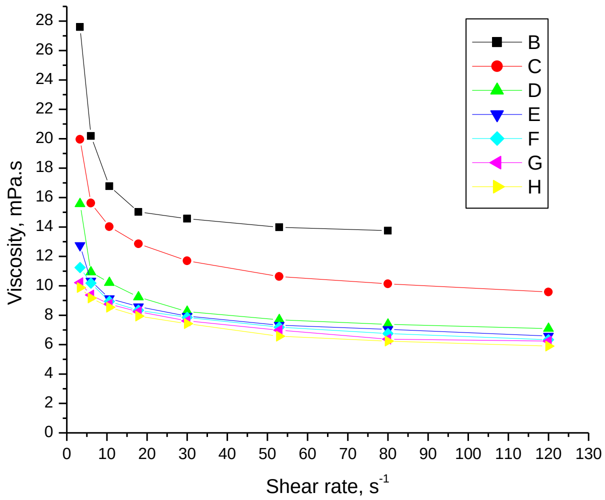

**Figure 1. Dependence dynamic viscosity versus shear rate at temperature: B-40°C, C-50°C, D-60°C,
E-70°C, F-80°C, G-90°C, and H-100°C.**

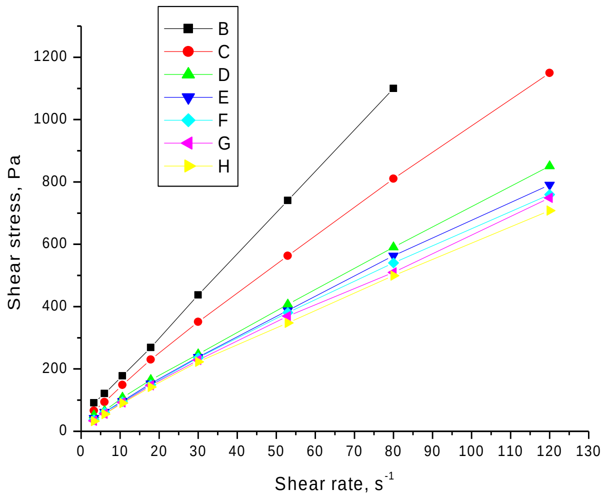

Figure 2. Rheograms for oil coconut at temperature: B-40°C, C-50°C, D-60°C, E-70°C, F-80°C, G-90°C, and H-100°C.

Fig. 3 shows the dependence of the dynamic temperature viscosity on the entire shear rate range. As can be seen from the graph, the dynamic viscosity decreases with increasing temperature and remains almost constant at high shear rates. The dependence of dynamic temperature viscosity shows a polynomial decrease over the entire shear rate range.

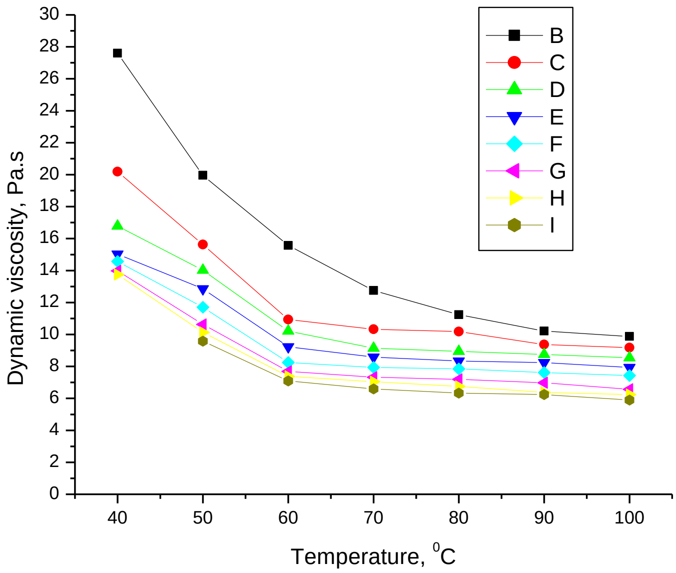

Figure 3. Dependence dynamic viscosity versus temperature at shear rate: B-3.3s^{-1}, C-6s^{-1}, D-10.6s^{-1}, E-17.87s^{-1}, F-30s^{-1}, G-52.95s^{-1}, H-80s^{-1}, and I-120s^{-1}.

Fig. 4 shows the dependence of the dynamic viscosity on the correlation coefficients. At all temperatures and shear speeds, they have values between 0.9500 and 0.9900. As the issues increase the errors are larger as seen in the graph.

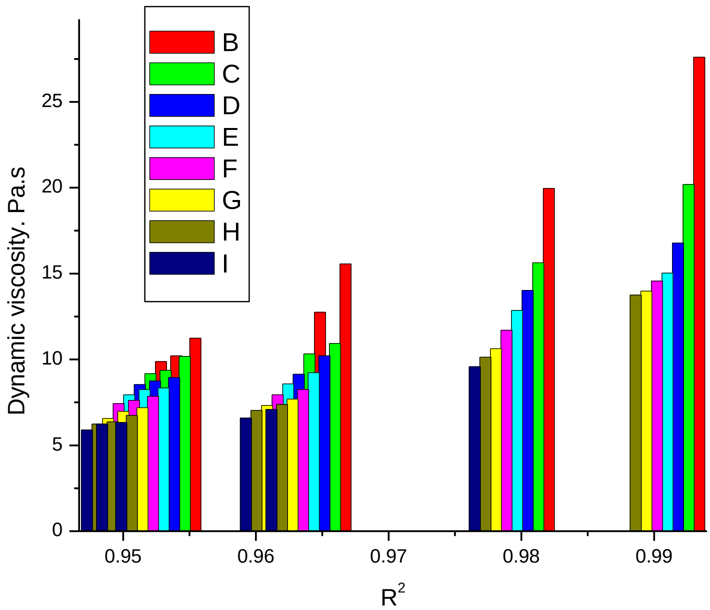

Figure 4. Dependence dynamic viscosity versus R^2 at temperature: B-40°C, C-50°C, D-60°C, E-70°C, F-80°C, G-90°C, and H-100°C.

Fig. 5 shows the graph of the temperature dependence of correlation coefficients for all shear speeds and dynamic viscosities. As can be seen from the graph this dependence is described by a polynomial relation of the form.

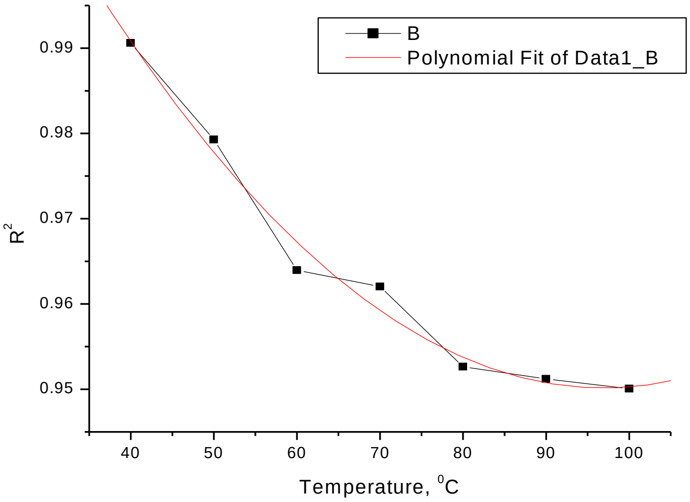

Figure 5. Dependence R^2 versus temperature for oil coconut.

4. CONCLUSIONS

It can be concluded that, for the investigated oil the dynamic viscosity decreases exponentially with the shear rate at all temperatures. The shear rate decreases linearly increase with the shear stress for coconut oil. The dynamic viscosity decreases with increasing temperature and remains almost constant at high shear rates. The dependence of dynamic temperature viscosity shows a polynomial decrease over the entire shear rate range.

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