Research Paper

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Regression Models that Describe Sunflower Oil Dynamic Viscosity of Temperature Absolute

Chemistry

KEYWORDS : Relationship, Dynamic Viscosity, Sunflower Oil

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ABSTRACT

This article proposes two new relations of dependence of ln viscosity depending on temperature inverse shear rates between 3.3 and 120s-1. The constants A, B, and C were determined by Origin 6.0 software by fitting linear or polynomial curves obtained from experimental data. The two proposed relationships give correlation coefficients close to one.

INTRODUCTION

Sunflower oil is the non-volatile oil compressed from sunflower (Helianthus annuus) seeds. Sunflower oil contains predominantly linoleic (48–7%), oleic (14–40%), palmitic (4–9%) and stearitic (1–7%) [1, 2]. There are several types of sunflower oils produced, such as high linoleic, high oleic and mid oleic. High linoleic sunflower oil typically has at least 69% linoleic acid. High oleic sunflower oil has at least 82% oleic acid. The variation in the unsaturated fatty acids profile is strongly influenced by both genetics and climate. Sunflower oil also contains lecithin, tocopherols, carotenoids and waxes. Sunflower oil's properties are typical of vegetable triglyceride oil. It is light in taste and appearance and has high vitamin E content. The refined oil is clear and slightly amber-coloured with a slightly fatty odour. Sunflower oil is liquid at room temperature and has the following characteristics: smoke point (refined): - 232 °C, smoke point (unrefined) - 227 °C, density (25 °C) - 917 kg/m^3, refractive index (25 °C) - 1.473 [3, 4]. The sunflower oil has been proposed several empirical relationships describing the temperature dependent dynamic viscosity. The more important of these is the Andrade equation (1). Andrade [5, 6] equations are modified versions of equations (2) and (3) [7-12]:

$$\eta = A\cdot 10^{B/T} \quad (1)$$

$$\ln \eta = A + B/T + C/T^2 \quad (2)$$

and

$$\ln \eta = A + B/T + CT \quad (3)$$

T is the temperature absolute and A, B and C in the equations (1) to (3) are correlation constants. This article proposes two new relationships of dependence of the ln viscosity with 1/T for sunflower oil. The dynamic viscosity of oils was determined at temperatures and shear rates, the 100°C and the 40°C, respectively, 3.3 to 120 s^{-1}. The purpose of this study was to find a linear or polynomial dependence between temperature and natural logarithm of dynamic viscosity of sunflower oil using Andrade equation changes. Equation constants A, B and C were determined by fitting linear or polynomial.

MATERIALS AND METHOD

The sunflower oil used in this work is provided by a company from Bucharest, Romania. The sunflower oil were 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 ranging was from 40 to 100^{0}C and the measurements were made from 10 to 10 degrees. The accuracy of the temperatures was ± 0.1°C.

RESULTS AND DISCUSSION

Figure 1 shows dependence the ln viscosity on the 1/T for studied sunflower oil at shear rate 3.3s^{-1}, 6s^{-1}, 10.6s^{-1}, 17.87s^{-1}, 30s^{-1}, 52.95s^{-1}, 80s^{-1} and 120s^{-1}.

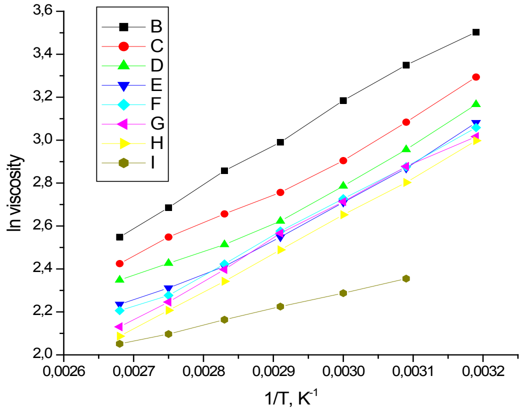

Figure 1: The dependence ln viscosity on the 1/T at: B – 3.3s^{-1}, C – 6s^{-1}, D – 10.6s^{-1}, E – 17.87s^{-1}, F – 30s^{-1}, G – 52.95s^{-1}, H – 80s^{-1} and I – 120s^{-1}

This article proposes two (4) and (5) dependency relations of ln viscosity according to the inverse temperature for sunflower oil. We used the computer program Origin 6.0 to determine the constants A, B and C and the correlation coefficients, R. The values of constants A, B and C were determined by fitting linear or polynomial curves obtained for sunflower oil.

$$\ln\eta = A + B/T \quad (4)$$

and

$$\ln\eta = A + B/T + C/T^2 \quad (5)$$

The dependence of ln viscosity on the 1/T for sunflower oil at shear rate 3.3s^{-1} (the black curve from Fig. 3) was fitting linear as shown in figures 3. The linear dependence of ln viscosity on the 1/T for sunflower oil at 3.3s^{-1} is described for equation (4):

$$\ln\eta = -2.5197 + 1895.23081/T$$

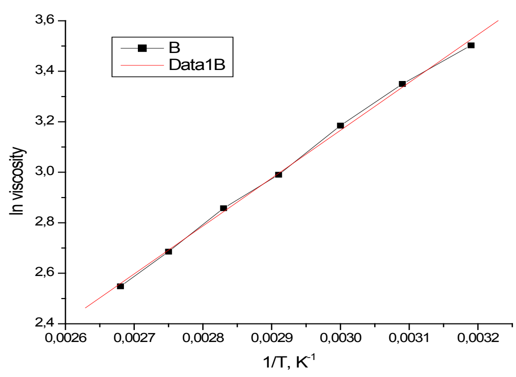

Figure 2: The dependence ln viscosity on the 1/T at 3.3s^{-1}

for right to B and 1B represents the linear fitting to B

Table 1 shows the value of parameters of the described by equation (4) sunflower oil and correlation coefficient, R. As shown in table 1 the software found it linear equation applied shear rate right of sunflower oil. The root mean square error means that experimental data is spread equation. Remains the same temperature range, where the equation was fitted other experimental data.

TABLE - 1
THE SHEAR RATE, VALUE OF PARAMETERS OF DESCRIBED BY EQUATION (4) AND COEFFICIENT CORRELATION FOR SUNFLOWER OIL

Shear rate, s-1	Value of parameters of the described by equation (4)		Correlation coefficient, R2
	A	B	
3.3	-2.5197	1895.23081	0.99901
6	-2.02832	1656.10189	0.99576
10.6	-1.98838	1600.93163	0.99196
17.87	-2.27895	1668.50662	0.99533
30	-2.3967	1707.6516	0.99878
52.95	-2.62642	1776.67103	0.99873
80	-2.68867	1779.94606	0.99984
120	0.0481	746.86777	0.99965

The dependence of ln viscosity on the 1/T for sunflower oil at shear rate $3.3s^{-1}$ (the black curve from Fig. 3) was fitting polynomial as shown in figure 3. The polynomial dependence of natural logarithm dynamic viscosity on the temperature for sunflower oil at $3.3s^{-1}$ is described for equation (5):

$$\ln\eta = -6.23162 + 4434.81152/T + (-432904.585)/T^2$$

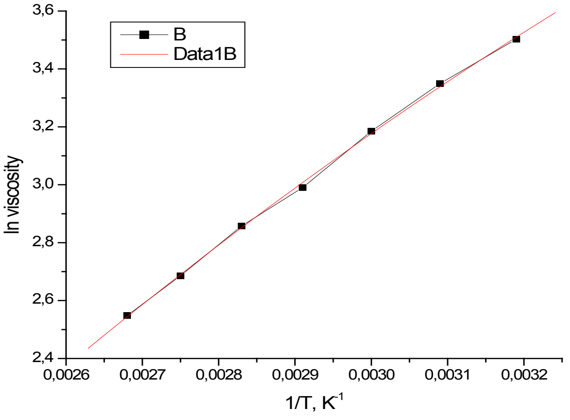

Figure 3: The dependence ln viscosity on the 1/T at $3.3s^{-1}$ for curve to B and 1B represents the fitting polynomial to B

Table 2 shows the value of parameters of the described by equation (5) sunflower oil and correlation coefficient, R. As shown in table 2 the software found it polynomial equation applied shear rate right of sunflower oil.

TABLE - 2
THE SHEAR RATE, VALUE OF PARAMETERS OF DESCRIBED BY EQUATION (5) AND COEFFICIENT CORRELATION FOR SUNFLOWER OIL

Value of parameters of the described by equation (5)			Correlation coefficient, R^2
A	B	C	
-6.2316	4434.8115	-432904.585	0.9991
5.7637	-3674.9680	908750.2511	0.9979
9.7945	-6460.5434	1.37418E6	0.9996
6.9047	-4614.6898	1.07105E6	0.9995
-0.0527	103.9644	273369.3442	0.9981
-6.5306	4447.8134	-455330.9820	0.9988
-1.3737	880.3194	153353.0690	0.9998
-0.2217	934.4332	-32511.6369	0.9993

CONCLUSIONS

The dynamic viscosity of sunflower oil was determined at temperatures between 313 and 373K and shear between $3.3s^{-1}$ and $120s^{-1}$. This article proposes two new relations of dependence of ln viscosity according to the inverse temperature. The values of constants A, B and C and the correlation coefficients were determined by linear and polynomial fitting of the experimental curves using Origin 6.0 software.

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