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Brief communication

Rheological Characteristics of Corn oil used in Biodegradable Lubricant

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ABSTRACT

The rheological behavior of corn oil can be studied with four rheological models found in the specialized literature.The rheological behavior of corn oil can be analyzed if it is subjected to an increasing shear rate. The behavior of this fluid can be appreciated based on the experimental data, graphically representing the variation the shearing stress with the shear velocity. This curve represents the mathematical model of the rheological behavior of the product. The rheological behavior of the corn oil was analyzed with the mixing rheometer type Viscotester VT 550 (Haake).

Keywords: Corn, Rheology, Lubricant.

INTRODUCTION

Due to their role and importance, vegetable oils are used both in food and as raw material for various industries. Following the processing of raw materials, edible oils, technical oils, hydrogenated oils, interesterified oils and margarine are obtained as finished products in oil factories. Among the edible and technical oils manufactured in our country, the most important is corn germ oil, the main physical and chemical properties are: density 921-926 kg.m^{-3} at 15°C, refractive index at t°C–1, 4689-1, 4736 at 15°C, viscosity at 20°C in E–9-11, melting point in °C-(-11), iodine index–111-130[1-3].

Vegetable oils are complex natural mixtures of simple lipids (glycerides and waxes), compound lipids (phosphatides, cerebrosides, sulfolipids) and substances resulting from the hydrolysis of the first two categories of lipids (alcohols, sterols, fatty acids, carotenoids, hyposoluble vitamins), glycerides representing 97.5-99% of vegetable fats.

In the vegetable kingdom, lipids accumulate in fruits, seeds and sprouts and to a lesser extent in leaves, bark, roots, in the protoplasm of the respective cells in the form of more or less fine suspension drops or in crystallized solid form, mixed with free fatty acids, steroid phosphatides, pigments, esterified oils. The role of lipids in organisms is multiple:

- protection against the cold, due to reduced thermal conductivity;
- Energy reserve;

- Solvent for fat-soluble vitamins;
- Plastic;
- Precursors of products of vital importance for the body through essential fatty acids[4-9].

The equations obtained from the literature of various mathematical models that describe the shearing rheological behaviour of corn oil are[9-16]:

$$\tau = \tau o+\eta^{\gamma} \quad (1)$$
$$\tau^{1/2} = \tau_{o}^{1/2} + \eta^{1/2}\ \gamma^{1/2} \quad (2)$$
$$\tau = k^{\gamma\ n} \quad (3)$$
$$\tau = \tau_{o} + k^{\gamma\ n} \quad (4)$$

Where: τ or σ is shear stress (Pa) τ_o is yield stress η is dynamic viscosity or shear viscosity (Pa*s) γ is shear rate (s^{-1}), n is the power law index (which is equal to "1-m", if m is the shear thinning index) and *k* is a constant.

MATERIAL AND METHODS

The rheological behavior of corn oil can be analyzed in the temperature range 40-100°C if it is subjected to an increasing shear rate. The behavior of this fluid can be appreciated based on the experimental data, graphically representing the variation the shearing stress with the shear velocity. This curve represents the mathematical model of the rheological behavior of the product. The rheological behavior of the corn oil was analyzed with the mixing rheometer type Viscotester VT 550 (Haake).

RESULTS AND DISCUSSION

Corn oil rheograms in the temperature range studied using the experimental data were shown in Figures 1-7.

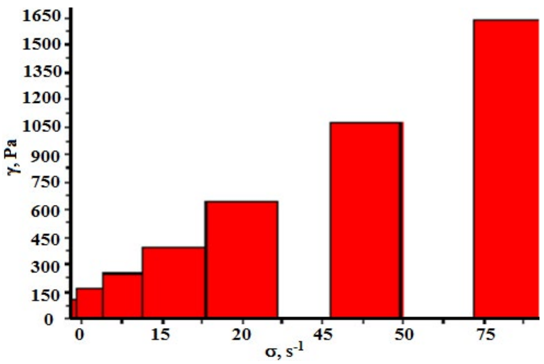

Fig. 1. The graph shows for corn oil at t=40°C

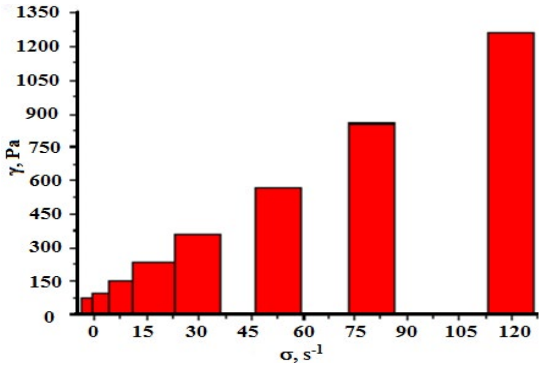

Fig. 2. The graph shows for corn oil at t=50°C

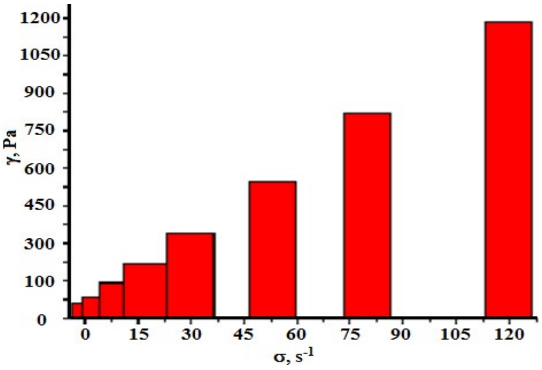

Fig. 3. The graph shows for corn oil at t=60°C

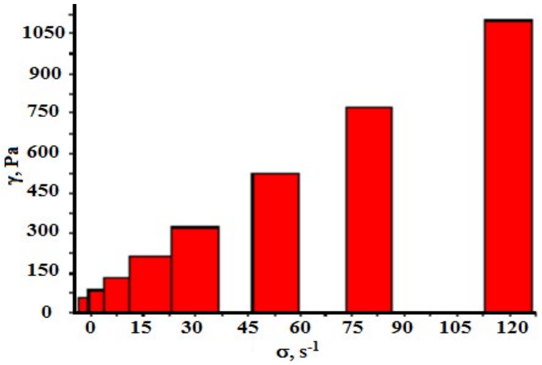

Fig. 4. The graph shows for corn oil at t=70°C

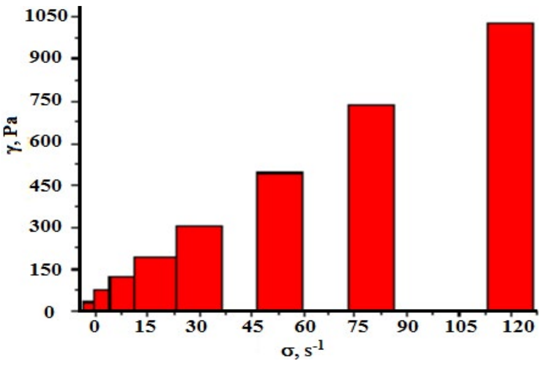

Fig. 5. The graph shows for corn oil at t=80°C

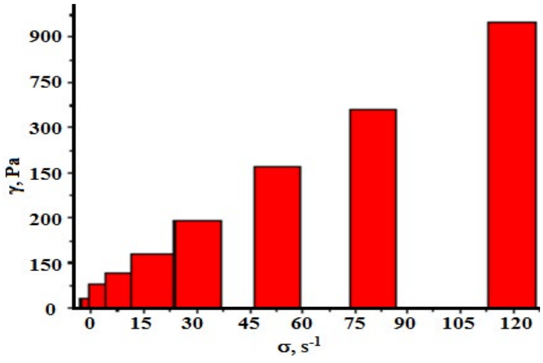

Fig. 6. The graph shows for corn oil at t=90°C

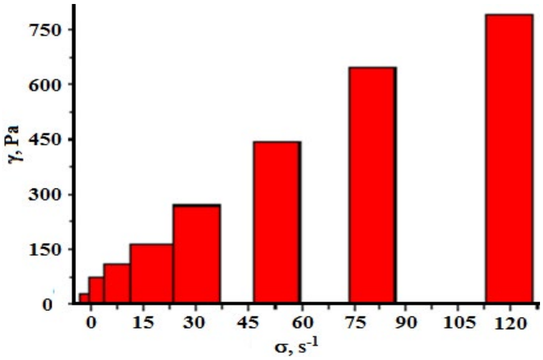

Fig. 7. The graph shows for corn oil at t=100°C

The correlation coefficient, R^2 for the equations (1-4) applied on the experimental data shown in Figures 1-7 are given in Table 1.

Table 1: Parameter equations, R^2 for eq. (1)-(4)

	Correlation coefficient, R2			
Temperature,°C	Eq.(1)	Eq.(2)	Eq.(3)	Eq.(4)
40	0.9999	0.9990	0.9990	0.9992
50	0.9999	0.9992	0.9992	0.9993
60	0.9999	0.9997	0.9997	0.9997
70	0.9999	0.9990	0.9990	0.9990
80	0.9999	0.9972	0.9971	0.9972
90	0.9998	0.9989	0.9990	0.9989
100	0.9998	0.9989	0.9990	0.9989

As can be observed from the Table 1, all the 4 equations give very good correlation coefficients, but the equation (1) shows the best fit (R^2 close to one) for the entire temperature range chosen.

The graphs 8 and 9 exhibit the temperature dependence of the dynamic viscosity at different shear rates for the corn oil, since the performance of a lubricant is correlated with its viscosity.

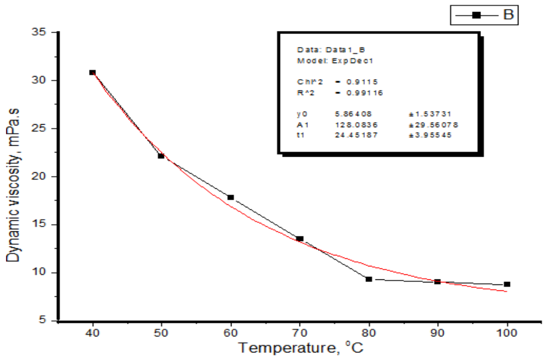

Fig. 8. The graph shows η=f(t) **for corn oil at** γ**=3.3 s^{-1}**

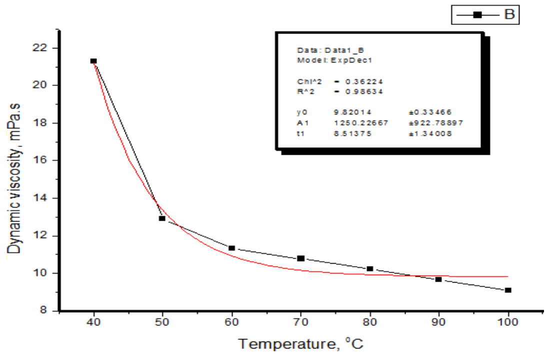

Fig. 9. The graph shows η=f(t) **for corn oil at** γ**= 30 s^{-1}**

The Fig. 10 shows the correlation of dynamic viscosity in log scale vs. the 1/T[17-19] for the studied corn oil.

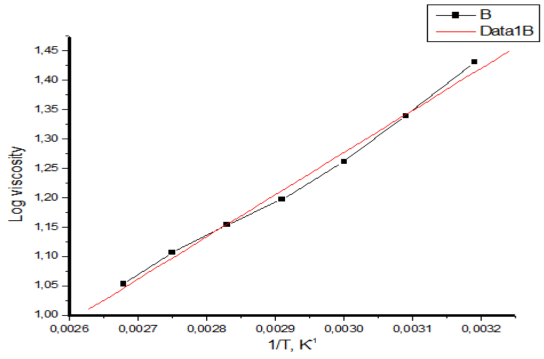

Fig. 10. The graph shows log

CONCLUSION

Rheological behavior of corn oil can be analyzed if it is subjected to an increasing shear rate. The behavior of this fluid can be appreciated based on the experimental data, graphically representing the variation of the shearing stress with the shear velocity. This curve represents the mathematical model of the rheological behavior of the product. The rheological behavior of the corn oil was analyzed with the mixing rheometer type Viscotester VT 550 (Haake).

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Conflict of interest

The author declare that we have no conflict of interest.

REFERENCES

1. Veljkovi V.B.; Biberdži M.O.; Bankovi-Ili I.B.; Djalovi I.G.; Tasi M.B.; Nježi Z.B., & Stamenkovi O.S., *Renewable and Sustainable Energy Reviews*., **2018**, *91*, 531-548.
2. Cerqueira M.A.; Souza B.W.; Teixeira J.A.; & Vicente A.A.; *Food hydrocolloids.,* **2012**, *27*(1), 175-184.
3. Dupont J.; White P.J.; Carpenter M.P.; Schaefer E. J.; Meydani S.N.; Elson, C.E., & Gorbach S.L., *Journal of the American College of Nutrition*., **1990**, *9*(5), 438-470.
4. Strocchi A., *Journal of Food Science*., **1982**, *47*(1), 36-39..
5. Stanciu I., *Journal of Science and Arts*., **2019**, *3*(48), 703-708.
6. Stanciu I., *Journal of Science and Arts*., **2019**, *4*(49), 938-988.
7. Stanciu I., Journal of Science and Arts., **2011**, *1*, 55-58.
8. Stanciu I., *Journal of Science and Arts*., **2018**, *18*(2), 453-458.
9. Ruiz-Mendez M.V.; Posada M.; Abian J.; Calaf E.R.; Blount B.; Molero-Castro N.; Philen R. and Gelpi E., *J. Food. Chem. Toxicol*., **2001**, *39*(1), 91.
10. Sterpu A.E.; Dumitru A.I. and Popa M.F., *Analele Universitatii., Ovidius" Constanta– Seria Chimie*., **2012**, *23*(2), 133.
11. Rodenbush C. M., Hsieh F. H., Viswanath D. S., *J. Am. Oil Chem. Soc*., **1999**, 76-141.
12. Moreau R.A., Johnston D.B., Powell M.J., & Hicks K.B., *Journal of the American oil Chemists' Society*., **2004**, *81*(11), 1071-1075.
13. Perez A.T., Characterisation of the rheological properties of lubricants for EHL film thickness prediction, TriboUK, Imperial College, London., **2010**.
14. Krisnangkura K.; Yimsuwan T.; Pairintra R.; *Fuel*., **2006**, 85-107.
15. Esteban B.; Riba J. R.; Baquero G.; Rius A.; Puig R., *Biomass and Bioenergy*., **2012**, *42*, 164-171.
16. Azian M.N.; Kamal A. A. M.; Panau F.; Ten W.K., *J. Am. Oil Chem. Soc*., **2001**, *78*, 1001.
17. Sheibani A.; Ghotbaddini-Bahraman, N. A. S. E. R., & Sadeghi, F. A. T. E. M. E. H., *Orient. J. Chem*., **2014**, *30*(3), 1205-1209.
18. Omar M. N.; Nor N. N. M & Idris, N. A., *Orient. J. Chem*., **2009**, *25*(4), 825.
19. Audu S. S.; Aremu M. O., & Lajide, L., *Orient. J. Chem*., **2013**, *29*(3), 979-989.