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Rheological Behavior of Rapeseed Oil Shear Rate 3.3s^{-1} and 120s^{-1}

Ioana Stanciu*

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Abstract

Rheology is a branch of science with multiple implications in numerous sectors of industry, also constituting a generous field due to its multidisciplinary character. Thus, solving a problem in rheology calls for knowledge from modern mathematics, physics, chemistry, chemical and mechanical engineering, and materials science. Driven by the appearance of new materials (plastics and synthetic fibers, varnishes and paints, detergents, adhesives, pharmaceutical and cosmetic products, biological materials, etc.) Rapeseed ranks third in the world as a source of vegetable oil, after palm oil and soybean oil Through the exponential fit, we found a relation between the dependence of the dynamic viscosity on the temperature at different shear rates. The obtained correlation coefficients have values close to unity for all shear speeds to which the refined rapeseed oil was subjected. The found equation faithfully describes the non-Newtonian behavior of the studied oil in the temperature range. For the studied oil, the correlation coefficients have values between 0.9725 and 0.9955.

Keywords: Rapeseed, Temperature, Rheology, Shear rate

Introduction

Rheology is a branch of science with multiple implications in numerous sectors of industry, also constituting a generous field due to its multidisciplinary character. Thus, solving a problem in rheology calls for knowledge from modern mathematics, physics, chemistry, chemical and mechanical engineering, and materials science. Driven by the appearance of new materials (plastics and synthetic fibers, varnishes and paints, detergents, adhesives, pharmaceutical and cosmetic products, biological materials, etc.) and the need to process them, rheology has contributed to the deepening of these fields, developing its area of study. The flow or movement of all types of materials can also be described using specific equations that have been developed over time. Both gases and solids flow, but usually when we hear the term ”flow” we think of liquid products. Because of this, the term rheology is most often related to the flow of liquids. It also does not exclude the existence of a rheology of the gaseous state and a rheology of the solid state. The most eloquent example of solid state rheology is the mechanical properties of bodies, which represent their response to various stresses to which they are subjected. The classical theory of fluid dynamics developed through theoretical research on an ideal or perfect fluid, incompressible and devoid of viscosity and elasticity, called Pascal's fluid. Until the introduction of the boundary layer concept by Prandtl, the results of this research had limited applicability (PHG, 2010; Jaensson & Vermant, 2018; Meng *et al*., 2019; Chew *et al*., 2020; Kuzubasoglu & Bahadir 2020; Pilorgé, 2020; Aleidi *et al*., 2022; Dhanasekar *et al*., 2022; Maghami *et al*., 2022).

Rapeseed (Brassica oleracea) has been cultivated as a plant since the 16th century, having a distribution area both in warmer climates and colder climates (Azian *et al*., 2001; Hazar & Aydin, 2010; Thickness prediction, 2010; Stanciu, 2012; Likhanov, *et al*., 2019; Fridrihsone *et al*., 2020; Kauser *et al*., 2022; Natarajan *et al*., 2022; Remizova *et al*., 2022).

Andrade’s equation is (Azian *et al*., 2001; Stanciu 2012; Likhanov *et al*., 2019; Alhussain *et al*., 2022; Deana *et al*., 2022; Sumantri *et al*., 2022):

$$\eta = A\exp^{\frac{B}{T}} \quad (1)$$

By logarithmizing equation (1) we obtain:

$$\ln\eta = \ln A + \frac{B}{T} \quad (2)$$

Esteban (Azian *et al*., 2001) ys Azian (Azian *et al*., 2001; Stanciu, 2012; Likhanov *et al*., 2019) introduced an equation with three constants:

$$\ln\eta = A + \frac{B}{T} + \frac{C}{T^2} \quad (3)$$

Where A, B, C - constants of the material.

Materials and Methods

The types of refined rapeseed oil used in this paper are produced in Romania.

Refined rapeseed oil was studied at increasing shear rates and temperatures between 40 and 100 ^{O}C with the Haake VT 550 viscometer. The oil has non-Newtonian behavior in the temperature range at which it was studied.

Results and Discussion

Ioana Stanciu*
Department of Physical Chemistry, Faculty of Chemistry, University of Bucharest, 030018, Bucharest, Romania.

***E-mail:** istanciu75@yahoo.com

Dependence dynamic viscosity versus temperature **(Figures 1-7)** of rapeseed oil at shear rate.

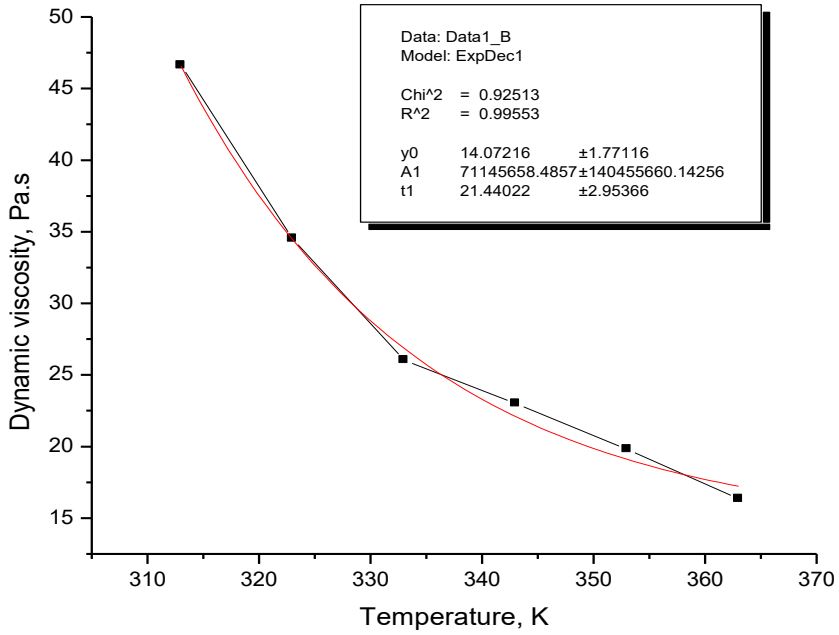

Figure 1. Dependence η =f(T) at shear rate 3.3s^{-1}

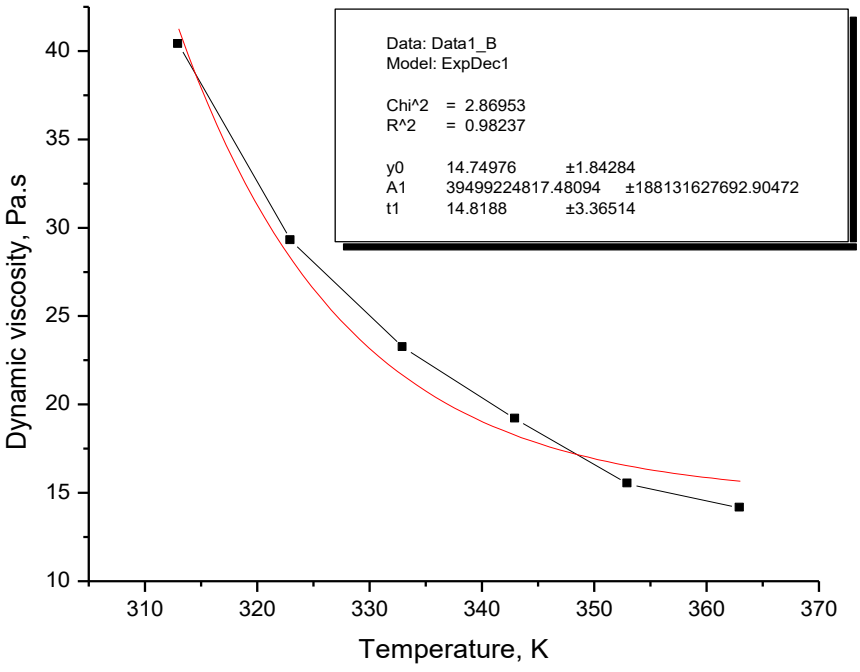

Figure 2. Dependence η =f(T) at shear rate 6s^{-1}

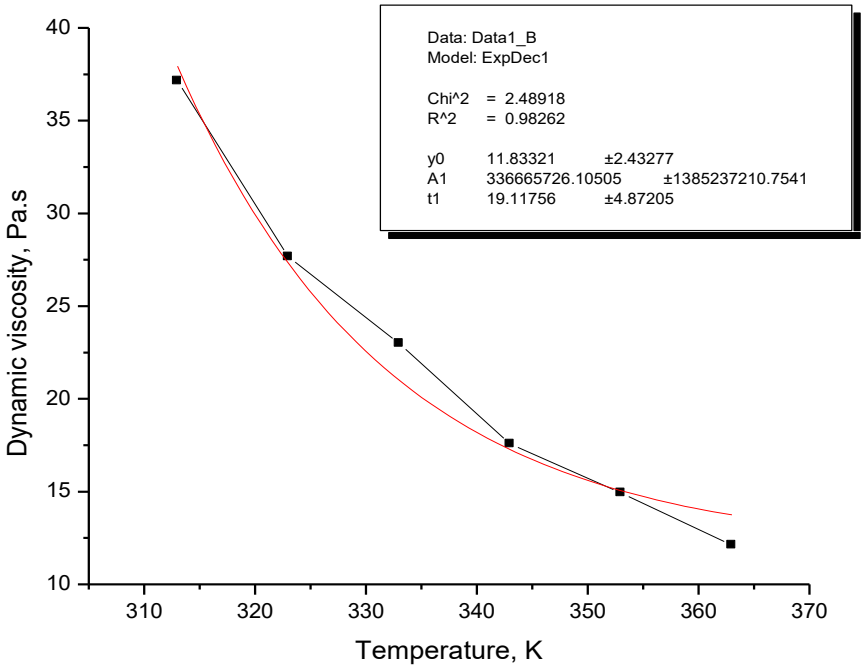

Figure 3. Dependence η =f(T) at shear rate 10.6s^{-1}

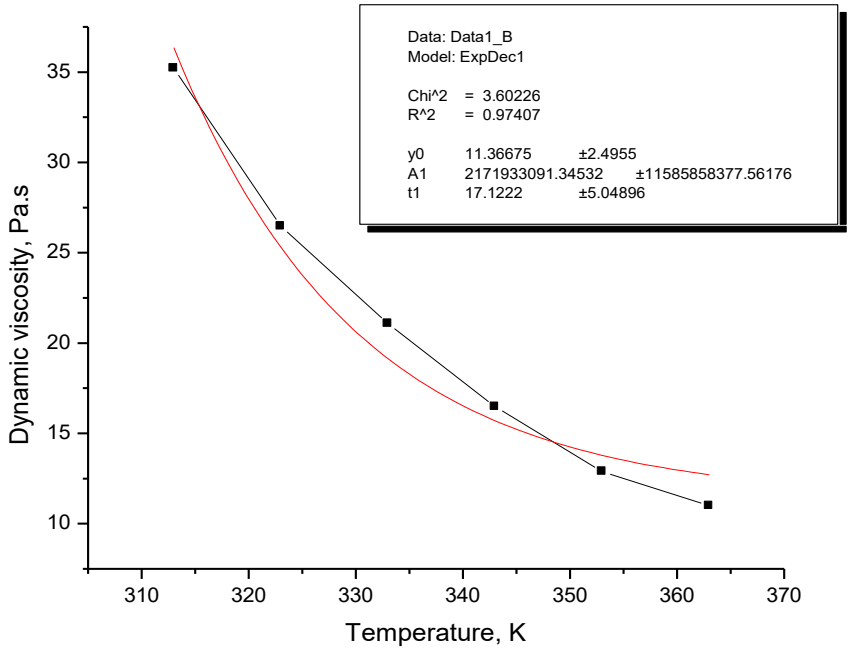

Figure 4. Dependence η =f(T) at shear rate 17.87s^{-1}

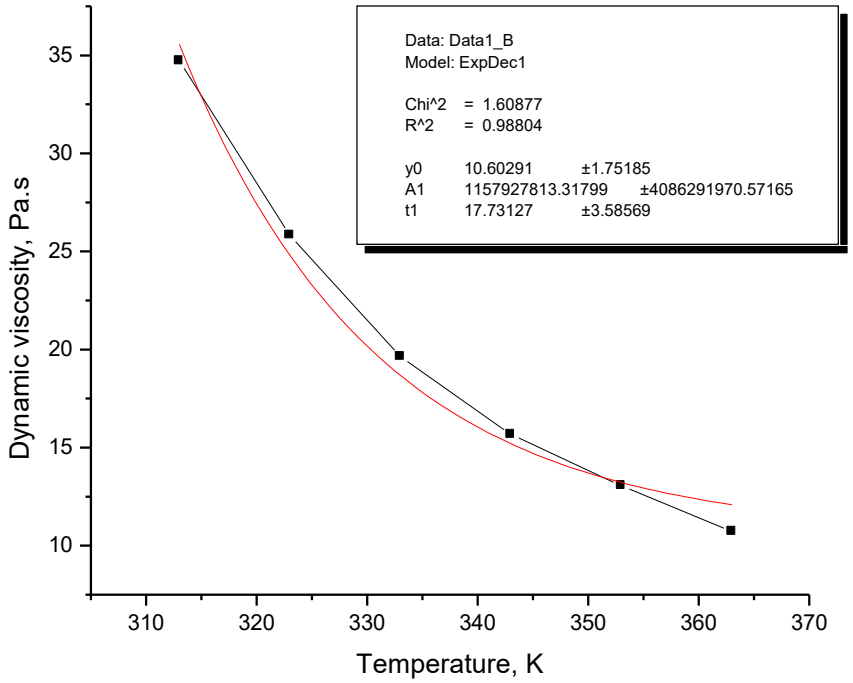

Figure 5. Dependence η =f(T) at shear rate 30s^{-1}

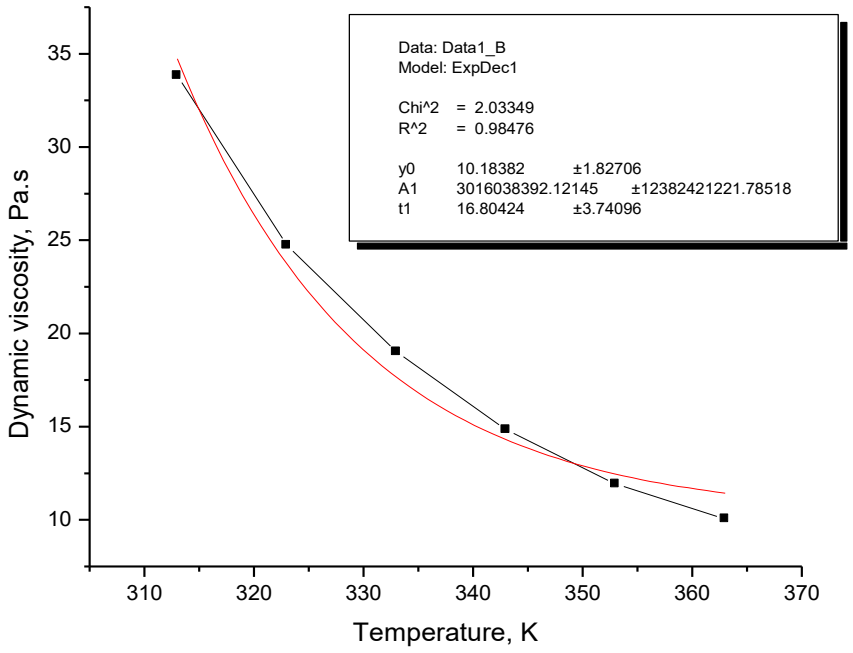

Figure 6. Dependence η =f(T) at shear rate 52.95s^{-1}

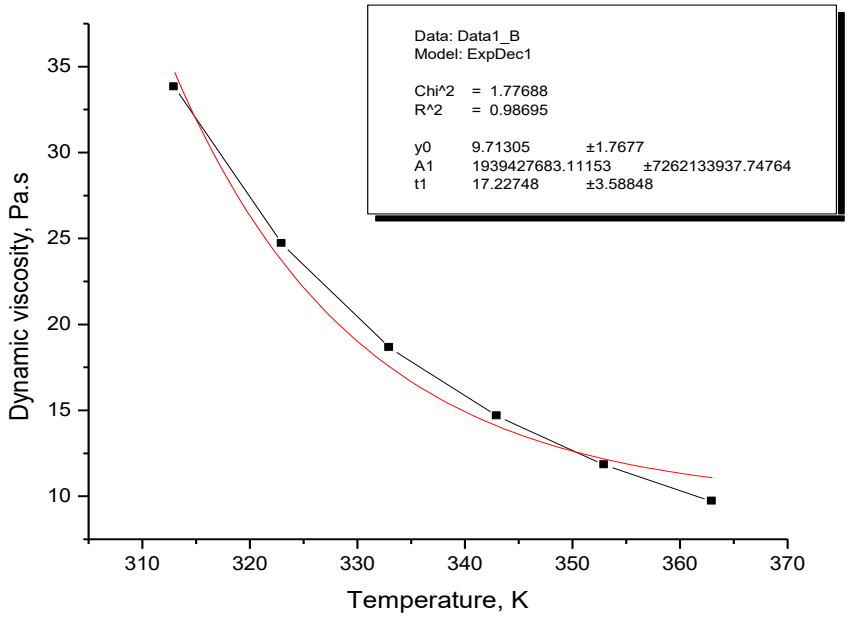

Figure 7. Dependence η =f(T) at shear rate 80s^{-1}

Eq. (4) for experimental data of refined rapeseed oil:

$$\eta = \eta 0 + A\exp(-T/B) \quad (4)$$

The correlation coefficients obtained with equation (4) have values between 0.9725 and 0.9955.

Conclusion

This article proposes an equation that shows the dependence of dynamic viscosity on temperature in exponential form with three parameters that depend on the studied oil. The found equation faithfully describes the non-Newtonian behavior of the studied oil in the temperature range.

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Conflict of interest: None

Financial support: None

Ethics statement: None

References

**** PHG, Reglementarea tehnică, Uleiuri vegetale comestibile", Anexa 4, Compoziţia în acizi graşi pentru identificarea uleiurilor vegetale dintr-un singur tip de materie primă, 2010.

Aleidi, S. A., Alosaimi, N. S., Aljumah, S. M., Alabdulmunim, R. A., & Alhussain, B. (2022). Assessment of Ionoseal's performance as a lining and sealing material in dental restorations: a comprehensive review. *International Journal of Dental Research and Allied Sciences, 2*(1), 13-19. doi:10.51847/iVCXX97n31

Alhussain, B. S., Alajmi, A. M., Odeh, L. G. H., Nasr, L. E., Alotaibi, N. A., & Alqaidi, S. A. (2022). EDTA Vs citric acid decalcifying solutions: a systematic review to compare the clinical efficacy. *Annals of Dental Specialty, 10*(2), 81-85. doi:10.51847/Dr5Ixlw1hD

Azian, M. N., Mustafa Kamal, A. A., Panau, F., & Ten, W. K. (2001). Viscosity estimation of triacylglycerols and of some vegetable oils, based on their triacylglycerol composition. *Journal of the American Oil Chemists' Society*, *78*(10), 1001-1005.

Chew, S. C. (2020). Cold-pressed rapeseed (Brassica napus) oil: Chemistry and functionality. *Food Research International*, *131*, 108997.

Deana, N. F., Seiffert, A., Aravena-Rivas, Y., Alonso-Coello, P., Muñoz-Millán, P., Espinoza-Espinoza, G., Pineda, P., & Zaror, C. (2022). Review of available studies and guidelines in the field of prevention of COVID-19 infection in dental centers. *Annals Journal of Dental and Medical Assisting, 2*(1), 1-7. doi:10.51847/4VxEtFTh77

Dhanasekar, P., Rajayyan, J. S., Veerabadiran, Y., Kumar, K. S., Kumar, K. S., & Chinnadurai, N. (2022). Evaluation of alum and purification process of water by coagulation method. *Bulletin of Pioneering Researches of Medical and Clinical Science, 1*(2), 1-6. doi:10.51847/R8GyfOmMDh

Fridrihsone, A., Romagnoli, F., & Cabulis, U. (2020). Environmental life cycle assessment of rapeseed and rapeseed oil produced in Northern Europe: A Latvian case study. *Sustainability*, *12*(14), 5699.

Hazar, H., & Aydin, H. (2010). Performance and emission evaluation of a CI engine fueled with preheated raw rapeseed oil (RRO)–diesel blends. *Applied Energy*, *87*(3), 786-790.

Jaensson, N., & Vermant, J. (2018). Tensiometry and rheology of complex interfaces. *Current Opinion in Colloid & Interface Science*, *37*, 136-150.

Kauser, S., Morrissey, H., & Ball, P. (2022). England local community pharmacists opinions on independent prescribing training. *Journal of Advanced Pharmacy Education and Research, 12*(1), 30-37. doi:10.51847/PaNZ94aVtA

Kuzubasoglu, B. A., & Bahadir, S. K. (2020). Flexible temperature sensors: A review. *Sensors and Actuators A: Physical*, *315*, 112282.

Likhanov, V. A., Lopatin, O. P., & Yurlov, A. S. (2019, December). Study of the effective performance of the diesel engine when working on methanol and methyl ether rapeseed oil. In *Journal of Physics: Conference Series* (Vol. 1399, No. 5, p. 055026). IOP Publishing.

Maghami, H., Parhizkar, H., Riasaty, A., Banani, A., Poustfroosh, M., & Hasehmpour-Sadeghian, M. (2022). Identifying the parenting style of students' parents of an school at Shiraz University of medical sciences. *Journal of Advanced Pharmacy Education and Research, 12*(1), 91-96. doi:10.51847/tLcoO2yvKI

Meng, F., Wong, L. N. Y., Zhou, H., Yu, J., & Cheng, G. (2019). Shear rate effects on the post-peak shear behaviour and acoustic emission characteristics of artificially split granite joints. *Rock Mechanics and Rock Engineering*, *52*(7), 2155-2174.

Natarajan, G. P., Venkataraman, S. M., Pitchamuthu, S., & Rengaraj, M. (2022). Impact of silicon seed priming on osmoregulants, antioxidants, and seedling growth of maize grown under chemo-stress. *World Journal of Environmental Biosciences, 11*(2), 1-7. doi:10.51847/ODzSUPDgnz

Pilorgé, E. (2020). Sunflower in the global vegetable oil system: situation, specificities and perspectives. *OCL*, *27*, 34.

Remizova, A. A., Bitarov, P. A., Epkhiev, A. A., & Remizov, N. O. (2022). Reparative-regenerative features of bone tissue in experimental animals treated with titanium implants. *Journal of Advanced Pharmacy Education and Research, 12*(2), 110-116. doi:10.51847/Sprxb1DKyv

Stanciu, I. (2012). A new viscosity-temperature relationship for mineral oil SAE 10W. *Ovidius University Annals of Chemistry*, *23*(1), 27-30.

Sumantri, A. F., Bashari, M. H., Tadjoedin, H., & Atik, N. (2022). Risk of coronavirus disease 2019 (COVID-19) infection on leukemia patients: basic science to clinical aspect. *Journal of Advanced Pharmacy Education and Research, 12*(1), 38-45. doi:10.51847/qqIktBAHB7

Thickness prediction, TriboUK, Imperial College, London, 2010.