

Study rheological behavior of refined rapeseed oil

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Abstract. Extracted from rapeseed oil was subjected to purification and refining process and then characterized in terms of rheological, ie dynamic viscosity dependence study in terms of speed shear constant temperature. The results show that at 40⁰C, 60⁰C, 80⁰C and 90⁰C dynamic viscosities of oil decreases with shear rate. At higher shear rates of 20s⁻¹ shows lower viscosity oil fluctuations, became almost constant.

Keywords. rheological behavior, rapeseed oil, viscosity dynamic

Introduction

As the uppermost herbaceous edible oil crop in Romania, rape (*Brassica Napus*) has been planted for thousands of years. The rapeseed oil extracted from the rape seed is top-quality edible oil, which contains rich fact acids, fast-soluble vitamins, phospholipids and pigments but lacks cholesterol [1]. The color of rapeseed is deep yellow. The characteristic of large viscosity, least saponification value among semi-drying oils and high-content erucic acid can be used to distinguish rapeseed oil from other vegetable oils [2, 3].

Besides the direct application of edibility, rapeseed oil is also the important raw industrial material [4] and widely applied to industries of machinery, rubber, chemical, plastic, painting, textile, soap, pharmaceutical and bio-diesel [5-7]. Especially, rapeseed oil can be used as the good lubricating oil in cast steel industry, margarine, fire extinguishing oil and mental preservative [8-10]. Moreover, the arisen biodiesel engineering in recent years around the whole world results in the increase of the proportion of rapeseed transformed into biodiesel year by year [11-13].

Using rapeseed oil as fuel for diesel engines series is possible without long term problems because of its properties which differ greatly from those of diesel fuel (viscosity, reaction to boiling). For this reason fuel has to be adapted to convert diesel engine to vegetable oil methyl esters of fatty acids biodiesel or the engine be adapted to vegetable oil. For both alternatives were developed in the meantime more practical procedures. Production and use of fuel based on rapeseed oil is an important point in research. Using other vegetable oils in adapted engines, such as rapeseed oil is still not sufficiently researched and tested and therefore may appear more related risks. Vegetable oil can be produced in the central industrial oil mills, fruit and seed oil. Rapeseed oil is composed mainly of triglycerides. In addition, oil quality can be influenced by degradation products division of fats and fatty substances are associated in the composition of vegetable oils [14].

The crude rapeseed oil has the unpleasant odor and pungency, and is unsuitable direct edibility. Therefore, crude rapeseed oil needs refining process of degelatinizing, deodorization, deacidification and decoloration to obtain edible high-quality rapeseed oil [14]. The refined rapeseed oil becomes the neutral, colorless, odorless and flavorless liquid without volatility, and can also dissolve some organic compounds and fat-soluble vitamins. Meanwhile, the refined rapeseed oil is widely applied to food industry, especially to produce salad oil, butteries and shortening oil [15]. The common flow of producing refined oil from rapeseed oil by mechanical pressing is obtained; finally, the total crude rapeseed oil is treated by refining procedure to form the high-quality edible oil.

Most of researches had focused on the processing and utilization of rapeseed oil, especially on the deep refining and industrial application in recent years. However, they didn't analyze the liquid rheological characteristic of rapeseed oil to elucidate the instruction for the technology parameters of industrial operation [16, 17].

Structure and composition of vegetable oils mainly influences their characteristic properties as density, viscosity, heat capacity, flash point, iodine number. Melting point of oils is even lower; the more unsaturated fatty acid ratio is higher.

Viscosity-based fuel is rapeseed oil, especially at low temperatures, often higher than fossil diesel fuel. Flashpoint is the value of over 240°C, much higher than normal diesel fuel, which has positive effects on storage and transport, but requires technical adjustments to the engine. Rapeseed oil is suitable, because of printing or fatty acids, its use as a fuel because it is a good compromise between the behavior of the viscosity / temperature and oxidation stability [14].

In the paper, the rapeseed rheological analysis of dynamic shear rate – viscosity relationship of the rapeseed obtained from good rapeseed by mechanical and refining was carried out at gradient temperatures, providing scientific foundation for the rheological application of rapeseed oil industry [18].

Experimental details

Vegetable oil used in this work is provided by a company in Bucharest, Romania. In our investigation we used only refined rapeseed oil.

Vegetable oils have investigated using a Haake VT 550 Viscotester developing shear rates ranging between 3 and 120 s⁻¹ and measuring viscosities from 10⁴ to 10⁶ mPa.s when the HV₁ viscosity sensor is used. The temperature ranged between 40 and 90°C and the measurements were made from 10 to 10⁰C. The accuracy of the temperature was ± 0.1⁰C.

Results and discussion

Speed dependent dynamic shear viscosity at 40°C, 60°C, 80°C and 90°C is shown in the following graphs. Refined rapeseed oil shows an exponential decrease of viscosity with shear rate as shown in Figure 1. Parameter values are given inside the figure, the correlation coefficient is 0.99425 and at 40°C rapeseed oil has a pseudoplastic fluid behavior.

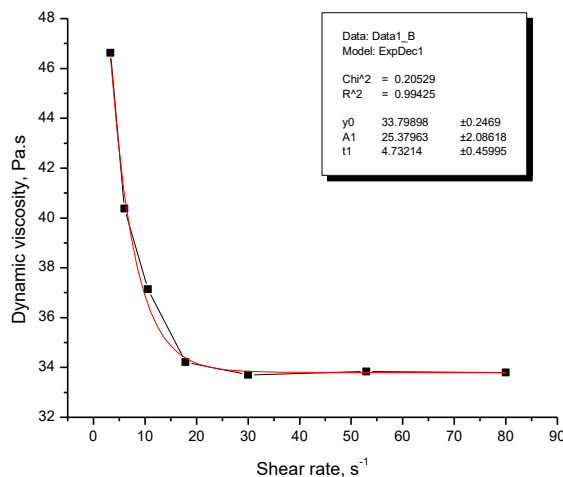


Figure 1. Relationship between viscosity dynamic and shear rate of rapeseed oil at 40°C

In terms of growth temperature 20°C is not observed significant changes in the behavior of refined rapeseed oil. Figure 2 shows the dependence of dynamic viscosity shear rate for the same sample of rapeseed oil refined at temperature constant 60°C. Oil has pseudoplastic behavior and correlation coefficient has the value 0.99614.

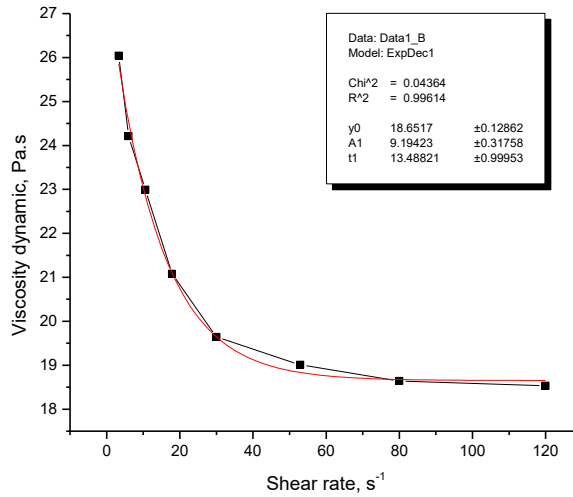


Figure 2. Relationship between viscosity dynamic and shear rate of rapeseed oil at 60⁰C

Pseudoplastic has oil and reaction temperatures of 80⁰C and 90⁰C as shown in figures 3 and 4. Correlation coefficients have values of 0.99479 and 0.99548.

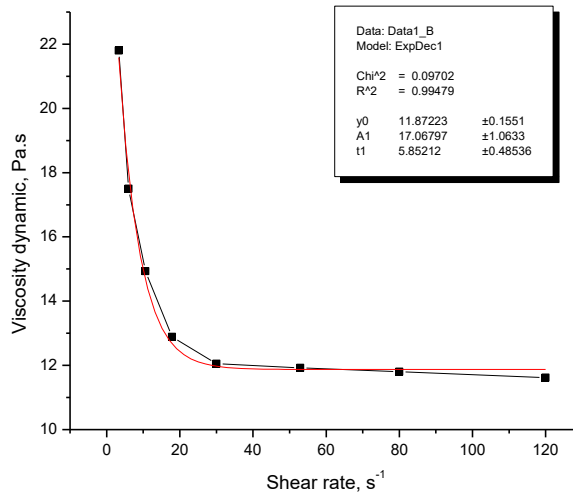


Figure 3. Relationship between viscosity dynamic and shear rate of rapeseed oil at 80⁰C

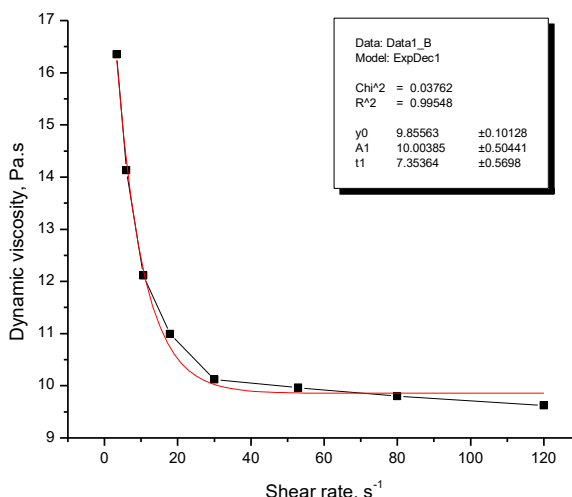


Figure 4. Relationship between viscosity dynamic and shear rate of rapeseed oil at 90°C

The analytical results shows that the rising temperature results in the corresponding gradual decrease of viscosity of rapeseed oil at each constant shear rate (figure 5). However, the viscosity at 80°C and 90°C are fairly close. This result reveals that viscosity of rapeseed oil is not correlated with the variation of shear rate at a special constant temperature, but is negatively correlated with temperature at a special constant shear rate. Therefore, when rapeseed oil is used as the raw of edible oils and industries, the working procedures at high temperature will not influence its rheological characteristic distinctly, and the temperature of 80°C and 90°C should be priory used.

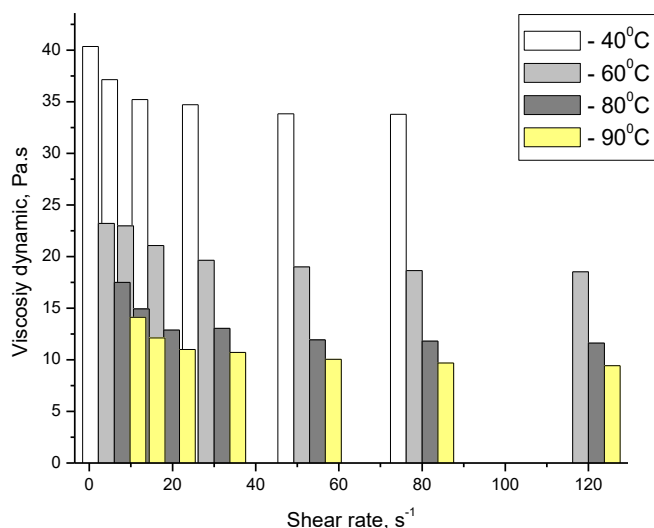


Fig. 5. Relationship between temperature and viscosity of rapeseed oil and at constant shear rate

Conclusions

Refined rapeseed oil is pseudoplastic behavior at all temperatures studied. Graphic representation of dynamic viscosity dependence on shear rate shows a decreasing exponential constant temperature in which correlation coefficients have values between 0.99425 and 0.99548. Rheological study of the oil extracted from rapeseed shows that at higher shear rates of 20s⁻¹ dynamic viscosity does not show significant declines, becoming almost linear portion.

This result reveals that the viscosity of rapeseed oil is not correlated with the variation of shear rate at a special constant temperature, but is negatively correlated with temperature at a special constant shear rate.

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