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Viscosity of Rapeseed and Argan Vegetable Oils, and their Comparison with the Mineral Oil

[1]Meryem Belgharza, [2]El Habib El Azzouzi, [1]Imane Hassanain, Rajaa Rochdi, Adnane El hamidi, Imane Ellouzi, El, Fadoua El Makhoukhi, [1]Mohamed Alaoui El Belghiti.

[1]Laboratoire de Chimie Physique Générale, Département de Chimie, Université Mohammed V, Faculté des Sciences, Avenue Ibn Batouta, BP 1014 Rabat.
[2]Laboratoire de Physique des Matériaux, département de physique, Université Mohammed V, Faculté des Sciences, Avenue Ibn Batouta, BP 1014 Rabat.
[3]Laboratoires de chimie appliquée à l'Ecole Nationale de l'Industrie Minérale, Avenue Hadj Ahmed Cherkaoui BP 753 Agdal Rabat.

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ABSTRACT

We report in this study viscosity measurements of vegetable oils (rapeseed and argan) and mineral oil as a function of temperature. These measurements,formed between 20 and 80°C, show that the viscosity of the rape oil decreases noticeably compared to the argan oil when increasing temperature. This decrease has allowed us to consider that it can be used as biofuel instead of mineral oil when the temperature is above 160 ° C.

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INTRODUCTION

The recent energy context (sharp rise in oil price) and environmental concerns (limit greenhouse gas emissions) lead some socio-economic actors, particularly from farming and para-agriculture, to focus on the use of pure vegetable oils as a source of energy, such as automotive fuel (biofuel), stationary engines (pumps, generators), combustion (heat buildings, greenhouses ...) and for industrial applications (lubricants, non-toxic solvents, paints, inks ...).

These oils are produced from oilseeds (rapeseed, sunflower ...) available on agricultural land, with or without fallow system, in greater or lesser amounts depending on soils, agricultural and economic contexts. Some local governments as well as the agricultural sector give them more and more importance and questioning about their use as a partial alternative to fossil fuels [1].

Vegetable oil fuel, also known as pure or crude vegetable oil name is refined crude oil produced from oil crops such as rapeseed, sunflower, soybean etc. ... without chemical modification by pressing, extraction or comparable procedures. It can technically be used up to 100% as biofuel for diesel engines, subject to minor changes. Indeed, the characteristics of the oils (high density, high viscosity-temperature behavior) can lead to disruption in engines, in particular a tendency to form deposits in the combustion chamber with a risk of fouling. Implementation of specific devices such as a heater can significantly reduce the problems associated with oil pumpability [2,3].

MATERIELS AND METHODS

Vegetable oils are generally of very low toxicity and have excellent biodegradability. These qualities are due in particular to a low resistance to oxidation and hydrolysis [4]. These two characteristics are favorable to eco-toxicological aspects.
Our oils, Argan rape were purchased on the market [5].

2.1 Materials:

The viscosity is measured by an Osswald viscometer:

Corresponding Author: Meryem Belgharza, Laboratoire de Chimie Physique Générale, Département de Chimie, Université Mohammed V, Faculté des Sciences, Avenue Ibn Batouta, BP 1014 Rabat.

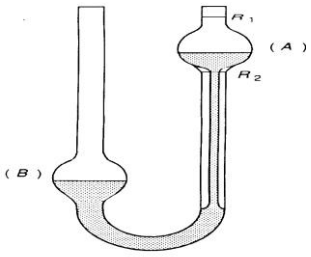

Fig. 1: Osswald viscosimeter.

2.2 Methods:

- *Measurement of the viscosity of vegetable oils:*

It consists on measuring the time during which a volume V of the fluid is passing through a capillary tube. The viscosity is proportional to the flow time as:

$$\nu = K \cdot \Delta t$$

The constant K of the device is given by the viscosimeter's manufacture [6].

RESULTS AND DISCUSSION

To study the physical properties of an oil (Argan, Rapeseed and mineral oil), we proceed to the consideration of the viscosity as a function of temperature, the fact that this parameter can give a lot of information on oil study [7].

We studied the variation of viscosity of the vegetable oils (Argan, Rapeseed and the mineral oil) as a function of temperature. The results obtained are represented in figures 2.

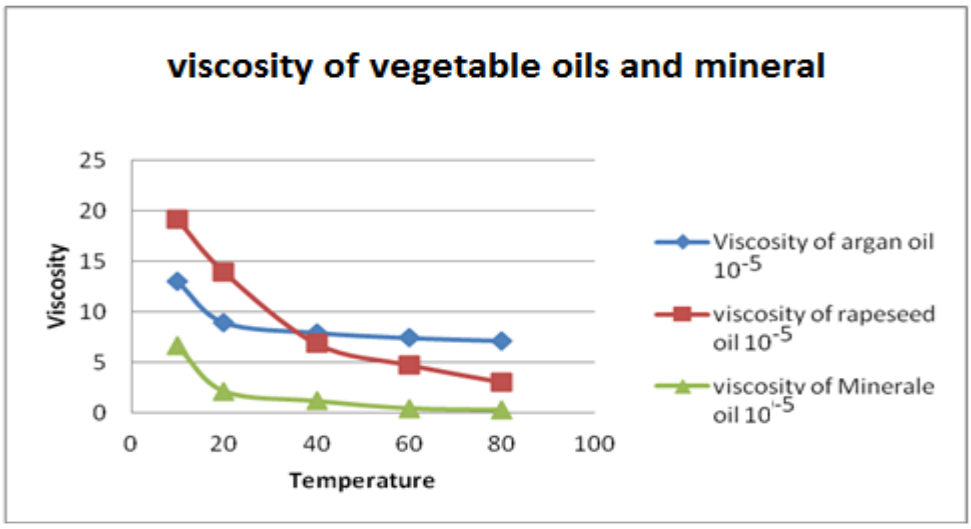

Fig. 2: Mesurements of the viscosity of vegetable oils : Rapeseed, Argan and mineral oil [5].

Figure (2) shows the measurements of the viscosity of vegetable (Rapeseed and Argan) and mineral oils. The main difference between them is the high viscosity of the vegetable oils. Nevertheless, it decreases when heating it at 70-80 °C [5], where it had a comparable viscosity to the mineral oil. We can also notice, from the curve, that the Rapeseed oil has a viscosity lower than 4,5 mm^2/s at the highest temperature. This indicates that it could be used as a biofuel at temperatures greater than 160°C, which is useful for engines that operate at high temperatures [8].

Otherwise, for Argan oil the decrease in viscosity was not important and becomes constant at the temperature of 40°C.

Calculating the viscosity of the Rapeseed oil at different temperature (170, 180 and 190°C) for the Arrhenius equation:

$\eta = A \exp(Ea/RT)$ (1)

η: Kinematic viscosity

A: Pre-exponential factor ($m^2.s^{-1}$)

Ea: Activation energy ($J.mol^{-1}$)
R: Perfect gas constant ($J.K^{-1}.mol^{-1}$)
T: Temperature (K)
Results of the viscosity of Rapeseed oil at different temperatures are presented in table 1.

Table 1: Values of viscosity of the Rapeseed oil at different temperatures.

Temperature en °C	Viscosity of vegetable oil (Rapeseed) (mm^2/s)
170	5.375
180	4.686
200	3.625

Based on the values obtained and compared with the viscosity of the mineral oil at the same temperatures from the literature [8] we can conclude that the rapeseed oil can be used instead of mineral oil, especially for engines that operate at high temperature. However, the viscosity of Argan oil remains practically constant above 40 ° C. Adding the fact that it is very rare, we cannot use it as a biofuel.

It is envisaged in the future to add certain percentage of rapeseed oil in mineral oil for use as biofuel [8].

3. Conclusion:

In our study, we may well conclude that the rapeseed oil can be used instead of the mineral oil for engines that operate at high temperatures. However, the viscosity of Argan oil remains constant at the temperature above 40°C.

Looking ahead, we expect to complete our work by studying the possibility of using rapeseed oil as a biofuel for engines operating at low temperatures (100 ° C, 120 ° C) by compound it with the mineral oil [8].

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