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Modeling of the electrical resistivity of vegetable oils: Palm and Prickly pear oil.

M Serghini Idrissi[3], O K Kabbaj[3], A Bouziani*[1], S Bougarrani[1], I Hassanain[1], K Ellouzi[1], A Kafih[2], A Elhourch[2], L El Moussaoui[1], S Belekbir[1], F Hlimi[1], L Hammari[1], M Belgharza[1], and M Alaoui El Belghiti[1].

[1]Equipe physico-chimie des matériaux, Nanomatériaux et environnement, Département de Chimie, Université Mohammed V, Faculté des Sciences, Avenue Ibn Batouta, BP 1014 Rabat.
[2]Equipe de la chimie analytique et électrochimie, Université Mohammed V, Faculté des Sciences, 4 avenue Ibn Batouta B.P. 1014, Rabat.
[3]Laboratoire De Spectroscopie, Modélisation Moléculaire, Matériaux et Environnement, Département de Physique, Université Mohammed V, Faculté des Sciences, Avenue Ibn, Batouta, BP 1014 Rabat.

ABSTRACT

In this study, we report the measurement of the resistivity of two vegetable oils: palm, and Prickly pear depending on the temperature. This study showed that the electrical resistivity decrease when the temperature T increase (25-100 C°). This diminution was assigned to the effect of thermal stirring on the disorientation of the molecules of the oil. This study can be useful for a possible application of these oils in the technological field.
Keywords: Electrical resistivity, transformer, dielectric.

Corresponding author

INTRODUCTION

The concept of green chemistry [1] was created to "support the design of products and processes that reduce or eliminate the use and formation of hazardous substances." These rules ecodesign sometimes seem restrictive, but they can become profitable, especially for chemists and manufacturers. The principles of green chemistry tend to more environmentally friendly methods of synthesis of the environment and the use of renewable raw materials [2].

Because of their chemical inertness when subjected to electric fields, oils are often used as insulation for some electrical applications, including transformers, circuit breakers, cables and capacitors.

There are prototypes of biodegradable insulating oil for electrical transformers based on derivatives of vegetable oils (fatty acids) and with unmatched performance at low temperatures. Biodegradability and non-toxicity of these insulating oils are substitutes choice for those customarily used are all based petrochemical derivatives and therefore more prone to price fluctuations of petroleum products [3].

The electrical properties of the oil depend on their chemical composition and molecular. The electrical resistivity ρ and dielectric strength are the main electrical characteristics of a substance. The electrical conductivity of oil is due to the presence of free charges and under the effect of an electric field, these charges move to thereby provide an electrical current. The electrical resistivity is the reciprocal of the electric conductivityσ.

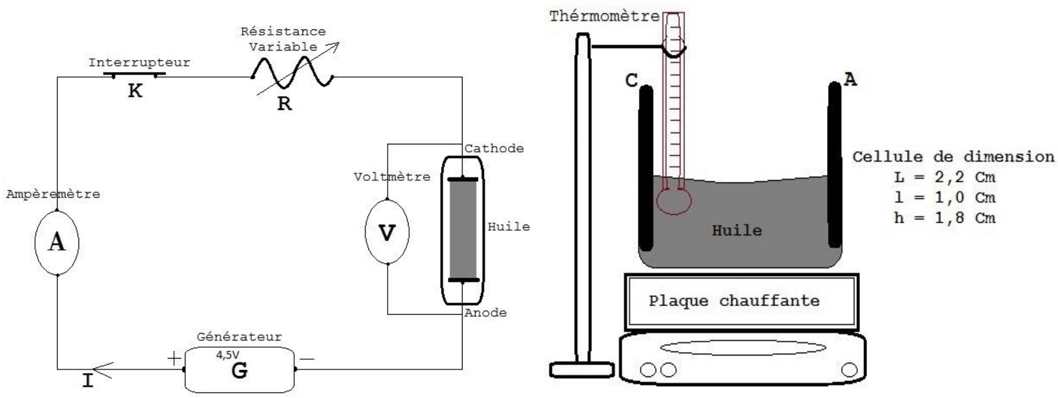
The electrical resistivity is a fundamental parameter in the non-destructive characterization of the compounds [4,5]. The study of the electrical conductivity depending on the temperature of oil: palm and Prickly pear allow us to better characterize these oils.

MATERIALS AND METHOD

We used the resistivity measurement method known as "two points method": electrical resistance of the oil was determined by measuring the current and potential difference between the two electrodes of the cell (see montage).

Materials

Schema of the cell used to measure the electrical resistivity.



a. Montage of the equipment used. **b. cell of measurement of resistivity.**

Method

Computation of the resistivity was based on the following formula: $\rho = R \times \frac{S}{L}$

Where ρ : Electrical Resistivity (Ω.cm); R : Resistance (Ω); S : Section (cm²); L : length(cm)

Modelization

The variation of the resistivity of vegetable oils depending on the temperature was modeled with the Arrhenius equation: $\rho = \rho_0 \exp(Ea / RT)$ where ρ is the resistivity, ρ_0 is the Exponential factor (Ω /m) E_A is the activation energy (J/mol), R is the gas constant (J /mol/K), and T is the temperature (K) The ρ0 value may be approximated as high-temperature resistivity (ρ_0 of $\rho\infty$)

Equation (1) can be rewritten as follows: $\ln(\rho) = \ln(\rho_0) + (Ea / RT)$

The aim of this study is to adapt our results to the Arrhenius equation, and determine from this modeling, the physico-chemical characteristics of the oil studied.

RESULTS AND DISCUSSION

Results

The measurements of the electrical resistivity of palm vegetable oil are shown in Figure 1.

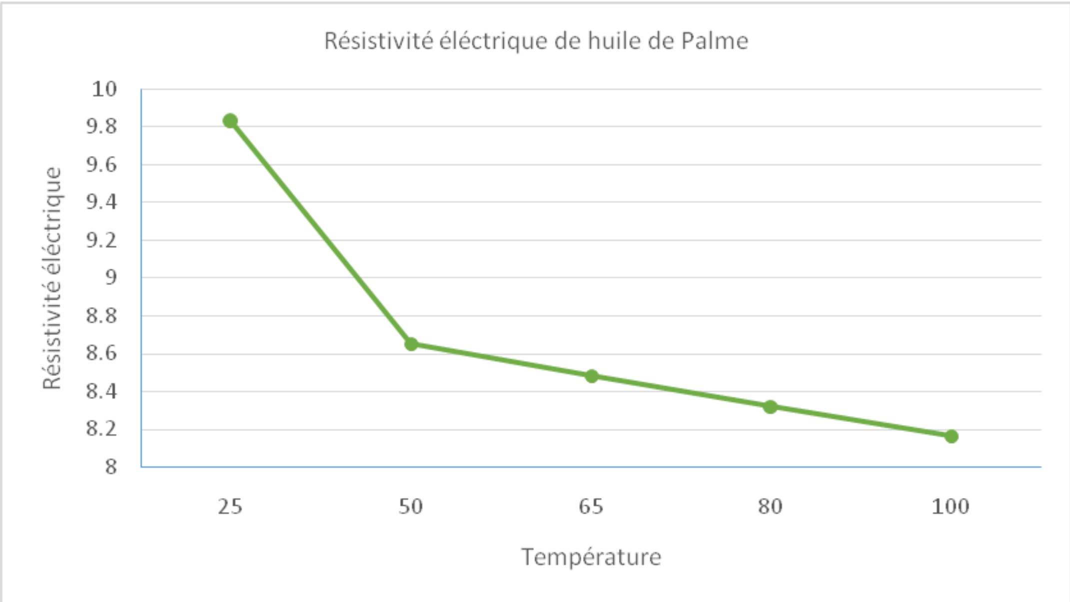


Figure 1: Electrical resistivity vegetable palm oil (10^6 Ω / cm)

The results of modeling, vegetable palm oil are shown in Figure 2.

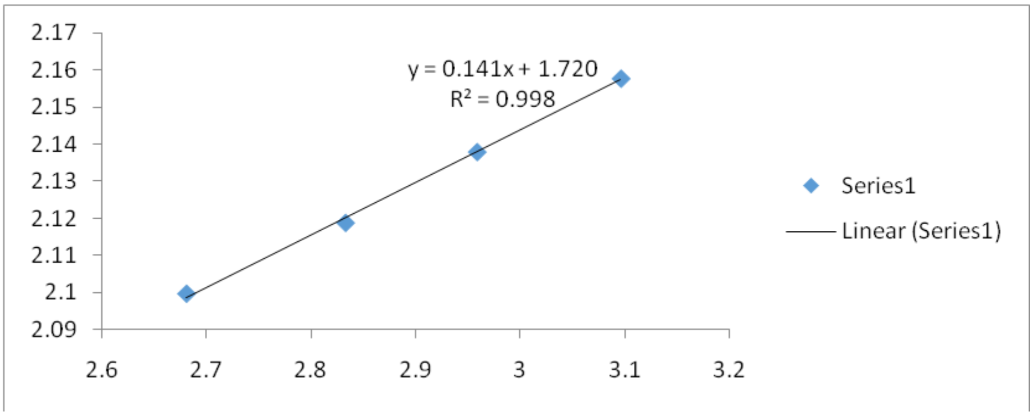


Figure 2: Modeling the electrical resistivity of the vegetable oil

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The measurements of the electrical resistivity of Prickly pear oil are shown in Figure 3

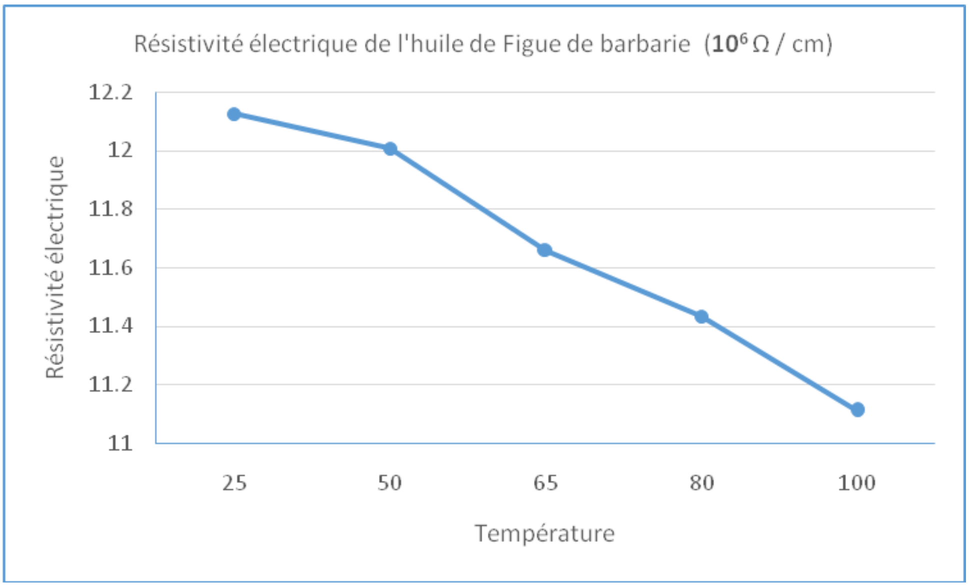

Figure 3: Electrical resistivity of the vegetable oils of prickly pear ($10^6\,\Omega$ / cm)

The results of the modeling of the vegetable oil, prickly pear are shown in Figure 4.

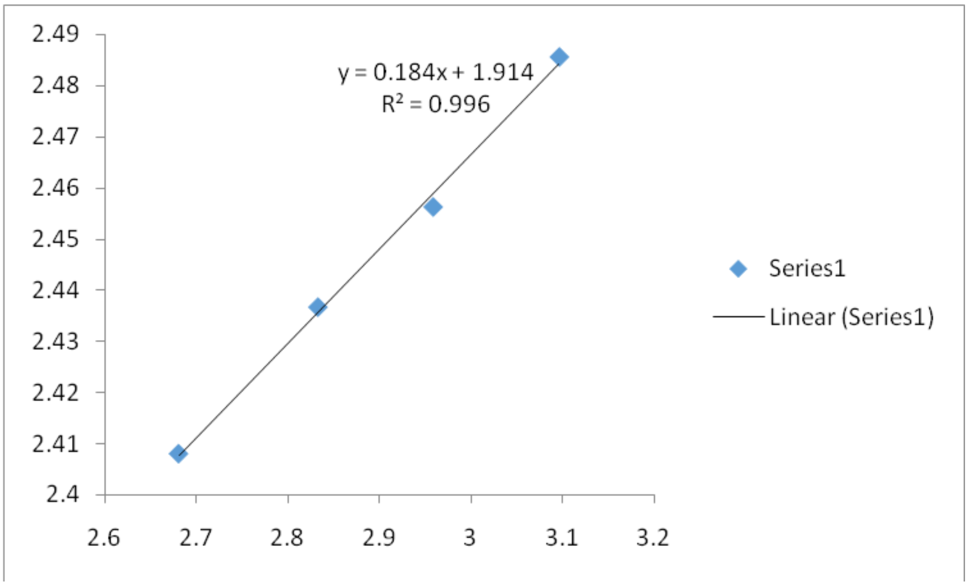

Figure 4: Modeling of the electrical resistivity of the Prickly pear oil

Table 1: Important parameters of the ln (electrical resistivity) versus temperature

Sample	**ρ_∞ (x$10^6\Omega$,cm)**	**E_a(KJ/mole)**	**R^2**
Palm oil	5.59	1.174	0.998
Prickly pear oil	1.53171	6.78	0.9969

The results show that the infinite-temperature resistivity **(ρ_∞)** of the palm oil is larger than the other oil, while the activation energy **(E_a)** of the Prickly pear oil is the largest one.

(ρ_∞) palm oil > (ρ_∞) Prickly pear oil (E_a) Prickly pear oil > (E_a)palm oil

DISCUSSION AND CONCLUSION

The causes we can give to explain this change (decrease in the electrical resistivity depending on temperature) are:

- ✓ Different chemical changes occurring to this oil.
- ✓ The orientation of the molecules (decrease in viscosity) which facilitates the passage of current in the oil.
- ✓ The electrical resistivity of vegetable palm oil, decreases with temperature, experimentally and as predicted by Arrhenius equation.
- ✓ The activation energy and the pre-exponential term were obtained. These results can be used as a means to characterize the quality of the oil. These values depend on the nature of the oil.

REFERENCES

[1] Anastas P.T., Warner J.C., Green chemistry theory and practice, Edition Oxford University press, 1998.

[2] Baumann H., Bühler M., Fochem H., Hirsinger F., Zoebelein H., Falbe J., Angew. Chem. Int. Ed. Eng., 1988, 27, 41-62.

[3] Vitilingon G. et al. (1998) Development of rapeseed oil burners for drying and heating, Industrial Crops and Products 7 (1998) 273-279

[4] AZIZ TEKIN and EARL G. HAMMOND.JOURNAL of the American oil Chemists' Society, 2000,volume 77,number 3, (281-283).

[5] A.K.MAHAPATRA, B. L. JONES, C.N.NGUYEN, and G.KANNAN, 2010, « An Experimental Determination of the Electrical Resistivity of Beef ». Agricultural engineering international : the CIGR Ejournal. Manuscript 1664.Vol. XX. July.