Comparative study of the Dynamic Viscosity of Vegetable Oils with those of Mineral Oils

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A B S T R A C T

Extracting a new biodegradable and non-toxic compositions made from vegetable oils, namely argan oil and sunflower was highlighted. A comparative study of the properties of these oils with synthetic silicone oil was performed. Initial investigations confirm the feasibility of their use in lieu of mineral insulating oils in distribution transformers, to reduce environmental impacts and increase the safety of these devices.

I N T R O D U C T I O N

The vegetable oil processing industry involves the extraction and processing of oils and fats from vegetable sources. Vegetable oils and fats are principally used for human consumption but are also used in animal feed, for medicinal purposes, and for certain technical applications. The oils and fats are extracted from a variety of fruits, seeds, and nuts. The oils and fats are extracted from a variety of fruits, seeds, and nuts.

Since ancient times, essential oils are recognized for their medicinal value and they are very interesting and powerful natural plant products. They continue to be of paramount importance until the present day. Essential oils have been used as perfumes, flavors for foods and beverages, or to heal both body and mind for thousands of years (Baris et al., 2006; Margaris et al., 1982; Tisserand, 1997; Wei & Shibamoto 2010).

Therefore, several studies have been performed to assess quality of the oil on the basis of their physical properties: viscosity, refractive index, electrical resistivity etc. Pace, Risman, Bengtsson and El Al Shami [1] suggested that the electrical properties can be used as indicators of quality of vegetable oils. Several researchers have worked on the chemical and physical properties of vegetable oils [2,3, 4, 5, 6, 7, 8 and 9].

Mineral insulating oils are widely used as dielectric and heat transfer fluids in many electrical equipment: transformers, capacitors, cables, circuit breakers etc. Their introduction has particularly increased the dielectric strength equipment, reduce the volume (equal power), but also to increase their operational life. Thanks to advances in refining techniques and a better understanding of the technical requirements, the quality of the dielectric liquid has been continuously improved, so that the basic chemical structure of current products is not very different from the first l oil tested in the 1890s. Or, are growing concerns of the public and legislators about the problems of pollution and safety, adherence increasingly strong issues of depletion of fossil resources and sustainable development are these mineral oils are less well accepted. Already, disposal at end of life filled with oil materials, (de) contamination soles and water after always possible leak, flammability and toxicity of these products pose many problems to the operators, even if the insulating mineral oils are still currently the best technical and economical solution.

Faced with this situation, it seemed interesting to research a greener alternative to existing dielectric fluids, vegetable oils and quickly emerged as potentially interesting. Indeed, some of their electrical and thermal physicochemical characteristics appear close to those expected mineral oils or better. In addition, unlike oil products, non-toxic, biodegradable oils can be produced locally from renewable resources. In this work, knotted have measured the viscosity of both vegetable oils: Argan and sunflower and compared the results to the values of Silicone Oil. The properties are systematically evaluated the pour point and viscosity.
The viscosity is an important parameter for dielectric liquids with heat power depends, especially in the case of processors without forced circulation (convection). At the operating temperatures, the oil will be more fluid, more heat transfer will be effective outwardly.

**MATERIALS AND METHODS**

*Extraction of oils:*

The extracted oils were studied by a new method which comprises drying the product under vacuum (12 mm Hg) and at a temperature below 60 ° C, for a period of one hour. This process has allowed us to eliminate 40% humidity and get a clear paste, contrary to the conditions of drying in an oven for 24 hours, which often gives a partial oxidation of pulp and oil. The extraction of avocado oil and sunflower oil with ethyl alcohol from pulp obtained by this new method allows isolating an oil of better quality compared to traditional processes; more isolated meal keeps its qualities following mild conditions proposed.

2 - *Measurement of dynamic viscosity:*

The viscosity of the oils studied was measured using an Ostwald viscometer. Said capillary viscometer consists of a U-tube with variable radius. In one of the vertical branches of the U, is set high in a wider portion which is bulbous directly followed by a capillary. The tube returns to its standard width and then performs the bent portion of the tube. In the other vertical arm, there is a second bulb, even larger, but this time, in the lower part.

Two points located one above the upper bulb (A), the other below the same bulb (B) determine a known volume. The goal is to measure the time required for liquid to pass the upper point A to point B. lower The thus obtained is used to determine the dynamic viscosity \( \eta \) of the liquid knowing its density \( \rho \) via Poiseuille’s law:

\[
\Delta t = \frac{k \eta}{\rho}
\]

The kinematic viscosity is obtained by dividing the dynamic viscosity by the density is:

\[
\nu = \frac{\eta}{\rho}
\]

Where is a constant clean viscometer provided by the manufacturer, or to be determined by calibration with a liquid whose density and viscosity are known. However, is a constant only if the liquid is always set at the same level (point A) at the beginning of each experiment and if there are no bubbles.

**RESULTS AND DISCUSSION**

Table 1 shows the values of the kinematic viscosity measured on Argan oil and Sunflower parallel to typical values obtained pure silicone oil and for different values of the temperature. In Figure 1 we have extended the variation in viscosity versus temperature for the three oils.

<table>
<thead>
<tr>
<th>Kinematic Viscosity</th>
<th>Silicone Oil (10^-5)</th>
<th>Tournesol Oil (10^-5)</th>
<th>Argan Oil (10^-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>2.1</td>
<td>-</td>
<td>8.968</td>
</tr>
<tr>
<td>40</td>
<td>1.15</td>
<td>2.282</td>
<td>7.951</td>
</tr>
<tr>
<td>60</td>
<td>0.457</td>
<td>1.987</td>
<td>7.446</td>
</tr>
<tr>
<td>80</td>
<td>0.301</td>
<td>1.763</td>
<td>7.102</td>
</tr>
</tbody>
</table>
The very high viscosity of the silicone oil and Sunflower oil is related to the presence of large quantities of monounsaturated fatty acids and specific hydroxylated of these two oils. However, it is noted that for temperatures around 120 °C, the viscosity values for the two oils become very close.

Conclusion:
In this work, we proposed a novel method for extraction of biodegradable and non-toxic compositions based on vegetable oils. The first results showed that vegetable oils studied can be used in transformers, especially at high temperatures (120 °C).

RÉFÉRENCES