# CHARACTERIZATION OF THE CASHEW NUTS OIL AS A LUBRICANT PLANT

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***Abstract.*** *This paper intends to analyze the intensive properties of the in-nature cashew nut oil as well: density, viscosity, flash-point, extreme pressure, flow point, turbidity and others required for lubricant characterization. Believing to be a fountain of lubricant oil economically viable, whereas it is about an abundant product in our region. And also encourage the clear engineering and the exploration of the region's potential. At all there are eleven tests of the properties of fluid and a test of attrition divided in three stages: the first one consisting by extraction and some basic properties tests, the second just for more specific properties tests and the third by the abrasion test of the workpiece of a mechanical system. The cashew nut has two types of oils, one is found in the almond and another found in the shell of the nut, together they form a third oil, so this third is the mixture of the others two. This research works with this fusion of the two oils because of the easier method to extraction. In a conventional squeezer is extracted a determined quantity of oil, which has a direct relation with the quality and the quantity of the nuts. After extracted, the fluid was subjected to tests specified by the technical norms, essentials to its characterization*

***Keywords****: Cashew nuts, lubricant oil, clear engineering, oil extraction.*

## 1. INTRODUCTION

The lubricating oil is one of the most important items to keep in harmony a mechanical system, whereas it reduces the wear related to the friction, protects the metal from oxidation and corrosion, beyond dissipates the excessive heat. Despite of, its absence or its wrong use may cause serious damage, and may compromise part or all the system.

Most part of the lubricating oils found on the market are of a mineral origin, extracted from petroleum or synthesized, being classified according to their physicochemical properties.

Starting from the need of a product technically and economically viable, involving since its production to the clean engineering concepts; this article examines the capacity of using of a vegetable oil as a lubricant. To it was used of the cashew nut as raw material (abundant material in the west Potiguar) working since the improvement of it’s the oil extraction ‘til it’s preliminary characterization, from basic tests such as density, viscosity, viscosity index, and turbidity, among others, to assess concomitantly the technical and socio-economic potential of the use of the cashew nut as a lubricant oil.

## 2. THEORETICAL BASEMENT

A large amount of fluids, in some way, can make function of a lubricant. However, to better receive this classification they must be framed in conditions such as, improve the capacity to separate the surfaces when in movement and have some degree of stability as changes. From this line of reasoning, we aimed analyze these characteristics to frame, in the lubricants classification, other fluids different of petroleum and derivatives.

With innovative character, we processed and analyzed a fluid of vegetable origin to obtain a lubricant exclusively vegetable. Among the various options of seeds and fruits that contain considerable content of oil, we decided to work with cashew nuts, once their middle average of extraction is about 45.7%, according (LIMA, GARCÍA, LIMA, 2004). Furthermore, the cashew nut being a fruit abundant in the state, we guaranteed to be obtained easily, as well it has a wide variety of oil depending on the harvest and storage time, being possible to obtain oils with different properties and/or characteristic relating, also, with the extraction method.

The nut of the cashew has two distinct types of oils, one from the almond and other from the bark. The mixture of these two oils gives rise to a third type of oil, which for its extraction is not necessary to separate the almond from the porous material that involves it, and neither submit it to any treatment or process of separation. Thus, according on the need for unchanged fluid properties and it’s conservation "in-nature" as well as the practicality involved in the obtaining system. The working fluid analyzed was the last presented which call of OBA - oil bark in addition of almond.

It's valid to emphasize that this study was ignored the quality of raw material about the type of harvest and storage time, as well as other factors that can contribute to change the properties or influence the yield of the extraction process. Thus, we worked only with the yield relations versus quantity, according to the equipment or the extraction method.

To characterize an oil as lubricant, tests are made according to ASTM standards, among which we take as basis the following: ASTM-D-445, ASTM-D-4052, ASTM-D-2270 for viscosity, density and viscosity index, respectively. with the value of that last characteristic, the variation of viscosity in function of the temperature, we can sub classified a lubricant as multi graduate to a smaller variation, or mono graduate for a bigger variation. After have realized the tests according to American Society for Testing and Materials, the results obtained are observed according to the parameters already established by the Society of Automobile Engineers and by the International Organization for Standardization.

The ISO classification is usually used for industrial oils at a temperature of 40 º C, showing tolerance error of 10%. However the SAE classification, which its most part works with lubricants multi graduated, is divided into two: one used for engine oil and one for gear oils.

The analysis is focused in the following intensive properties:

Density: Indicates how much mass has a determined volume in a certain temperature. Also used to indicate if there was contamination of the oil and to determine the kinematical viscosity. To determine the density of the lubricants, various equipments of test are used like a hydrometer, picnometer, hydrostatic balance or digital densitometer (Theo and Wilfried, 2007).

$$\rho = \frac{m}{v} \tag{1}$$

Viscosity: Describes the internal resistance that the fluid has to flow. As much viscous, bigger is the capacity that the oil has to remain in two surfaces in movement. It is divided into dynamic viscosity (absolute) and kinematical viscosity, where we find μ to the dynamic viscosity and its result divided by the density indicates us the kinematical viscosity, which is that in fact interests us, whereas the peaces of the system works in movement.

$$\mu = \frac{\partial y}{\partial u}\tau \tag{2}$$

$$\upsilon = \frac{\mu}{\rho} \tag{3}$$

Viscosity index: is important only in applications where the engine is subjected to frequent cycles, according to (Handbook of Lubrication and Tribology, second edition), the index expresses the degree of viscosity variation in function of the temperature variation, so, as much the viscosity index, lower is the viscosity variation of a given oil when subjected to different temperatures. This equation is derived from the concept of patterns oils: one with a viscosity IV = 0 with viscosity L, and the other with IV = 100 and a viscosity H.

$$IV = \frac{L-U}{L-H}x100 \tag{4}$$

## 3. METHODOLOGY

The third type of oil defined previously witch we called of OCA was, previously, extracted in two different ways, with the objective to compare between the yield according to the method used.

For the first method of extraction was used a electric press, Witch is no more than a kind of windmill coupled to an electric motor, operating according to the following configuration: a milling witch in the moment that grind the cashew nuts pushes it to a set of disk arranged in parallel with the purpose of pressing the mass formed, promoting the flow of oil, through the discs and their collector a deposition in a tray while separates the dropping that leads dry into another tray collector.

The second method was designed from the use of a hydraulic press. Thus, it was necessary to adapt the equipment to avoid the contamination of the oil, being built a device similar to a piston from the following materials:

- A tube of stainless steel with internal diameter Øin = 36.0 mm, outside diameter Øex = 38.2 mm and length L = 56.2 mm.
- Two plates of steel, with diameters of the base and the piston respectively equal to ØBA = 38.8 mm, ØEM = 35.0 mm and thickness = 4mm

- A becker glass

Still in the manufacture of the "plunger" a hole in the end lower of the tube was machined, to the flow and collection of the fluid extract. The top plate, which acts like a piston, travels internally by tube distributing the force exerted by head of the press to squeeze the nuts along the tube, removing so, the oil for analysis.

## 4. RESULTS AND DISCUSSIONS

Analyzing the first method of extraction, we could see that the behavior of the system did not satisfied the expectations. This as about the theoretical didactic as about the proposed by the manufacturer of the equipment. In the final process, the extract obtained was presented very viscous like a pasty. It is, didn't have separation between the oil and the nuts peel, occurring only a compaction of the raw material.

The raw material used in electric presses was separated into two samples, the first and second weighing 501.0 g to 506.3 g, respectively. However, with this the two attempts to extract were not satisfactory.

It is believed that the failure of this method is due the facility that the chestnuts have to be broken independently of the grain size. Although apparently strong it is a fragile material, so that the force of the press crushed it in witch way that the solid particles were mixed with the fluid while the pressure of the discs was insufficient to drain the oil.

With the acquired data from the experiment, we draw a graph WEIGHT X INCOME. However, as yield for our objective had been zero, we got a constant curve along the ordinates, axis corresponding to the weight.

Beyond the obtaining of an extract not satisfactory, the use of the electric presses don't provide us data about the stresses and forces involved in the process and necessary to the extraction, because it doesn't have data about the to milling speed or torque applied ; knowing only to be automatically driven by an electric motor.

To the second method of extraction, through the use of hydraulic press, we worked up initially with the specification presented earlier in the methodology. By pressing the first sample was extracted a satisfactory amount of oil, but in the collection method was lost a considerable due the positioning of the left orifice of the fluid. Considering the damage to the process, it was necessary to change the cell of the press, in a way that the flow of fluid occurred with the minimum loss possible.

In its new configuration, the hole on the side of the cylinder was sealed with solder and a new, with 7mm in diameter, was opened at the base. However, the yield desired was not achieved, the nuts when crushed staked the left collection, preventing the fluid flow and imprisoning it in the tube.

As an alternative to facilitate the flow through the base, was added to the cell a metal plate forming a sort of internal basis with the following characteristics:

Thickness Es = 19 mm

Diameter Ø=30 mm

Grooves with a depth of 3 mm by 3 mm wide, spacing of 5mm and a central slot perpendicular also with a depth of 3mm by 3mm wide.

Figure 1. System used as a cell of the press. Photo: Luanda Kívia

Thus, to press the samples in the basic internal, the liquid flows between the internal lateral spacing formed due to the difference between the diameters and directed by the grooves, flows through, the hole at the base of the cylinder. With this measure we extracted the oil of the cashew nut, however, as shown in Tab. 1 , without significant changes on the income.

Table 1. Weight versus income depending on the pressure.

| Methods | N°1 | N° 2 | N° 3 | |
|---|---|---|---|---|
| Weight of samples (g) | 222,7 | 206,6 | Samples | 223,3 |
| | | | | 219,4 |
| | | | | 213,4 |
| Yield (g) | 33,5 | 18,2 | Samples | 34 |
| | | | | 37,2 |
| | | | | 38,1 |
| Yield in percent (%) | 15,04 | 8,80 | Samples | 15,22 |
| | | | | 16,95 |
| | | | | 17,85 |

The samples had almost the same weight, whereas the maximum capacity of our cell is one of the parameters in use. The yield according by weight was almost constant having as modifying variable the method of extraction as well as pressure exercised from the press.

From fluid extracted were given up the beginning of the analysis and their intensive properties.

To determine the density was used the method of picnometer, having as base concepts studied and presented in the theoretical basement. In order to better the accuracy, all the laboratory glassware were calibrated. Finally, for this first sample were obtained:

- ✓ Oil volume: 57.7 cm³;
- ✓ Oil mass: 50g.

Applying these values in Eq. (1), we obtain:

$$\rho = \frac{m}{v} \Leftrightarrow \rho = \frac{50(g)}{57{,}7(cm^3)} \Leftrightarrow \rho = 0{,}98$$

As expected, the density of the fluid extracted is lower than the density of the water. However, although it were one of the factors that characterize it as an oil, it is not sufficient to characterize it as a lubricant. For it, we had to find its viscosity its and viscosity index.

The viscosity was measured with a reometer, when were plotted dy/dv in function of the shear $\tau$, we could see a linear straight. The derived of this function is the apparent viscosity of the fluid, in the case of the OBO, the derived is a constant, it is, in a determined degree of temperature the viscosity of the oil isn't changed, what ensure a bigger stability. So the viscosity let to be considered apparent and now is considered real, due the behavior of a Newtonian fluid, like can be seen in the Fig. 2.

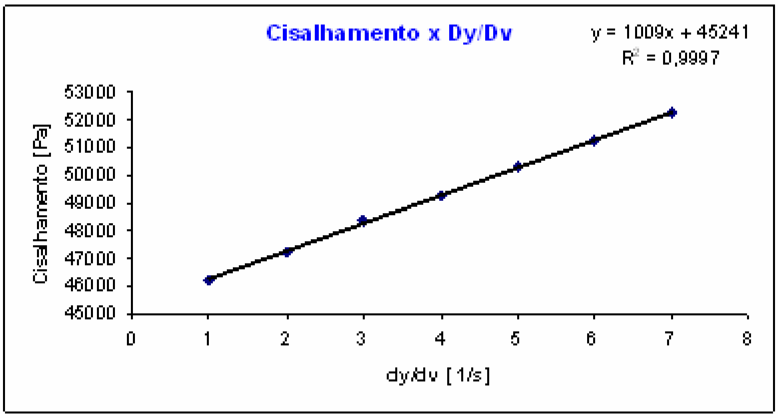


Figure 2. Chart Shear x Dy / Dv

This behavior was applied in all the tests realized with the cashew nut oil, but when altered the temperature, the viscosity vary in a exponential relation. Look the Fig. (3).

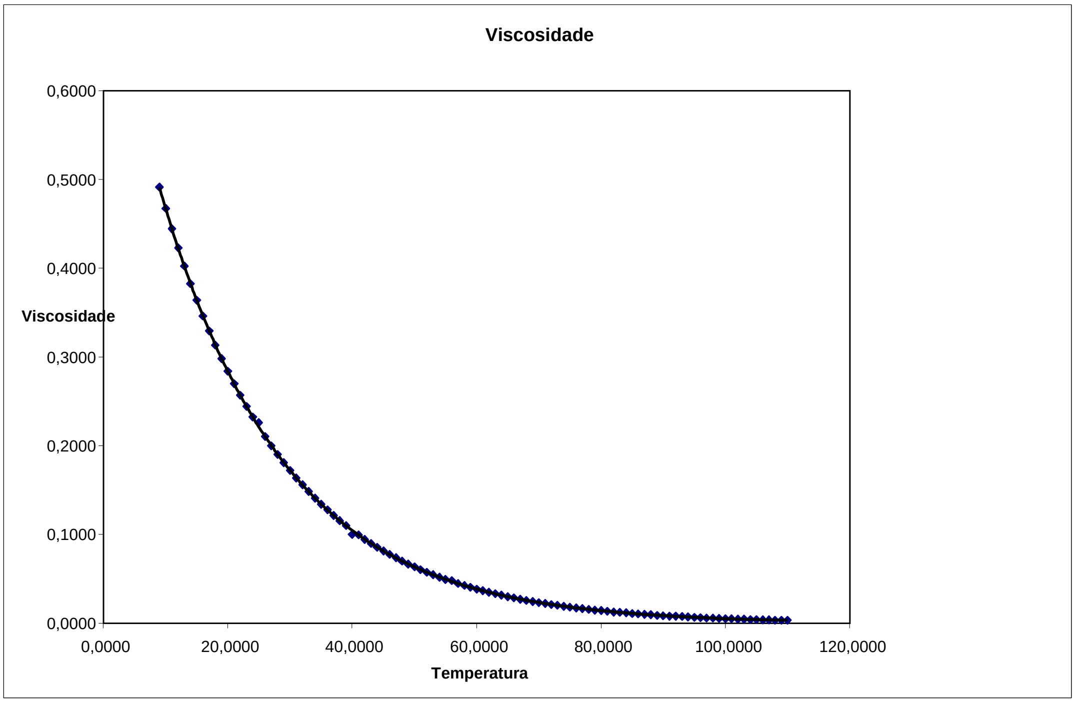


Figure 3. Char Viscosity x Temperature

O Reometer gives us the dynamic viscosity in Pa*s, but the important for us is the kinematical viscosity, so we apply the Eq. (3) to viscosity in 40°C.

- ✓ μ = 0,099378 Pas
- ✓ ρ = 0,98g/cm³ = 980 Kg/m³

$$\upsilon = \frac{\mu}{\rho} \Leftrightarrow \upsilon = \frac{0{,}099378}{980} \Leftrightarrow \upsilon = \frac{0{,}099378}{980} \Leftrightarrow \upsilon = 1{,}014 * 10^{-4}\, m^2/s$$

Transforming to centistokes we have: $\upsilon = 101{,}4cSt$

In 100°C were not done viscosity, due the boil point be next to 95°C, because of it, we extrapolated the equation of the Fig. (3).

- ✓ μ = 0,0052 Pas

Appling again the Eq.(3)

$$\upsilon = \frac{0{,}0052}{980} \Leftrightarrow \upsilon = 5{,}3 * 10^{-6} m^2/s$$

Transforming to centistokes we have: $\upsilon = 5{,}306 cSt$

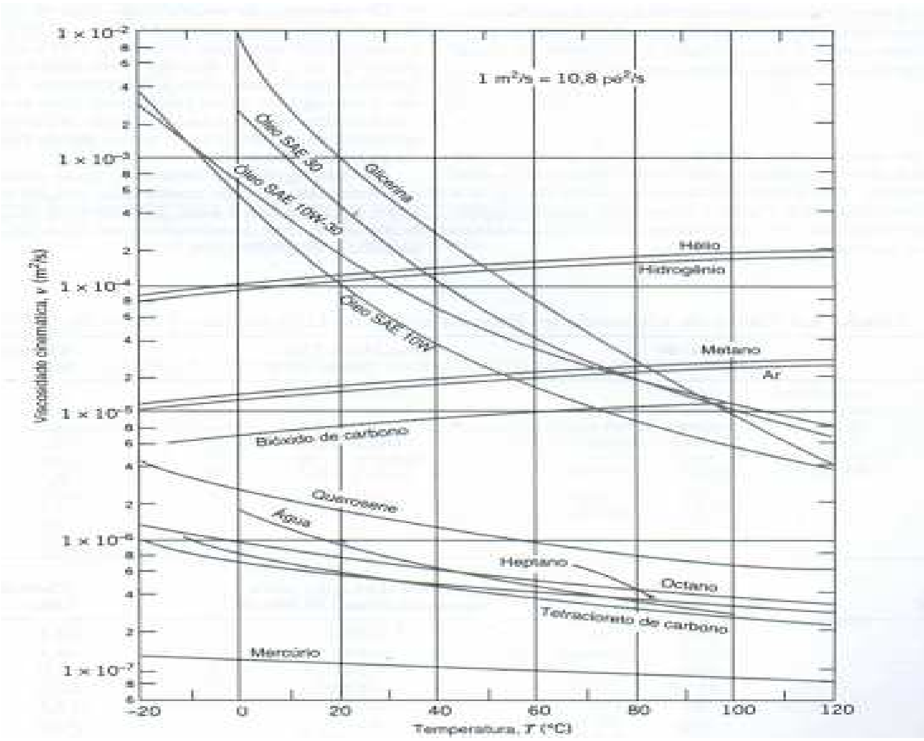


Figure 4. Diagram of viscosity versus temperature for various oils.

From the viscosity found, we calculated the viscosity index, it is, the viscosity degree variation front to the temperature variation. According to the values of the interpolation:

- ✓ L = 119,94
- ✓ H = 69,48

$$IV = \frac{L-U}{L-H} x100 \quad \Leftrightarrow \quad IV = \frac{119{,}94 - 101{,}4}{119{,}94 - 69{,}8} x100 \Leftrightarrow IV = 36{,}97$$

## 5. CONCLUSION

Although apparently considered easy, the tests realized are primaries to the characterization of the fluid. So, with the achievement of the dates about mainly the viscosity, considered the most important characteristic about the performance of the oil while lubricant, we could conclude that, in fact, the oil extracted from the cashew nut has characteristics similar to others lubricant oils already used commercially on the market.

So, according to the proposed as central idea of the article, from this prior characterization, considered very satisfactory, the researched at the area will be depth to better comprehension of the OBA behavior in function of others pertinent properties to its lubricant character. And, concomitant to the development of a project of optimization of the extraction methods and collection of the cashew nut substratum, we work finally with palpable expectations about a vegetal lubricant oil, obtained by a clear system and socio-economically viable.

## 6. ACKNOWLEDGEMENTS

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