THE IMPORTANCE OF PRE-TREATMENT WITH ALKALINE WASH FOR THE OBTAINTION OF BIODISEL FROM VEGETABLE OIL ALOE VERA

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Abstract *— The importance of producing biofuels in large scale and the technical aspects required by the market have resulted in biodiesel derived from plant oil kinematic viscosity related researches. Transesterification is the most common and efficient way to reduce viscosity. Considering that it is a one-step process, it has become the simplest and most affordable method when compared to others biodiesel obtaintion processes. But further than the main trasesterification process, there are other processes that aim to reduce the impurities from raw materials which are used throughout the process. The colorless gel extracted from aloe vera, which is the focus of this work, could only adapt to the trasensterification process after it went through an alkaline wash, showing the relevance of this method when it comes to obtain the final product.*

Index Terms — Biodiesel, Aloe Vera, transesterification. alkaline wash.

INTRODUCTION

Given the energy demand and the consequences of the exagerated use of non renewable raw materials, emerges the challenge of uncovering new technologies which are viable to replace and adapt inovations according to market behaviour. Rudolf Christian Diesel's contribution with a reactor-engine capable of working with plant oil made the diesel engines emerge as an alternative, however it is still necessary to transform the raw plant oil through chemical processes according to the technical aspects required. [1]

The main concern is the plant oil kinematic viscosity, which is greater than that of the petroleum, derived fuels, such facts cause bad fuel atomization and consequent issues related to deposits in the combustion chamber. Given this fact, it is intended to find the best way to solve plant oil high viscoity related issues. [2]

The four most investigated methos lately when it comes to biodiesel production are: transesterification, pyrolysis, petroleum derived diesel dilution and the micro emulsion. Whereas the transesterification is the chemical method most used to reduce tryglicerides, improving the physical properties for diesel engines [2]. In summary, due to the fact that the process is fast when in the presence of a catalyst, has a low cost and is developed on a single stage at ambiemt pressure, it becomes more viable when it comes to market requirements. In this method, according Furfari (2008), the biodiesel is aqcuired through a reaction between the plant oil and a substance coming from the reaction between an alcohol (methanol, ethanol, propanol, butanol) and a catalyst (acid, basic, enzymatic) resulting on fatty acids and glycerin (which is removed through decantation). [3]-[4]-[5]

Methanol was chosen for this work considering some technical aspects of the transesterification, Freedman et. al., (1886, p.1377) presented arguments concerning methanol's better technical viability when compared to that of the ethanol. Ethanol would be better suited in a anhydrous way or on a situation where the amount of water was inferior, because even a slight amount of water could inhibit the reaction. The separation of the glicerine, which is a subproduct of the reaction, in ethyl ester would require a bigger amount of steps, while in methyl ester it is done through a simple decantation process.[6]

A fact of great importance for akalyne transesterification, used in this work, is that some substances cannot be removed through decantation and filtration and can jeopardize the reaction, given this fact there is a need for a pre-treatment.[7]

This work focuses on performing a study of the art and evolution through raw material preparation analysis, so as to suit the aloe vera gel to the best conditions, eliminating unwanted chemical substances, in order to reach a high efficiency rate during the transesterificaiton process. In short, free fatty acids, humidity and acidity rate are aspects to be analysed and treated prior to the transesterification process.

PRE-TREATMENT: FILTRATION AND ALKALYNE WASH

The first step of the process is to prepare the plant oil with the best conditions for the transesterification process. The parent author (2003) mentions that the treatment is according to the characteristics of the fatty material utilzied. Whereas the type of test of the following physico-chemical characteristics, acording to research are indispensable for obtaining better results:[7]-[8]

- Acid index: the acid index is the amount of sodium hydroxide (NaOH) consumed for the neutralization of

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the free fatty acids present in one gram of biomass. Can be mesaured by automatic titration.

- Humidity: percentage of water and of any other volatile substance present in the sample. Determined through a Karl Fischer test.
- Specific mass: ratio between the homogenous and compact mass and the volume ocupated by it. Can be mesaured using a densimeter.
- Peroxide index: indicates the presence of peroxides and other related products, originated by fatty acid oxidation. Is possible to be measured through automatic titration.
- Saponification index: in summary, according to Araujo (2009), represents the amount of base necessary to trigger saponification on a certain amount of oil. Can be determined through a simple acid-base titration test [10].
- Kinematic viscosity: a fluid's resistance to flowing, due to intermolecular relations. It is possible to measure a fluid's internal friction using a viscometer.

Oxidative stability: Evaluates an oil's resistance to oxidation. Widely utilized to observe an oil's characteristics when it comes to exposure time, even though the resources used were developed slowly.

During the aloe vera's gel extraction process using a small mechanic press, which is ideial for laboratory researches, it was possible to observe a certain amount of solid waste coming from this method. However these were easily eliminated when passed through a folded gauze located in the interior of a funnel, working as a paper filter, but this turns to be a rather slow process due to high oil viscosity.

Considering that the oil presented an acid PH while the catalyst, sodium hydroxide (NaOH), is a base, it was necessary, further then filtering, a method capable of reducing the acidity. The 100 ml sample was therefore needed to be submited to a neutralization or alkalyne wash process, which was also useful for removing the free fatty acids and the remaining saponifiable materials. "this way, the pre-treated oil, having a low rate of free fatty acids, can be transesterified with an alkalyne catalyst in order to convert triacylglycerols into methly esters".[2]-[7]

The neutralization was conducted using heated distilled water and sodium hydroxide. The oil was added to the mixture once it was properly stirred, and so it was possible to observe the appearance of solid particles which were removed with the help of a paper filter. Subsequently drying was performed, by heating the water which was added during the alkalyne wash beyond its boiling point (Up to 120°C, approximately), as shown on figure 1.

Drying has its importance because the same way the free fatty acids prevent a satisfactory result after transesterification, a minimum amont of water is also able to inhibit the reaction.

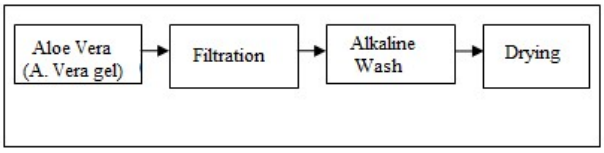

FIGURE 1
PRE-TRATMENT PROCESS

TRANSESTERIFICATION AND FREE FATTY ACIDS

As priorly mentioned, transeseterification is a process through which an ester is obatined from another ester. Considering the methanol advantages compared to other low molecular power alcohols and the positive results yielded by basic catalysts which presented a shorter reaction times than those of the acid ones. This is why this work was initiated with the transesterification reaction aiming for a chemical balance capable of favoring a continuous process and with a faster reaction. [2]-[6]

In summary, KNOTHE et al. (2006) describes that the molecule which is responsible for the generation of the plant oil originates as subproducts three methyl ester and one glycerin molecules. The catalyst's function is to break the link between the fatty acids and the glycerin. It is possible to remove the glycerin through decantation or by using a centrifugal machine (for a faster development). [2]

According to SCHUCHARDT et al.(1998) the biodiesel production process through alkalyne transesterification presents some issues related to the appearance of soap and the consumption of the catalyst, which is resposbile for reducing the reation's performance. [9]

When the alcohol reacts with the hydroxide it produces water, causing the hydrolysis of the produced esters and contibuiting for the increasement of the rate of existing free fatty acids which are the cause of soap formation (figure 2). A viable alternative is the removal of this free fatty acid excess through a pre-treatment step, mentiong before. [8]

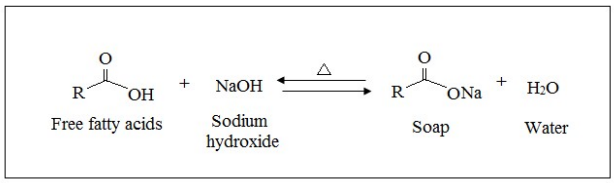

FIGURE 2
FATTY ACIDS SAPONIFICATION REACTION

METHODS USED FOR THE TRANSESTERIFICATION PROCESS

- The heating equipment was switched on and a Becker containg 100ml of aloe vera's gel was placed on it. The temperature was monitored until it reached 40°C, when the heater was than switcehd off.
- The methanol (20 mL) and sodium hydroxide (0,2 g) mixture were added to the oil insided the becker.
- The stirring went on for 20 minutes and than the mixture rested for aproximately 24 hours. Decantation was identified accordingly.

RESULTS

At first, crude oil, without any pre-treatment, was used, and so the sample presented high acidity rate, high viscosity and small solid particles. This fact jeopardized the transesterification and created a high amount of soap and fragments coming from the leaf's fiber, which clogged the decantation funnel preventing the separation of the phases, having as result a dark color, strong smell and high viscosity oil.

Thus, began a pre-treatment test including filtration only, enhancing the aspect of the oil after transesterification, but still keeping some of the bad effects priorly mentioned, evidencing that the solid particles were not the main issue.

Subsequently, an alkalyne wash was conducted, and through this it was possible to realize that after the transesterification reaction there was neither formations of soap nor traces of leaf fiber and after 24 hours of rest the phases separation was clear.

CONCLUSION

This research is still at a study level, other variables that can influence the transesterification reaction, such as temperature and rotation during the pre-treatment process, are to still be added.

Nevertheless, it was possible to improve the transesterification process through an alkaline wash, establishing conditions related mainly to the acidity index, reducing the existing free fatty acids, which are also responsible for causing the increasement of the deterioration process.

The results evidences that it is possible to improve the reaction, analyzing the effects of the physico-chemical analysis and reshaping it according to technical aspects that contribute to a better efficiency when to comes to alkaline transesterification. This way, a parameter of the ideal conditions takes shape.

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