Synthesis of biopolyol from vegetable oils

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***Abstract*— Growing concerns about the deterioration of the environment caused by conventional polymers have oriented global research towards renewable resources. Vegetable oils are one of the most readily available alternative renewable resources. The aim of our study is to synthesize a biopolyol from Sunflower oil which will be the substitute for petroleum polyol for the development of polyurethane (PUR) foams. A sustainable process for using these oils has been developed using different types of catalysts. Sunflower oils were epoxidized using homogeneous catalysts and the peroxy acid. The process provides a tool to create cleaner technology for the production of biocomponents that will be the building blocks of sustainable polymer materials.**

***Index Terms*— biopolyol, biopolymers, transesterification , epoxydation , SAN, PURs.**

I. INTRODUCTION

The main raw materials for the production of bio- based polyols are different natural oils, such as soybean oil, palm oil, sunflower oil, corn oil, etc. Vegetable oils represent an excellent alternative renewable source of raw materials for the manufacture of polyurethane (PUR) components such as polyols. All natural oils, with the exception of castor oil, must be chemically modified before they can be used for the production of PUR, as they do not contain hydroxyl groups.

Current research is focused on the chemical modification of vegetable oils, with the aim of improving their physicochemical properties or valuing them as raw materials.

Among the various methods, the epoxidation of vegetable oils has attracted a lot of attention.

II. SYNTHESIS OF BIOPOLYOL

The synthesis of biopolyol was carried out in two stages, the first consists of the acid epoxidation of a triglyceride, which is sunflower oil, and the second consists of the transesterification with methanol of the epoxidized oil obtained previously [1].

A.Epoxidation of sunflower oil

The sunflower vegetable oil is first reacted with hydrogen peroxide (H2O2) and acetic acid to give at a final stage the epoxidized sunflower oil (**Fig.1**).

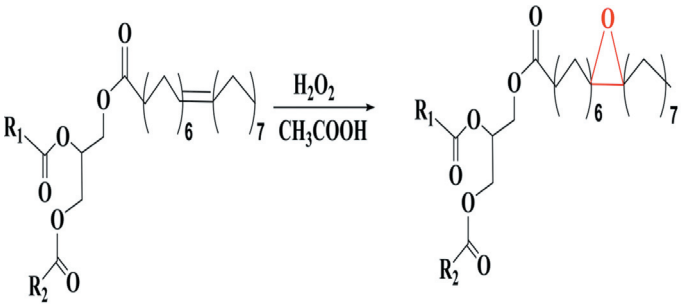

Fig.1: Reactional mechanism of epoxydation.

For this reaction, 300g of sunflower oil was mixed with 40ml of acetic acid (CH3COOH) and 1ml of 98% sulfuric acid (H2SO4), the mixture is heated in a reflux assembly (Fig1) until reaching a temperature of 65°C, then 60ml of hydrogen peroxide were added drop by drop to the reaction mixture until the quantity was exhausted [2].

B. Spectral collection and pretreatment

The most commonly used epoxy ring opening reaction is by alcoholysis using methanol (or another mono-alcohol) in water, with a catalyst based on fluoroboric acid (Fig.2).

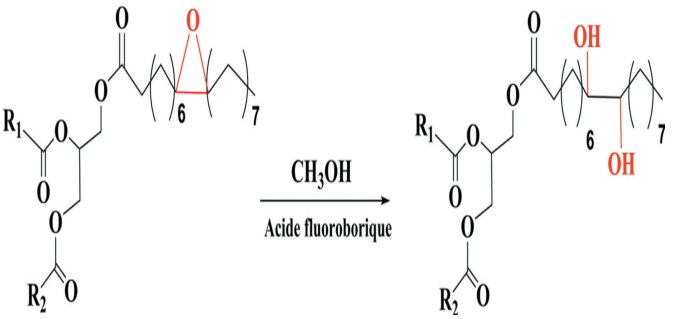

Fig.2: Reactional mechanism of Transesterification.

The reaction uses 50g of the epoxidized oil obtained above, heated with 100ml of methanol at the reflux temperature of the latter, with fluoroboric acid as catalyst. After heating for 30 minutes to a temperature between 50°C and 65°C (methanol reflux temperature), the reaction yield reaches about 80% [3].

III. RESULTS AND DISCUSSIONS

A. Epoxydation:

The results obtained from the epoxidation of sunflower oil are shown in figure 3. The peaks observed on the spectrum show a great similarity with the results previously published in the literature.

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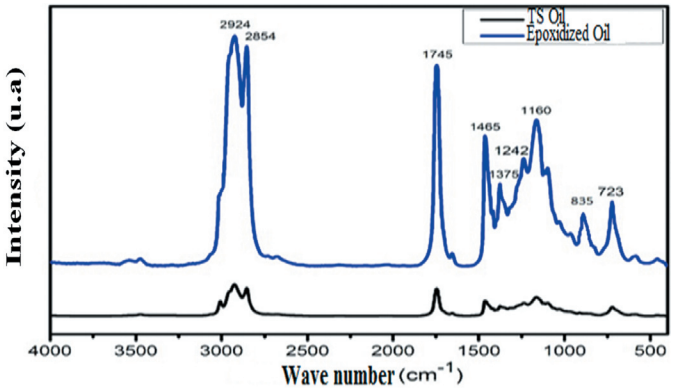

Fig.3:FTIR spectrum of epoxidized oil.

The epoxidation process allows the disappearance of the double bond C=C on the spectrum of epoxidized oil, which is justified by the disappearance of the characteristic peak corresponding to this bond at 3010 cm-1. In other terms, the double bond turns into an epoxy group, which is justified by the appearance of a new peak characteristic of the C-O-C bond at 835 cm-1. Moreover, the characteristic peak at 1750 cm-1 corresponds to the elongation vibration of C=O of carbonyls and the peaks of 1450-1350 cm-1 correspond to the vibration of CO group elongation of aliphatic esters [4].

B. Transesterification

The results obtained after treatment of the epoxidized oil with methanol are shown in fig.4. We clearly note the appearance of the characteristic peak at the (OH) group on the spectrum of biopolyol at 3400cm^{-1}.

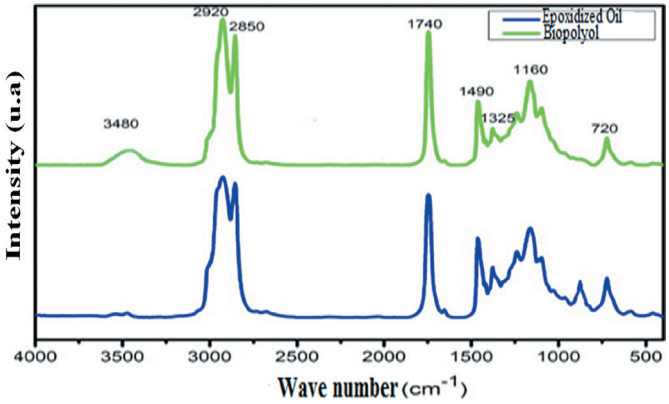

Fig.4. FTIR spectrum of biopolyol.

The transesterification step allows the opening of the C-O-C (epoxy) ring to transform it to hydroxyl groups. This is justified by the conversion of the epoxy peak located at 835cm-1 into a new large characteristic peak at 3400cm-1 which corresponds to the group (OH). Moreover, the opening of an epoxy group also allows for the appearance of another C-O ether bond which is identified by the characteristic peak at 1170cm^{-1}. The structure of fatty acid triglycerides is marked by the stretch peak of the C=O bond at 1745cm^{-1} [5].

This results was confirmed by RAMAN spectroscopy as shown in Fig.5.

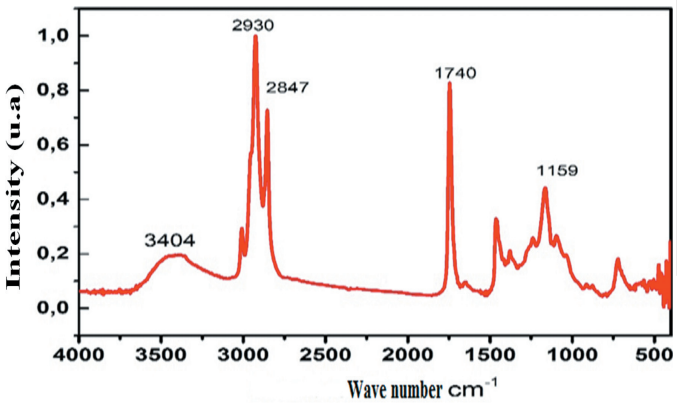

Fig.5. RAMAN spectrum of biopolyol.

IV. CONCLUSION

Through this work, we confirmed that the performance of epoxidized oil depends not only on raw materials, but also on the used catalyst. The use of sunflower oils enables the production of valuable polymeric materials. Processes such as the production of biobased polyol by transesterification and the synthesis of epoxidized sunflower oil, have already been carried out on a large scale industrially since several years. It represents a promising area especially with the inevitable consumption of petroleum oil.

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