PRODUCTION OF POLYURETHANE FROM CELLULOSE THAT IS EXRACTED FROM CITRUS PULP

UGUR KUSAT

TURKİSH Air Force Academy Istanbul, Turkey
E-mail: ukusat5123@gmail.com, 3616kusat@harbiyeli.hho.edu.tr

Abstract- Polyurethane(PU) has multiple characteristics. PU changed world in 20th century, PU is combining skills like energy saving, safety, durability so PU being used for many properties in many industry. That PU is produced from petroleum-based raw materials. Therefore they cause environmental problems. In this study cellulose is extracted from citrus pulps from juice factory waste and used instead of petroleum-based polyols in production of PU. With waterborne method bio-based PUs are obtained.

Keywords- Polyurethane, Cellulose, Pulp, Foam, Insulation, , Bio-based, Environmental Problems.

I. INTRODUCTION

Polyurethanes are versatile, modern and safe. They are used in a wide variety of applications to create all manner of consumer and industrial products that play a crucial role in making our lives more convenient, comfortable and environmentally friendly. Polyurethane is a plastic material, which exists in various forms. It can be tailored to be either rigid or flexible, and is the material of choice for a broad range of end-user applications such as insulation of refrigerators and freezers, thermal and acoustic insulation in aircrafts, building insulation, cushioning for furniture, mattresses, car parts, coatings, adhesives, rollers and tires, composite wood panels, shoe soles, sportswear.

In the production of traditional polyurethanes, petroleum-based raw materials are used. And petroleum is not a sustainable method. The energy consumption speed in the world is a thousand year's fossil formation[1]. Using this information, because the lifetime of the fossil reserves, which form a significant part of prevailing energy sources, is limited and because, according to the studies, they are not able to meet the constantly increasing energy demand, also regarding the damage that the greenhouse effect caused by the gases it emits like carbon dioxide makes to the environment, the renewable energy sources also became a actual subject beside nuclear energy and studies of producing fertile energy from these sources was started. Connection of covalent between diisocyanate and polyol create molecule of polyurethane. Repeatedly group of arroyyed urethane linked and then polyurethanes are occurred. First Otto Bayer obtained polyurethane from reaction of di-isocyanate with diol in 1937, in the I.G. Farben industry in German, Leverkusen[2].

However remainder of membranes result of juice extraction created and important disposal cost. But, late studies showed that citrus peel waste symbolizes a potentially precious resource that can be turned into valuable products.

Briefly orange peel contains soluble sugar, starch, fiber including cellulose, hemicellulose, lignin and pectin, ash, fat and protein. (Rivas et al., 2008).

Citrus pulps are obtained from fruit juice factory. The other pulps are used for heating and feeding animals. But citrus pulps have more amount and high moisture so they cannot use citrus pulps so they pay money to disposal pulps.

Total citrus utilization for processing amount is 29022.9 tons in the world in 2010. Approximately, 50–60% of the processed fruit becomes citrus peel waste, which is composed of the peel, seeds and membrane residues resulting from juice extraction. [4]

II. DETAILS EXPERIMENTAL

2.1. Extraction of Cellulose from Citrus Pulp

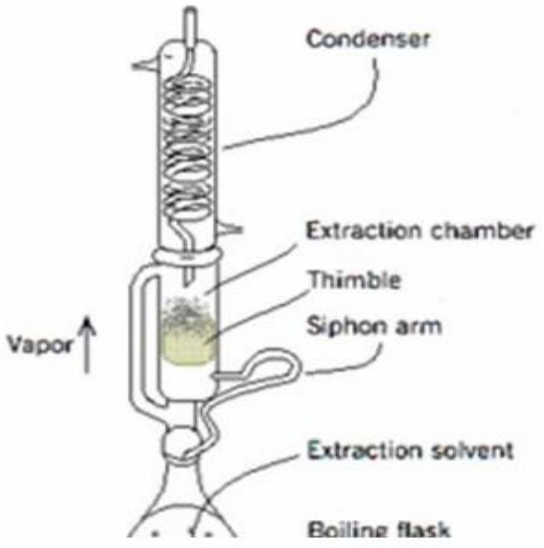


Fig. 1: Soxhlet extractor

Pulps from Aksu in Antalya, Turkey. Firstly pulps are dried in oven to avoid decay then grinded in mixer to get powder. The powder was placed in soxhlet extractor. 500ml toluene and 250ml ethanol were used as re-solvent. System was executed at 150 (with re-cooling) and 500rpm. The powder in extractor was

dewaxed by heating under re-cooler. Powder was showered by ethanol that was poured from open part of soxhlet mechanism. So, fiber was obtained by taking away toluene. After the extraction process, a mixture was produced which contains cellulose, hemicellulose and lignin fibred material.

2.2. Oxidation:

6 grams of fiber which was in desiccators was placed in the balloon. 80ml distilled water was added on it. The solute was placed in 60°C water shower and mixed with mechanic stirrer for 20min. At the end of the process, 2N NaOH was added and stirred again for 10min. 2ml H2O2, which was % 50 in density, was added. pH was measured in the beginning of the reaction. For 3 hours, reaction was stirred with mechanic stirrer 60°C. And then pH was measured again. The suspension mix that was obtained by oxidation, was placed in centrifuge machine with tubes. The machine was operated in 300rpm for 20min. At the end the solid substances was precipitated at the bottom of the tube.

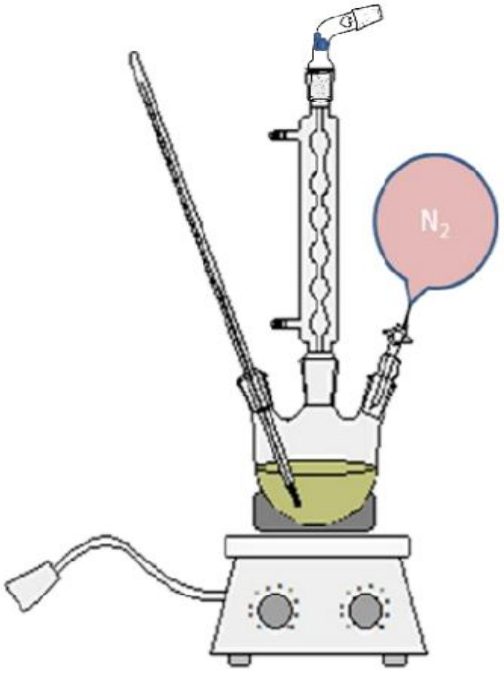


Fig. 2: Reaction Setup

2.3. Process of Polyurethane

The obtained cellulose was grinded until passes through 50-macrometre filter for the reaction. Glass balloon were put in 60°C oil bath. We put 3g cellulose into balloon and added 15ml pure waterless acetone to it. To resolve mixture easier, we also added 3ml NMP (N-methyl Pyrrolidone). The nitrogen was released to avoid any reaction of hexamethylene-diisocyanate(HDI) (which is powerful reactive) and air or other gases that can be released during the reaction, fastened a thermometer to one of the balloons during the reaction. Thus, temperature was observed. To avoid evaporation of re-solvents, re-cooler was attached to the other 0.5ml triethylamine(TEA) added as a catalyzer. After stirring for 10 minutes, 1ml HDI was added.

III. RESULTS AND DISCUSSION

In fruit juice factories, fruit pulps occur, after the process on fruits, as a waste. In this study, we examined the features of the polyurethane products made of cellulose which is made from the peel of orange and mandarin with a high output. Polyurethane products spectroscopic, calitative, cantitative and antimicrobial features are examined and results are compared and evaluated.

In this experiment three quarter of pulp is moisture. After the extraction process, a mixture was produced which contains cellulose, hemicellulose and lignin so fibred material. Fiber ratio is changed from %55 to %62. Fiber includes lignin, cellulose and hemi-cellulose. Cellulose is bonded to hemicellulose with hydrogen bond, to lignin with chemical bond.
In order to separate cellulose in this fiber, which is obtained with extraction method, from hemicellulose and lignin oxidation in peroxide environment has been preferred.[5]

The most productive cellulose has been found as a result of 60C and 3 hours oxidation. And also when less amount of fiber is used, the most productive cellulose has been regained. Study also showed that when more fiber is used, productivity decreased in half. Reaction has been done 60C for 3 hours with 0,76 mol/L 2N NaOH and 0,265 mol/L %50 H2O2 for the oxidation of fibers. Productivity of cellulose we gained from this reaction has been found as %45-50. It shows that cellulose we gained is very pure. Characteristic FTIR spectrum of cellulose is shown in Fig.3.

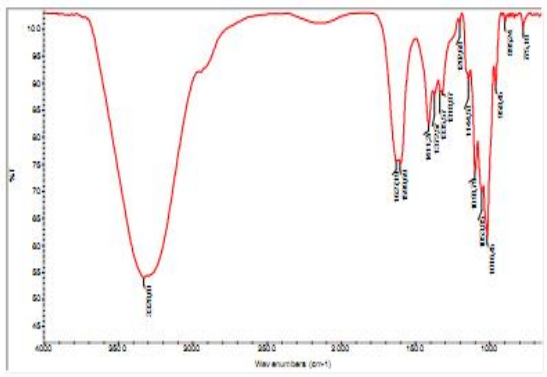


Fig. 3: Cellulose FTIR Spectrum

At first, several experiments were conducted to observe the most appropriate palyrethon synthesis. İn the synthesis, hexamethylene-diisocyanate (HDI) was used as hard segment and the cellulose gained from citrus pulp was used as soft segment.

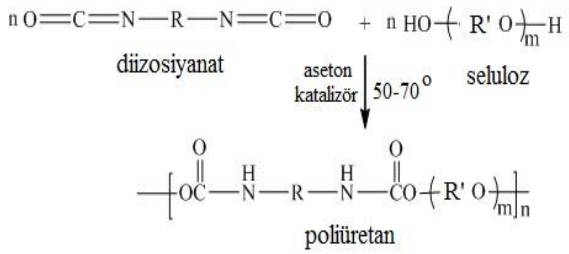


Fig. 4: Reaction of diisocyanate and cellulose



Fig. 5: Product of Polyurethane

FTIR is one of the method for analysis of organic compound and composition characteristic. So we use FTIR method for obtained material polyurethane.

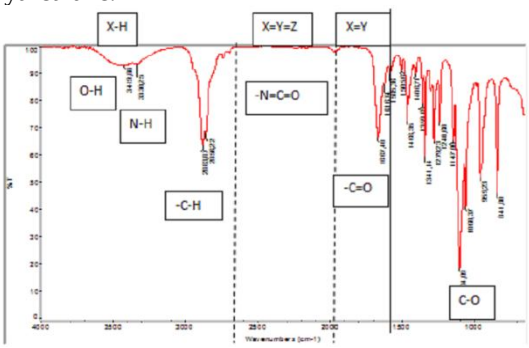


Fig. 6: FTIR Spectrum of PU

When we look at the spectrum (Fig.6) the vibration peak around 3400 cm^{-1} we see OH group. Between 3300-3332 cm^{-1} peak gives us N-H bond. and symmetric and asymmetric -CH- peak comes between 3000- 2850 cm^{-1} urethane groups -C=O peak comes 1641-1620 cm^{-1} . Urethane group (C-N and N-H) peaks come on 1585-1569 cm^{-1} these consist to literature , polyurethane polymerization synthesis successfully, it gives result us that we gain urea.[6]

CONCLUSIONS

We can use polyurethane alternative source of cellulose according to trees that give us more green world in the future. Also fruit waste can be use source of cellulose, it means that forest live more years avoiding to cutting for cellulose production. Cellulose is important our life but we can take it alternative ways. Polyurethane is important source alternatively using and it should be taken on orange and tangerine peels. There should be giving us greener environment.

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