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# A STUDY ON INDISPENSABLE PALM OIL BASED POLYURETHANE

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**Abstract:** The use of polyurethane is widely used nowadays due to its applicability in various fields such as construction, insulating and coating. For the handling of environmental issues, the study has been to use natural based glycerol that is using palm oil-based glycerol in polyurethane preparation. Without using chemical substances such as catalysts and surfactants, the study would look at the basic characteristics of palm oilbased polyurethane.
**Keywords:** polyurethane palm oil based, environmental friendly.

## INTRODUCTION

Polyurethanes are versatile polymers as is flexibility. Polyurethanes are block copolymers containing segments of low molecular weight polyester or polyether bonded to a urethane linkage (-NHCO-O) which can react with isocyanate groups and hydroxyl groups [1], [2]. Most of the materials such as a glycerol and polyester used in the production of polyurethanes derived from petrochemical-based resources such as crude oil and coal. However, use of these types of materials is considered to be unsustainable and require high costs and resulted in depletion of natural resources[3], [4]. According to demand, therefore, a need to find alternative sources to produce glycerols for positive impact in the production of polyurethane [5], [6].

As a result of the reduction of petroleum resources, environmental factors also play an important role in industrial competitiveness, which requires the use of lower cost and reduce negative impacts on the environment [7], [8]. Arising from these factors, one of which is capable of giving a good competition is the use of natural resources and of renewable sources produced from plants[1], [5], [6]. Among the efforts that have been done is to develop bio-based polyurethane foam using vegetable oils such as palm oil[9].

Palm oil has triacylglycerol features as illustrated in Figure 1, include the structure of glycerol with three fatty acids bonding wherein a liquid form known as oil, while in a solid form known as palm oil fat [1], [5], [10].

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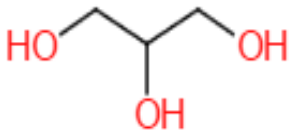


Figure 1: Structure of triglycerol

Palm oil is produced from oil palm where it is widely grown in tropical rain forests such as in Malaysia and Indonesia [11]–[13]. Palm oil is the biological resources that provide the highest return on oil-based hydrocarbons and far more effective than what- any other commercial crop oil [5].Continuous increase in the price of petroleum, giving users a paradigm shift towards the use of raw materials that are renewable for industrial and commercial use. The use of palm oil and its products, renewable and environmentally friendly, making palm oil as an alternative raw material for the production of palm oil-based polyurethane glycerol [14]. Furthermore, there is an increased awareness of social responsibility towards the environment to meet the demand for renewable resources and environmentally friendly products [7]. This paper presents the preliminary work for the preparation of polyurethane basic materials without any added catalysts and surfactants. The target of this study is to determine the basic characteristics of polyurethane.

## EXPERIMENT

### MATERIAL

The raw materials used in this study included palm oil where it was obtained from Kilang Kelapa Sawit Felda Neram, Kemaman, Terengganu. Diphenylmethane-4,4’-diisocyanate (p-MDI), sodium hydroxide and methanol purchase Naz Scientific Sdn Bhd., Selangor. Hydrochloric acid and Calcium hydroxide were purchased from Impian Z enterprise, Puchong, Selangor.

### PREPARATION OF GLYCEROL FROM PALM OIL

200 g methanol and 10 g of sodium hydroxide were mixed in a beaker until sodium hydroxide has dissolved and it calls sodium methoxide. At the same time, 800 g of palm oil is heated until it reaches 55 0C. At this temperature, pour the sodium methoxide in it and stir vigorously in 30 minutes. Leave it overnight at room temperature. It will separate into two different layers were the lower layer is the glycerol. Pour the 17 ml hydrochloric acid into the glycerol to dissipated water and salt. After this process, it becomes three layers were the second layer is the glycerol. Neutralise using 80ml diluted sodium hydroxide. The

evaporation process will have to do at 110 0C until the quantity becomes one-third of origin value. Filter it and using water bath at 60 0C for 1 hour to remove the excessive methanol.

**PREPARATION OF POLYURETHANE USING GLYCEROL PALM OIL BASED**

The formation of polyurethane foam in this study resulted from the exothermic reaction between palm oil- based glycerol and *p*-MDI. The glycerol was first weighed and polyurethane in the beaker and gently stir 5 minutes. *p*-MDI mixed and stir vigorously for 10 seconds, poured in aluminium for self-rising. The amount of glycerol and *p*-MDI on ratio 1:1.33. The foam is conditioned at room temperature for at least 24 hours before demolding and undergoes another 24 hours of room conditioning before cut into specimens for the curing process before testing is carried out.

**RESULTS AND DISCUSSION**

**CHARACTERIZATION OF PALM OIL BASED GLYCEROL**

The obtained palm oil based glycerol was dark brown liquid. The FTIR spectra were recorded on a Perkin-Elmer model Spectrum 100. The spectra were recorded in the range 700 - 4000cm$^{-1}$. The presence of hydroxyl group as shown in Figure 2 in the palm oil based is reflected by the transmittance peaks at wave numbers of 3340cm$^{-1}$ corresponding to an –OH stretching in an alcohol and 1040cm$^{-1}$corresponding to primary –OH stretching in an alcohol. From the result, palm oil was converted into OH functional. The obtained palm oil-based was completely dissolved in the methanol.

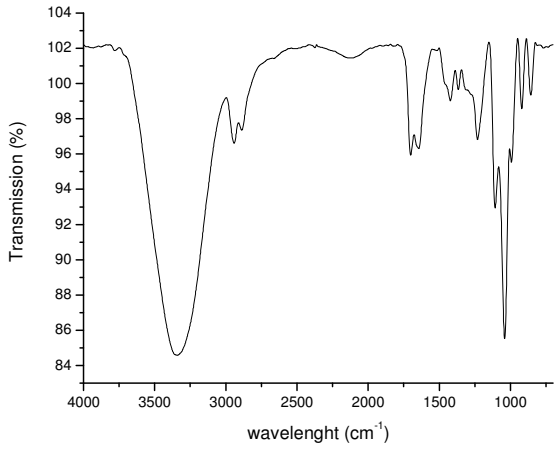


Figure 2 : FTIR spectra for glycerol palm oil based

In GC-MS analysis, the glycerol was detected at the retention time 13.794 min, 14.458min, 18.503min and 19.516min as shown in Table 1.

Table 1: GC-MS analysis for glycerol palm oil based

| No | Retention Time (s) | Area (%) | ID |
|---|---|---|---|
| **1** | 5.165 | 0.11 | Ethyl (trimethylsilyl)acetate |
| **2** | 13.794 | 35.84 | Glycerin |
| **3** | 14.548 | 16.98 | Glycerin |
| **4** | 18.503 | 33.38 | Glycerin |
| **5** | 19.516 | 12.90 | Glycerin |
| **6** | 20.065 | 0.05 | Butane, 2,2'-thiobis-Diglycerol |
| **7** | 20.237 | 0.23 | 3-Methoxy-2,2-dimethyloxirane Diglycerol |
| **8** | 21.896 | 0.50 | 1-Dimethyl(isopropyl)silyloxypropane |

## CHARACTERIZATION OF PALM OIL BASED POLYURETHANE

The foam produced is semi-rigid and light weight. It is yellowish according to the glycerol coloured. FTIR analysis is used to determine the reaction in the formation of polyurethane. Using the Perkin Elmer model Spectrum 100, the spectra were recorded in the range 400-4000cm-1. Finely ground samples and inserted into the mold to form a palette. The outcome spectra are illustrated in Figure 3. According to the spectra, Characteristic bands of the hydroxyl was obtained in the 3448cm$^{-1}$ regions. In the pre-polymer are observed band features of the isocyanates at 2312cm$^{-1}$ and polymerized urethanes in 1777, 1638 and 1521 cm$^{-1}$. These bands are typical of the stretching C=O and N-H bonds. At the wavenumber 2282cm-1, it represented the unreacted isocyanate NCO from the reaction[6], [9], [11].

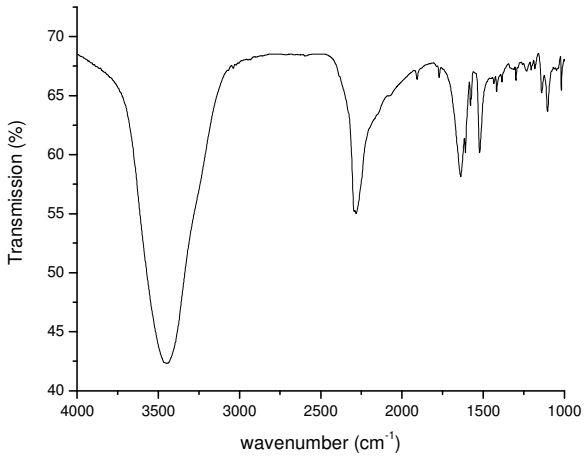


Figure 3: FTIR spectra for polyurethane palm oil based

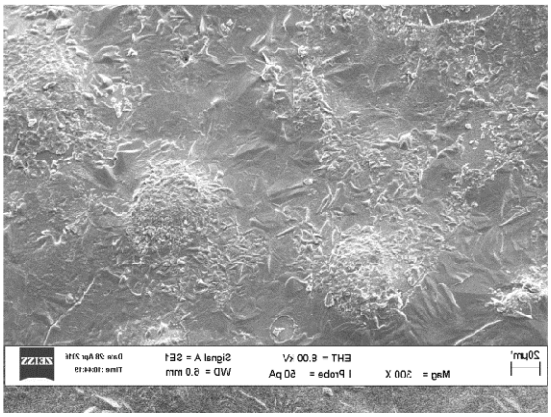

Figure 4: Surface of SEM micrograph

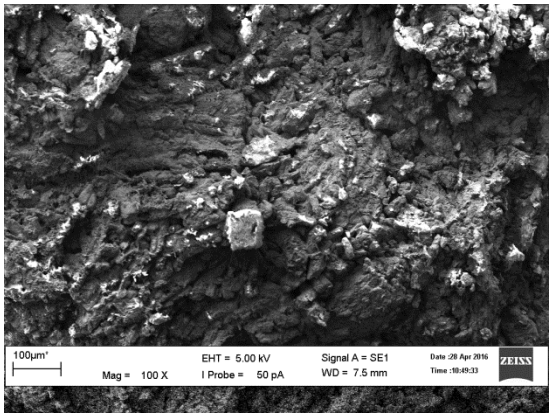


Figure 5: cross section of SEM micrograph

Figure 4 and figure 5 depict the surface and cross section of SEM micrograph for polyurethane. From the figure, it shows the existent white bumps discovered the sample. [15]also reported the same phenomenon.

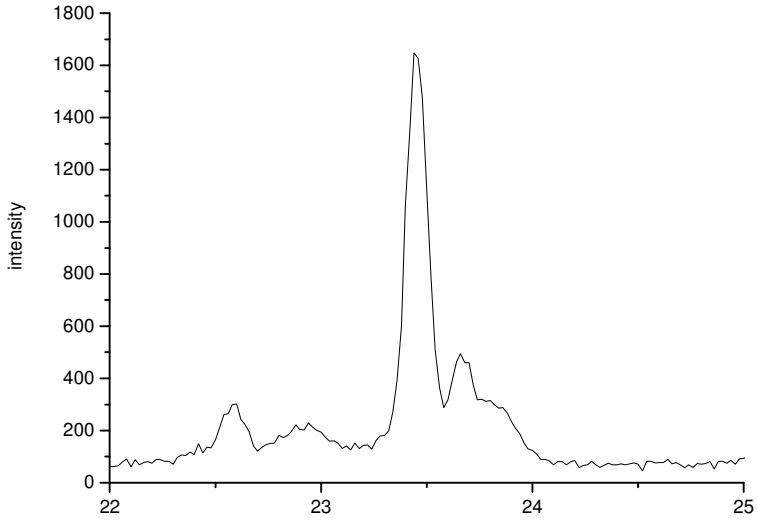


Figure 6: XRD pattern of polyurethane palm oil based of peak in range 22-25$^0$ 2θ.

X-ray diffraction techniques examine the long-range order produced as a consequence of very short range interactions. Figure 6 shows the X-ray diffraction pattern that was exhibits broad peaks at 2θ angles around 22.75, 23.5 and 23.75 in range 22-25$^0$ 2θ, indicating some degree of crystalline.

## CONCLUSION

Through observation and analysis was conducted on a sample, polyurethane palm oil based can be successfully produced through a simple process without adding a catalyst and surfactant. In this study, results simply show that the palm oil based glycerol is suitable for reaction with polymeric diisocyanates to form polyurethane foams. Processes such as the addition of catalyst and surfactant [11], [16], [17] to be done to get better results and meet the requirements of an application. These preliminary results indicate a bright future for oil-based PU palm for the production of PU that meets cost-saving and environmentally friendly.

## REFERENCES

[1] K.H. Badri, "Biobased Polyurethane from Palm Kernel Oil-Based Glycerol: Polyurethane," *Polyurethanes*, pp. 447–470, 2012.

[2] P. K.S. Pillai, S. Li, L. Bouzidi, and S.S. Narine, "Metathesized palm oil glycerol for the preparation of improved bio-based rigid and flexible polyurethane foams," *Ind. Crops Prod.*, 2015.

[3] L. Zhang, M. Zhang, L. Hu, and Y. Zhou, "Synthesis of rigid polyurethane foams with castor oil-based flame retardant glycerols," *Ind. Crops Prod.*, vol. 52, pp. 380–388, 2014.

[4] K. H. Badri, Z. Othman, and S. H. Ahmad, "Rigid polyurethane foams from oil palm resources," *J. Mater. Sci.*, vol. 39, no. 16–17, pp. 5541–5542, 2004.

[5] K. S. Chian and L. H. Gan, "Development of a rigid polyurethane foam from palm oil," *J. Appl. Polym. Sci.*, vol. 68, pp. 509–515, 1998.

[6] X. Kong, G. Liu, and J. M. Curtis, "Novel polyurethane produced from canola oil based poly(ether ester) glycerols: Synthesis, characterization and properties," *Eur. Polym. J.*, vol. 48, no. 12, pp. 2097–2106, 2012.

[7] M.Z. Arniza, S. S. Hoong, Z. Idris, S. K. Yeong, H. A. Hassan, A. K. Din, and Y. M. Choo, "Synthesis of transesterified palm olein-based Glycerol and rigid polyurethanes from this glycerol," *JAOCS, J. Am. Oil Chem. Soc.*, vol. 92, no. 2, pp. 243–255, 2015.

[8] M. Desroches, M. Escouvois, R. Auvergne, S. Caillol, and B. Boutevin, "From Vegetable Oils to Polyurethanes: Synthetic Routes to Glycerols and Main Industrial Products," *Polym. Rev.*, vol. 52, no. 1, pp. 38–79, 2012.

[9] M.H. Dzulkifli, M.Y. Yahya, and R.A. Majid, "Jurnal Teknologi Full paper Development of Rigid Biocomposite Polyurethane Foam for Load Bearing," *J. Teknol. full Pap.*, vol. 3, pp. 53–56, 2014.

[10] A. A. Septevani, D. A. C. Evans, C. Chaleat, D. J. Martin, and P. K. Annamalai, "A systematic study substituting polyether glycerol with palm kernel oil based polyester glycerol in rigid polyurethane foam," *Ind. Crops Prod.*, vol. 66, pp. 16–26, 2015.

[11] S. Chuayjuljit and T. Sangpakdee, "Processing and Properties of Palm Oil-Based Rigid Polyurethane Foam," *J. Met. Mater. Miner.*, vol. 17, no. 1, pp. 17–23, 2007.

[12] H. Pawlik and A. Prociak, "Influence of Palm Oil-Based Glycerol on the Properties of Flexible Polyurethane Foams," *J. Polym. Environ.*, vol. 20, no. 2, pp. 438–445, 2012.

[13] R. Tanaka, S. Hirose, and H. Hatakeyama, "Preparation and characterization of polyurethane foams using a palm oil-based glycerol," *Bioresour. Technol.*, vol. 99, no. 9, pp. 3810–3816, 2008.

[14] G. S. Tay, T. Nanbo, H. Hatakeyama, and T. Hatakeyama, "Polyurethane composites derived from glycerol and molasses glycerols filled with oil palm empty fruit bunches studied by TG and DMA," *Thermochim. Acta*, vol. 525, no. 1–2, pp. 190–196, 2011.

[15] I. A. Mohammed, E. A. J. Al-Mulla, N. K. A. Kadar, and M. Ibrahim, "Structure-property studies of thermoplastic and thermosetting polyurethanes using palm and soya oils-based glycerols.," *J. Oleo Sci.*, vol. 62, no. 12, pp. 1059–72, 2013.

[16] L. Chang, M. Sain, and M. Kortschot, "Effect of mixing conditions on the morphology and performance of polyurethane foam," *J. Cell. Plast.*, vol. 51, no. 1, pp. 1–17, 2014.

[17] F. N. Daud, A. Ahmad, and K. Haji Badri, "An investigation on the properties of palm-based polyurethane solid polymer electrolyte," *Int. J. Polym. Sci.*, vol. 2014, 2014.