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Fabrication of Seed Oil-Based Flexible Polyurethane and Identify Failures from the Processing Pathway

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Department of Chemical Engineering, Jayabaya University Jl. Pulomas Selatan Kav 23 Jakarta-13210, Indonesia flora_elvistia@yahoo.comdeimelda18@gmail.com, lubena2013@gmail.com, viscairsyad96@gmail.comAbstract

The preparation of polyurethane (PU) foam using green-based polyol from soybean oil as an alternative for petroleum-based polyurethane. The polyurethane was fabricated by using the prepolymer method following the two steps namely epoxidation and alcoholysis reaction. The FTIR, hydroxyl numbers were used to monitor the process of the synthesized polyol and determined the physicochemical properties. Choosing a suitable method for the processing of polyurethane foam soy-based became a major to the success of the production. Temperatures of operation, reactants, were not the only to be focuses dealing with organics the length of the reaction should also be considered. The research aimed to focus on the optimized fabrication of soy-polyol as intermediate to flexible foam polyurethane. Identify the use of the length of reaction to epoxidation reaction, and hydroxylation, and evaluates the correlation to the physical property of the foam product.

Keywords

Fabrication, flexible polyurethane foam, length of the reaction, foam physical property, soybean oil

Introduction

Polyurethane (PU) production from bio-based feedstock is being pursued to increase the renewable material fraction in foams. PU globally is consumed in the form of foams (Ionescu, 2016). Isocyanates

and polyols are petroleum feedstocks as two major components in polyurethane (PU) production. The amount of isocyanate is greatly affected to the PU foams' performances (Javni, Zhang, & Petrović, 2003);(Pechar et al., 2006);(Guo, Javni, & Petrovic, 2000), include compressive strength. Altering the amount of isocyanate in the foam formula the mechanical property could be modified, where the excess of isocyanate results in more rigid PU foams because of a more complete conversion of OH groups in polyols.

Literature Review

The side reactions that occur during the polyurethane production may have intense effects on the final properties, the products were temperature-dependent equilibrium with reactants (Lee, 1985). Isocyanate groups like TDI and TEA taking part in the growth of particles, where free isocyanates react with the hydroxyl functionality of polyol. The reaction was not closely controlled so it results in an undesirable property. The presence of secondary hydroxyl end groups in big amount in polyol medium unstabilized particle and emerge large size distribution. The idea of using seed oils in the formula provides an intrinsic hydroxyl functionality which suited to cost-competitive feedstocks (Firdaus, 2016). The reactiveness of isocyanates relatively slow with hydroxyl at room temperature, this was reflected in the incompatibility of nonpolar to denser isocyanate and polar to less dense polyol of hydroxyl even though a surfactant and catalysts were applied.

The tertiary amine (R3N) as catalyst drives reactions other than urethane formation (Tillet, Boutevin, & Ameduri, 2011);(Van Maris, Tamano, Yoshimura, & Gay, 2005), where the catalytic activity forming urethane bonds were

commonly known as gelling reaction tied in the rapid growth of molecular weight and increased viscoelasticity. The activity of isocyanates catalyzation and water resulted in a blow reaction to the formation of carbon dioxide as a result of blow reaction and forming a frothed morphologies (Sonnenschein, 2014);(Firdaus, 2011a).

The R3N catalyst reacted with hydroxyl and isocyanates, the presence of water drives the blow reaction where it has higher efficiency than the gelling reaction. Referred to some research findings, there was a heat formation the value depends on the type of alcohol and isocyanate structure (Wang, Wang, He, Mao, & Sun, 2013).

At elevated temperature, the urethane bond can revert to isocyanate and hydroxyl functionality (Okrasa, Czech, Boiteux, Méchin, & Ulanski, 2008);(Mohammed & Sankar, 2011);(Yang, Zhu, Li, Xia, & Li, 2010), where the revert occurred as a function of the urethane structure stability (Firdaus, 2011b). The structure contributes to urethane thermal stability. The aliphatics are more thermally stable than aromatics, where delocalization of aromatics stabilizes the activated states of reversion results. It was

found the urethanes synthesized from aromatic alcohols exhibit low thermal stability. Phenol somewhat often considered as aromatic alcohols where more acidic than aliphatic alcohols, has been widely used for protecting isocyanates to be available at elevated temperatures (>100 °C) (Kothandaraman, Nasar, & Lakshmi, 1994);(Wicks & Wicks, 1999).

The formation of urethane in the absence of a change in stoichiometry upon cooling exceedingly unaffected to the change of overall molecular weight (Koberstein, Gancarz, & Clarke, 1986). As the nucleophilicity increased it influenced the reactivity of an active hydrogen compound. It is well understood steric factor affected the reactivity of the isocyanate structure in NCO, where the electrophilic attack increased the negative charge density of the isocyanate oxygen which increased reactivity (Figure 1).

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