

**COMPOSITES OF POLYURETHAN BASED ON PALM OIL OIL WITH FILLING
MATERIALS BENTONITE-CHITOSAN AS ANTIBACTERIAL COATING ON
MEDICAL EQUIPMENT**

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ABSTRACT

Modification of polyurethane by adding fillers such as bentonite can improve the physical properties of polyurethane coatings. Polyurethane synthesis is carried out using the prepolymer method by reacting toluene diisocyanate (TDI) with palm oil based polyols. Bentonite addition is used to provide heat resistance in polyurethane coating material. The concentration of bentonite used was 1.5% b / b, 3.5% b / b, and 5.5% b / b. The resulting polyol synthesis will be analyzed using FTIR to see the OH group formed. The bentonite purification process was carried out by using cetyltrimethyl ammonium bromide in bentonite solution. The target in this study is the anti-bacterial properties of the products produced. Whereas to see the characteristics carried out SEM and FTIR analysis.

Keywords: *Antimicrobials, Bentonite, Chitosan, Crude Palm Oil, Polyurethane.*

PRELIMINARY

Technology development that continues to increase, is now a benchmark for developing anti-bacterial coating materials that can be used in medical equipment. The way that can be done is by engineering materials, or often called modifications, one of which is the manufacture of polyurethanes. Environmentally friendly research on paints and coatings (paints and coatings) continues to be pursued to this day. Polyurethane as a coating material has been widely used as a coating material, hardness and flexibility at low temperatures, and has resistance to corrosion and chemicals (Aqdas, et al., 2016). Polyurethanes are thermoplastic polymers produced from the reaction between polyols and isocyanates (Gonzales, et al., 2107). Currently, polyols in polyurethanes are synthesized from petroleum. The availability of petroleum which is increasingly narrow now encourages other parties to look for new alternatives as a substitute for petroleum. One alternative that can be used is vegetable oil. The synthesis that has been carried out with various vegetable oils such as canola oil, camelina oil, lanola oil, sunflower oil, nulin oil (Ourique, et al., 2017), neem oil (Zieleniewska, et al., 2015). Then the synthesis of polyurethanes from vegetable oils obtained from various plants such as jatropha, palm oil, soybeans, and cotton (Aqdas, 2016). In other words, vegetable oil can replace petrochemicals as the raw material for making polyols, besides that the use of polyols from vegetable oils is superior because of their abundant availability in nature and easily decomposed.

In this study, oil palm is used for the synthesis of polyols. At this time information on polyols derived from palm oil is still limited. The main components of palm oil are triglycerides or triglycerols which are triesters of glycerol and unsaturated fatty acids. Because the content of fatty acids is not saturated, palm oil can carry out epoxidation and hydroxylation reactions to form polyols which will be used for the

manufacture of polyurethanes.

Polyurethanes have properties that are very easily modified with other materials. In addition to improving the quality of paints and coatings produced and handling thermoplastic properties in polyurethanes, materials were chosen that could improve the mechanical properties of the polyurethanes. Bentonite obtained from clay purification can be used as filler material in polyurethane. Bentonite contains montmorillonite 50-80% and sterile substances. The addition of bentonite is carried out into the polymer matrix by showing an increase in thermal stability, fire resistance, and corrosion resistance for surface coating applications.

Another advantage of polyurethane is that it is safe to use in the medical world. Polyurethanes are usually applied to *paint and coatings*, the automotive industry, fibers, construction materials, and synthetic leather. With the addition of chitosan which is an alloy in modifying polyurethane, it can become anti-bacterial in polyurethane. According to the results of research showing that the intercalation of chitosan through the cation exchange process can increase thermal stability and antimicrobial activity of nanocomposites. Chitosan properties such as biodegradability, biocompatibility, non-toxic and anti-bacterial have become an attraction for the industry.

In this research, palm oil-based polyurethane will be made as a raw material for polyols modified with the addition of bentonite to improve the physical and mechanical properties of polyurethane. The resulting polyurethane coating was further modified with the addition of chitosan to provide anti-bacterial properties so that the coatings obtained not only have strength, stiffness, heat resistance, corrosion resistance, and chemicals but also have resistance to bacteria.

RESEARCH METHODS

Materials and tools

This research is divided into five main stages, namely: 1) Raw material preparation stage, 2) Polyol manufacturing stage, 3) Bentonite purification stage, 4) Polyurethane manufacturing stage, 5) Analysis phase.

Vegetable oil used in this study is palm oil. The palm oil used is palm oil which has been through FTIR analysis to see the presence of hydroxyl groups from the oil. While the isocyanate used is toluene diisocyanate (TDI). Then in the bentonite preparation stage, it is necessary to purify it first to remove the impurities.

The manufacturing stage of the polyol consists of two stages: the epoxidation reaction and the hydroxylation reaction. These reactions should be carried out in sequential time and do not give a long time interval to continue to the next reaction which will cause a decrease in hydroxyl numbers.

In the epoxidation stage, the palm oil used is reacted with CH_3COOH and H_2O_2 and using an H_2SO_4 catalyst to form an epoxide compound. Then proceed with the hydroxylation reaction which reacts the oil which has been oxidized with alcohol, then the catalyst and water to produce hydroxyl groups from opening the epoxide ring.

In the purification phase, the bentonite is carried out by adding surfactants to the bentonite which has gone through a reduction in size up to 100 mesh. The surfactant used is in the form of cetiltrimethyl ammonium bromide which functions to increase d-spacing in bentonite. Then the filtrate was washed with AgNO_3 solution to form a white precipitate and followed by drying bentonite in the oven.

In the process of making this polyurethane isocyanate and palm oil reacted, but to improve the thermal resistance properties of the resulting polyurethane added purified bentonite. Bentonite is added with each weight to see how the influence of the increasing use of bentonite in

polyurethane on its thermal resistance properties.

Polyurethane / Bentonite / Chitosan Preparation

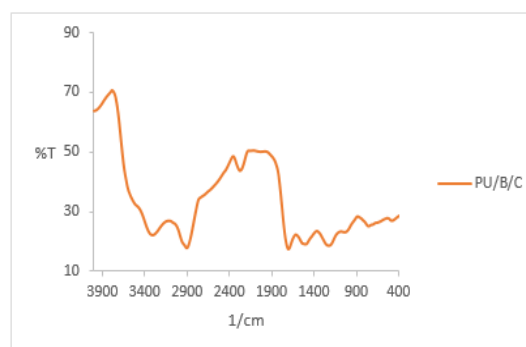
The polyol, bentonite, chitosan, and TDI mixed into the beaker glass were mixed with a magnetic stirrer at 200 rpm for 1 hour. In this procedure, a number of bentonite and chitosan are used, each 1.5, 3.5 and 5.5 weight percent (wt%). The resulting polyurethane is then cooled to room temperature. Furthermore, the chemical structure of polyurethane, bentonite, and chitosan were analyzed using FTIR, surface shape analysis using SEM, and anti-bacterial activity test with *E. ColidanS aureus*.

RESULTS AND DISCUSSION

3.1 Characteristics of Polyurethane Composites

3.1.1 Fourier Transform Infrared Spectroscopy (FTIR)

The results of the characterization of polyurethane samples using FTIR showed the formation of N-H (urethane) groups in polyurethane products as evidenced by the absorption of urethane wave numbers that widened at 3309 cm^{-1} . Then the absorption of the C-H group wavenumbers widened at 2904 cm^{-1} . Furthermore, the absorption of the group wave number C = O urethane widened at $1508.3\text{--}1705\text{ cm}^{-1}$. These results reveal that the formation of polyurethanes is seen from the presence of N-H, C = O, and C-H groups.

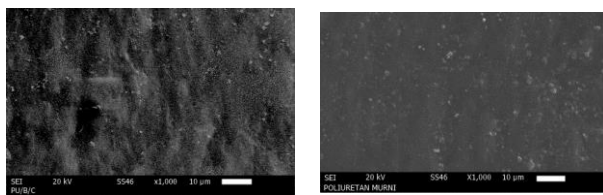


Picture 1. Spectrum FTIR PU/B/C

3.2 PU / B / C Composite Characteristics

3.2.1 SEM (scanning Electron Microscope)

Figure 2 shows the morphology of the surface of the layer by using representative SEM taken from each sample. In the picture below it can be seen that the surface of pure polyurethane is polyurethane produced by reacting only with two main components namely polyol and toluene diisocyanate (TDI) without the addition of filler, showing a good surface because it has been mixed well. The image below is an appearance of polyurethane surfaces that have been given the addition of fillers to improve the physical properties of polyurethane products. Comparable to pure polyurethane, the polyurethane with the addition of this filler shows a slightly more prominent and not smooth surface because it has been mixed which causes bentonite and chitosan to be spread evenly into the polyurethane product.



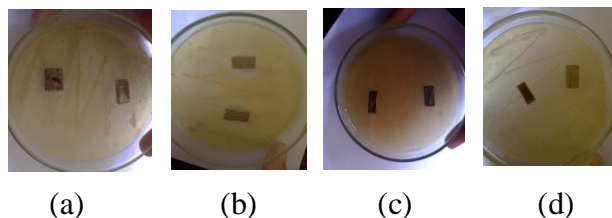
Picture 2. SEM of PU / B / C coating

3.2.2 Characteristics of Antibacterial Tests

From observations made for 24 hours, the bacteria produce inhibitory zones. PU-B-C with E.Coli (a) has a smaller inhibition area than PU-B-C which is planted with S. Aureus (b). That is because E. coli bacteria are gram-negative bacteria that have a more complex cell wall structure than S. aureus bacteria. This bacterium is a gram-negative bacterium that is resistant to some antibacterial substances, this is caused by three layers of cell walls found in this bacterium, so some compounds are not able to damage the tissue of the cell wall of E.coli bacteria. Whereas S. Aureus is a gram-positive bacterium that has a gram cell structure with more peptidoglycan, fewer

lipids and cell walls containing polysaccharides (theatric acid).

Whereas in the cell wall of gram-negative bacteria there are very few peptidoglycans and are between the outer membrane and the inner membrane of the cell wall. The outer cell wall of gram-negative bacteria is a component consisting of phospholipids and several proteins which are often referred to as auto layers. It can be concluded that gram-positive bacteria undergo a process of cell denaturation first compared to gram-negative bacteria. On plates that have been applied with pure PU and plates without applying PU with implanted bacteria E.Coli (c) and S. Aureus (d) do not have inhibition around the plate, it is caused by the absence of antibacterial substances contained on the surface of the plate.



Picture 3. Anti-microbial Test on E.Colidan S. Aureus Bacteria.

CONCLUSION

The addition of bentonite to polyurethane to provide antibacterial properties produced depends on the weight percent of the bentonite added, the more bentonite added to the polyurethane, the greater the inhibitory zone produced, as in this study the biggest inhibitory zone is found in the addition of weight percent. 5.5% b / b. The more weight percent chitosan is added to the polyurethane, the greater the bacterial resistance properties produced by the polyurethane. The surface morphology produced in the Polyurethane / Bentonite / Chitosan samples in this study did not give the appearance of a surface that is too smooth like pure PU, this is due to the

mixing of the matrix and filler which is less homogeneous.

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