

The Investigation of Macro Structure of Composite Material Mixed Rice Husk with Polyurethane as Insulation Material in Fish Cold Storage Boxes

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ABSTRACT

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This research aims to investigate the macro structure of a composite material mixed with rice husk and polyurethane. Determine the material with the best composition to apply to the cooler or fish storage area. The urgency of this research is the application of appropriate technological concepts to support the cold chain system so that the quality of fishermen's catches can be maintained. One of the efforts made is to make composite materials for insulation from a mixture of rice husks and polyurethane with various composition ratios ranging from 1:0.5 to 1:2 polyurethane-rice husks. The results of the research show that each composition obtains different results. From the macro photo test results it shows that the lowest maximum area is in the 1:2 composition, namely 1:2A 14393, 1:2B 5232, 1:2C 4013. From all the test results, the composition is 1:2 is the most feasible material for making fish cooler box insulation because, this composition does not affect the expansion of the polyol and isocyanate reaction

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I. Introduction

The marine and fisheries sector is one of the supporting sectors for national development because its potential is quite large, so it needs to be managed optimally in order to obtain maximum results. However, in reality there are still many catches whose quality does not meet expectations because the quality of the catch decreases after being landed [1][2].

Polyurethane is one of the materials commonly used as temperature-retaining insulation in fish storage areas [1][3]. If we look at the current conditions, fishermen really feel the constraints, especially the problem of the ever-increasing cost of insulation materials, this limitation is caused by the high price of insulation raw materials [1],[4]. From the rice processing industry, many derivative products are produced, one of which is rice husks. Rice husk has the potential to be used as a substitute raw material for insulators because its properties are not much different from natural insulator materials [2].

Polyurethane consists of a mixture of two chemical components, namely polyol and isocyanate components, which are mixed and stirred together, resulting in a chemical reaction and forming foam. The foam has air bubbles which function as a heat insulator [4][5]. Mixing rice husks and polyurethane is expected to maximize the thermal resistance of the fish box.

This research aims to investigate the macro structure of a composite material mixed with rice husk and polyurethane. Determine the material with the best composition to apply to the cooler or fish storage area. Based on the things that have been explained, this research carried out macro structure observations to detect variations in air bubbles from the reaction of a mixture of rice husks and polyurethane at a ratio of 1:0.5; 1:1; 1:1.5; and 1:2.



II. Research methods

2.1 Preparation of Specimen

Materials held in making specimens for observing macrostructure. These are polyurethane, rice husks, wax and board molds as well as several other supporting tools such as containers, stirrers and cutters.

Before the specimen making process is carried out, the rice husks are dried by drying them in the sun for 2-3 hours, and also prepare wax to coat the mold which is used to make it easy to remove the specimen from the mold. The process of making printed specimens with several compositions is as shown in table 1. The results of the printed specimens are as shown in Figure 1.

Table 1. Specimen Composition
Specimen Composition

No	Ratio	Polyurethane (%)	Rice husk (%)
1	1:0,5	66,67	33,3
2	1:1	50	50
3	1:1,5	40	60
4	1:2	33,3	66,67

The material is made in stages according to the predetermined composition of polyurethane and rice husks, namely 1:0.5, 1:1, 1:1.5, and 1:2. The composition ratio is measured based on volume. The printed material is in the shape of a cube according to the dimensions of the printing tool



Fig. 1. The Process of Composing Specimen

III. Macro structure observation

Before observations are carried out, each specimen is shaped/cut according to requirements, namely 500x500x500 mm and marked with a 10x10 mm square on the surface of the specimen to facilitate the macro photo testing process. Photos of the specimen surface were taken using a camera with a macro lens and the shooting distance was 150 mm. Specimens with various compositions are shown in Figure 2

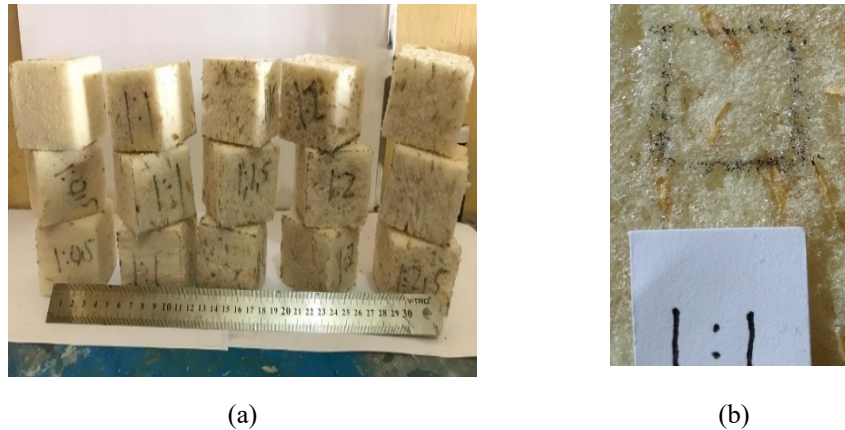


Fig. 2. Macrostructure test specimen

(a) Specimens with various compositions. (b) Observation of the macro structure of the specimen

The implementation of macro structure testing in this research complies with ASTM E3 standards, place the specimen on a white mat and provide sufficient light. Then take an image with a camera using a macro lens on the surface of the specimen which has been marked with a size of 10x10 mm. The image is copied to the computer for analysis using ImageJ software.

The ImageJ application is image processing software developed by Wayne Rasband from the NIH (National Institutes of Health). ImageJ is written using Java which can be run on Linux, Macintosh and Windows operating systems and can be used in 32 bit and 64 bit modes. Imagej can also be used online or installed on a computer. The advantage of ImageJ compared to other image processing software is that it is public domain software, which means there are no copyright restrictions. Users are allowed to run the program, share copies, and make positive changes to the program.

Some image formats that can be read are TIFF, GIF, JPEG, BMP, DICOM, FITS, and RAW. Apart from that, ImageJ can also be used to process images directly from cameras, scanners and video recorders. ImageJ allows users to create graphs from data as well as improve image quality. It is often used for analyzing microscope images, area measurements, particle counting, segmentation and measuring spatial or temporal features of biological elements

IV. Results and Discussio

4.1 Composition 1:0.5 mixture of PU and rice husk.

The results of macro photo analysis of PU and rice husk composite materials at a composition of 1:0.5 are as in Figure 3. This test is based on the area analyzed, namely 10x10 mm. Each test specimen is named 1:05A, 1:0.5B and 1:05C to facilitate data storage and processing. Data collection for each test specimen uses the same method, namely to produce data on the number of bubbles, maximum area of bubbles, total area of bubbles, average size of each bubble and percentage of bubbles in each specimen.

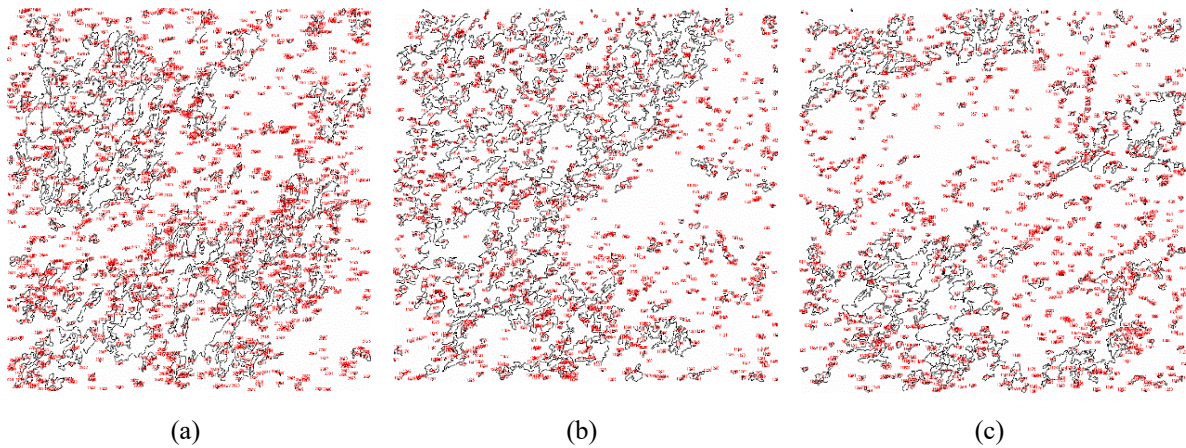


Fig. 3. Macro Photo Results of Specimen composition 1: 0.5 Mixture of PU and Rice Husk
(a). Macro photo of 1:0.5A specimen. (b). Macro photo of specimen 1:0.5B. (c) Macro photo of the 1:0.5C specimen

The results of calculating the number of air bubbles in an area of 10x10 mm in specimen 1:0.5A showed that there were 1471 air bubbles with a maximum area of 22111 μm^2 , for specimen 1:0.5B the number of bubbles was 1286 with a maximum area of 102037 μm^2 and in specimen 1: At 0.5C, the number of bubbles was 1261 with a maximum area of 12270 μm^2 . The difference in the number of bubbles is due to the wide area of bubbles detected when taking macro photos. The total area for specimens 1:0.5A, 1:0.5B 1:0.5C is 169755 μm^2 , 184260 μm^2 and 111996 μm^2 . In testing the composition of 1:0.5 mixture of PU and rice husk, the highest number of air bubbles was found in the 1:0.5A specimen and the lowest was in the 1:0.5C specimen. The average air bubbles in this specimen is 1339.3 μm^2 .

4.2 Composition 1:1 mixture of PU and rice husk

The results of macro photo analysis of the composite material mixed with PU and rice husk at a composition of 1:1 are as shown in Figure 4. The data for each test specimen is data on the number of bubbles, maximum area of bubbles, total area of bubbles, average size of each bubble and percentage of bubbles. each specimen. In the 1:1A specimen the number of bubbles was obtained as many as 1554 with a maximum area of 33744 μm^2 , in the 1:1B specimen the number of bubbles was obtained as many as 1459 with a maximum area of 13701 μm^2 and in the 1:1C specimen the number of bubbles was obtained as many as 1483 with a maximum area of 20493 μm^2 .

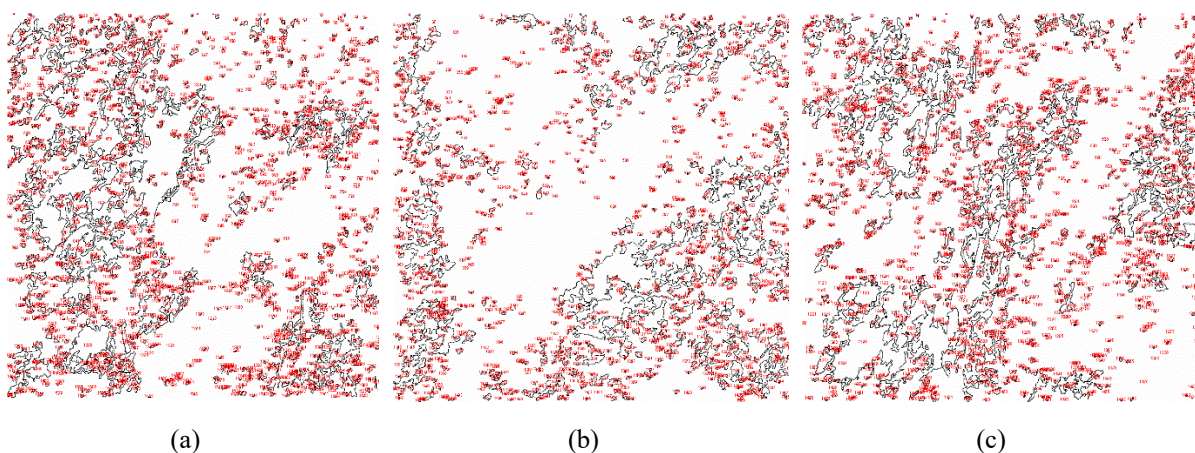


Fig. 4. Macro Photo Results of Specimen composition 1:1 Mixture of PU and Rice Husk
(a). Macro photo of 1:1A specimen. (b). Macro photo of specimen 1:1B. (c) Macro photo of the 1:1C specimen

The total area analysis for the 1:1A specimen is $127,283 \mu\text{m}^2$, for the 1:1B specimen it is $125,774 \mu\text{m}^2$ and the total area for the 1:1C specimen is $127,677 \mu\text{m}^2$. The difference in total area is caused by the size of the air bubbles. The largest number of air bubbles was found in the 1:1A specimen and the lowest number of air bubbles was found in the 1:1C specimen. The average air bubbles in the specimen composition of 1:1 mixture of PU and rice husk was 1032.3. The total bubble area in each specimen is $127283 \mu\text{m}^2$ in specimen 1:1A, $125774 \mu\text{m}^2$ in Specimen 1:1B and $127667 \mu\text{m}^2$ in Specimen 1:1B

4.3 Composition 1:1.5 mixture of PU and rice husk

The results of macro photo analysis of the composite material mixed with PU and rice husk at a composition of 1:1.5 are as shown in Figure 5. Observations on this specimen were also carried out using the same method, namely test observations based on the analyzed area of $10 \times 10 \text{ mm}$. Each test specimen was named 1:1.5A, 1:1.5B and 1:1.5C. The data observed for each test specimen were the number of bubbles, maximum area of bubbles, total area of bubbles, average size of each bubble and percentage of bubbles in each specimen.

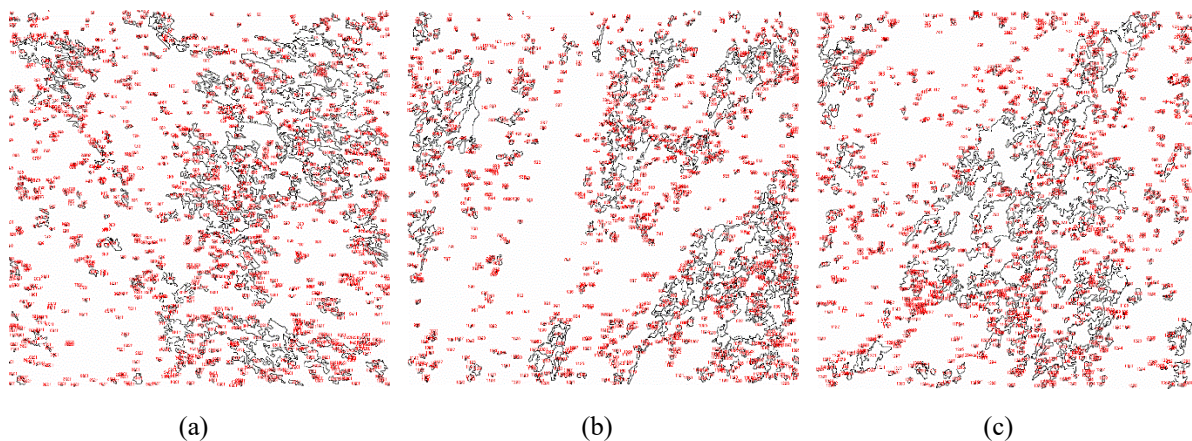


Fig. 5. Macro Photo Results of Specimen composition 1:1.5 Mixture of PU and Rice Husk
(a). Macro photo of 1:1.5 A specimen. (b). Macro photo of specimen 1:1.5 B. (c) Macro photo of the 1:1.5 C specimen

The 1:1.5A specimen obtained 1399 air bubbles with a maximum area of $13392 \mu\text{m}^2$, the 1:1.5B specimen obtained 1140 bubbles with a maximum area of $5942 \mu\text{m}^2$ and the 1:1.5C specimen obtained 1292 bubbles with a maximum area of $43057 \mu\text{m}^2$. The difference in the number of bubbles is due to the wide area of bubbles detected when taking macro photos. The total area for specimens 1:1.5A, 1:1.5B 1:1.5C is $113272 \mu\text{m}^2$, $82247 \mu\text{m}^2$ and $171613 \mu\text{m}^2$. In testing the composition of 1:1.5 mixture of PU and rice husk, the highest number of air bubbles was found in the 1:1.5A specimen and the lowest was in the 1:1.5B specimen. The average air bubbles in this specimen is 1277.

4.4 Composition 1:2 mixture of PU and rice husk

Observation of the macro structure of this specimen shows that the number of air bubbles in the 1:2A specimen is 745. In the 1:2B specimen the number of bubbles is 1496 and in the 1:2C specimen the number of air bubbles is 1405. The highest number of air bubbles is found in the 1:2B specimen. and lowest in specimen 1:2A. The average number of air bubbles in the 1:2 PU composition mixed with husk specimen was 1215.3 as shown in figure 6

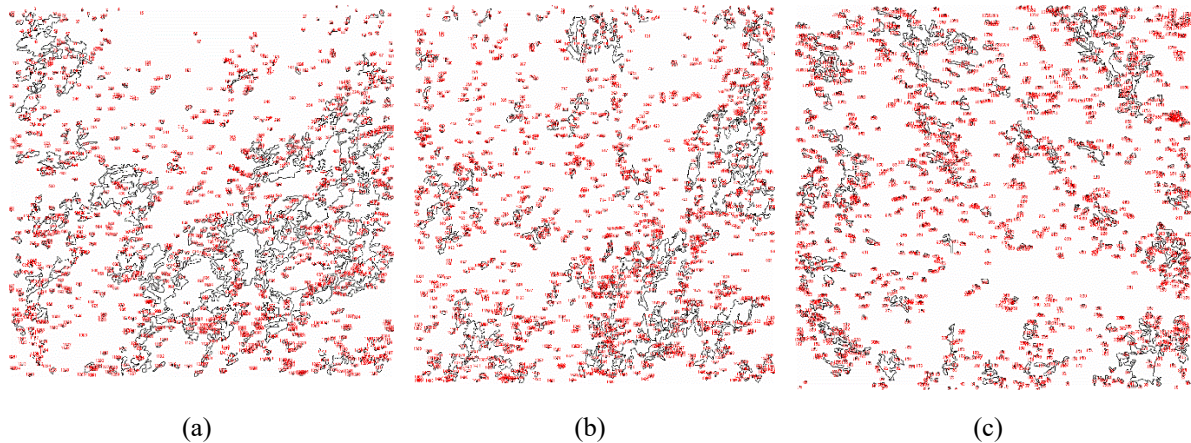


Fig. 6. Macro Photo Results of Specimen composition 1:2 Mixture of PU and Rice Husk
(a). Macro photo of 1:2 A specimen. (b). Macro photo of specimen 1:21B. (c) Macro photo of the 1:2C specimen

Test data for each composition obtained different results. The PU used in this research is non-CFC material with a polyol and isocyanate ratio of 2:3. From the results of this macro photo test, it was obtained that the lowest maximum area was a composition of 1:2, namely 1:2A 14393, 1:2 B 5232, 1:2 C 4013. If this is related to theory, the larger the maximum area, the greater the porosity, the greater the porosity, the smaller strength. From all the test results, the 1:2 composition is the most likely material for making fish trader box insulation because, this composition does not affect the expansion of the PU reaction, this composition is not in line with the thermal conductivity value which has the best composition, namely 1:0.5 with value 0.038 [2]. However, the composition of 1:2 is superior and better with 1:1 and 1:1.5 which greatly affects the material. If a composition of 1:0.5 is used, there will be less PU material and rice husks in the cooler box so this composition cannot reduce the use of PU.

V. Conclusion

Based on research on the macro structure of rice husk composite material as a PU mixture, specimens of 1:2 composition are the most likely to be used as insulation for fish traders' boxes. This composition does not affect the expansion of polyol and isocyanate, this composition also has a smaller maximum area and a greater number of bubbles. Thus, the composition of 1:2 PU mixed with rice husks can be recommended as fish storage box insulation.

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