Liquid Smoke Potential Solution on Texture and Bonding Sago Fiber-Matrix

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Abstract. The purpose of this research is to know the influence of sago fiber (SF) treatment with liquid smoke to the texture and bonding of fiber-matrix. Sago fiber was given two stage of treatment: (1) immersion the fibers with the liquid smoke with the time variation of 1, 2, 3, and 4 hours. (2) Then, the fiber is heating in the heater box at a temperature of 43 degree Celsius during 1 hour. Sago fiber, which have run into treatment and without treatment are grouped, then conducted a series of tests, namely: observation of the fiber texture and observations of bonding between fiber and matrix to figure out the shape of the texture and the bonding of fiber-matrix before and after the treatment with a digital microscope. The observations indicate that the treatment of fiber with the fiber texture form a liquid smoke into a grooved and the more rugged so the bond between fiber and matrix of the more compact.

Keyword: Liquid Smoke, Sago, Fiber-Matrix

1. Introduction

The development of science and technology is quite rapidly, both in the field of metallic materials and not metal, in which metallic materials dominate the industry. Addiction to excessive metallic materials will result some problems, are the depletion mineral miner availability and environmental issues. The existence of problems caused an alternative development of substitute metal materials such as the use of natural fibers. Natural fiber as an alternative material that is lighter, easier to form, cheaper price, but its utilization is still lacking due to the mechanical properties of natural fibers are still doubtful reliability. One of the natural cellulose fibers that have long been known to the community in Luwu regency of South Sulawesi province is sago stem fiber originating from sago trees that grow in swamps and in the past sago saplings are taken as raw material for rigging because of strong and durable up to hundreds of years. According to [1], [2], and [3], it is necessary to treat the surface of the fiber in order to produce better mechanical properties and adhesion strength considering that cellulose-based natural fibers have hydrophilic properties opposite the hydrophobic epoxy matrix. The fiber surface treatment is expected to improve the properties of fiber wettability and adhesion bonding to the matrix. However, the need to be considered in the selection of sizing materials should not cause the mechanical
degradation of the fiber, the process of infiltrating the sizing material into the pores of the fiber does not cause damage to the surface of the fiber which will reduce its mechanical strength.

In macromechanics, the utilization of natural fibers both as a reinforcement medium and filler in layered composites, both hybrids and sandwiches of various types, has been rapidly developed for structural applications, but a fundamental understanding of the direct interaction between natural fibers and the matrix for observing compatibility that includes the mechanical, chemical properties of composite reinforcement materials, whether in the form of fibers or particles has not been studied in depth since the choice of fiber material must also be compatible with the matrix material in order to obtain the ability to adhesive between fibers with a more compact matrix.

Based on the above brief description, the study of natural fiber of cellulose, especially sago fiber obtained from sago tree with the treatment of liquid smoke. Liquid fumes are liquids condensate of pyrolysis products such as wood containing the major constituent compounds of acids, phenols and carbonyls as a result of thermal degradation of cellulose, hemicellulose, and lignin components. The acid, phenol, and carbonyl compounds in the liquid smoke have contributed in providing characteristic properties of aroma, color, and flavor as well as antioxidants and antimicrobials [4].

The treatment is carried out in two stages, first stage immersion of treatment of the fibers with the liquid smoke in which the liquid smoke will react and will form a liquid-fiber-liquid compound. The lignin compound in the fiber contains a lot of water in which it will react with acetic acid from the liquid smoke resulting in the formation of a compound which will contain an increase in the composition of C, H, and O in the lignin compound. Thus the formation of such compounds will facilitate the decomposition of OH groups in lignin by going through the heating step. The formation of compounds is also done to avoid bacterial or fungal disorders that can reduce the strength of fiber during storage for a long time. [5] Two compounds in liquid fumes having a bactericidal effect are phenols and organic acids which in their combinations work together effectively to control microbial growth. In the second stage of treatment. Sago Palm Fiber (SPS) that undergo a heating process with a temperature of 43 degree celcius, will occur the evaporation process or degradation of O and H as H₂O. The distance between the fiber molecules increases in such a way that the molecular interactions, including the physical properties, are disturbed as the fiber diameter becomes smaller and the fiber texture becomes porous, grooved, and coarse. Sago-treated stem-bleed fibers were grouped and then performed a series of observations: texture observations and fiber-matrix bonding before and after treatment. The specific purpose of this research activity is to know the texture of sago fiber and the bonding between sago stem fiber with the matrix before and after treatment with liquid smoke. For the long term, this study aims to overcome the dependence of metal materials, overcome environmental pollution, and encourage increased utilization of abundant cellulosic fiber.

2. Method

The materials used were sago fiber, which was taken from Luwu regency of South Sulawesi Province, then soaked in drum for three weeks until rot. Furthermore, the fibers are separated from decayed leaf skin and then cleaned with water aquades until clean. After that, dried at room temperature.

The sago fibers are treated with liquid smoke. The treatments were carried out in 2 stages: (1) immersion of the fibers with liquid smoke for variations of time 1, 2, 3, and 4, (2) then the fibers were heated in a heating box at 43 degree celcius for 1 hour. Sago-treated saplings and non-curing treatments were grouped and then performed a series of observations: texture observations and bonding were performed by looking at changes in fiber texture and fiber-matrix forms before and after treatment. Table 1 shows the notation of this study.

- **Table 1. Study notation**

| No | Notation                  | Code | Remarks           |
|----|---------------------------|------|-------------------|
| 1  | Without treatment         | TP   | Without treatment |
| 2  | immersion in liquid smoke | P1J  | 1 hour immersion  |
|    | by                        | P2J  | 2 hours immersion |
duration of 1, 2, 3, and 4 hours, then 1 hour heating 43 degree Celsius.

The texture observations were performed using a digital microscope, while the compatibility observation was performed by preparing the matrix material of the epoxy resin with the mexpo catalyst, the specimen was prepared by mixing the matrix material with 1% catalyst of the matrix volume. After that, the results of specimen preparation are sanded until the fiber surface is clearly visible with the observation using a digital microscope. As for the image of the bonding specimen as shown in Figure 1.

![Specimen of bonding observation.](image1.png)

**Figure 1.** Specimen of bonding observation.

### 3. Results and Discussion

Digital microscope observation results to determine the texture form and bonding between enamel before and after treatment with liquid smoke. Observations can be seen in Figure 2.

![Changes in fiber texture](image2.png)

**Figure 2.** Changes in fiber texture

Figure 2 shows a significant change in the texture shape of the fibers before and after the treatment, where in the TP image the texture is smooth, but in the picture P1j - P4j there is a change of fiber texture to grooved and coarse, the longer the immersion time the more grooved and coarse fiber texture, the change is due to the treatment process with the liquid smoke in which the lignin is crushed on the fibers due to the acetic acid content contained in the liquid smoke. Texture roughness will also result in increased bonding between fiber-matrix, as in Figure 3.

This condition is reinforced with digital microscope photo data showing non-treated fibers that look fine and there is a gap between the fibers and the matrix so that there is no bond between the fibers and the matrix as in (Figure 3.a), while the fiber cross-section due to the treatment in (Fig. B - 3.e), it
appears that the matrix-fiber engagement becomes more compact. The longer the treatment time seems to be the more compact fiber-matrix engagement. Because the fiber and matrix interface bonds affect the strength of the composite and bond strengths affected by surface morphology and surface roughness of the fibers [6], [7], [8], [9], [10], [11].

![Figure 3. The form of bonding between fiber-matrix](image)

4. Conclusion
Based on the results of the research that has been done, it can be concluded that sago fiber can potentially be used as boosters on composite after experiencing the treatment because: (a) Treatment with liquid smoke can change the shape of the texture of fiber sago stem become more dry and the texture becomes rough. (b) changes the shape of the texture of sago fiber boughs increase the bonding of fiber-matrix.

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