Abstract. The use of natural fibers as a filler in the industry still continue to be developed, given its eco-friendly and contains material which is great. This research was conducted to find out the influence of boiled water and rice husk as filler material in epoxy resins. The making of the specimen using the method of hand lay-up with each variation of filler 10%-40% of the total weight of material test and the specimen without filler 0% for contrast. Polymer materials used i.e. epoxy resins. Testing is done namely pull-test, test volume resistivity and surface resistivity. Pull-test is performed using standard ASTM D-638 and resistivity test using standard ASTM D 257. The test results showed that the maximum volume resistivity values reached in the levels of water hyacinth 20% whereas on rice husk volume resistivity increase continues to occur until levels of 40% of the epoxy resins. Surface resistivity continues to increase in the levels of water hyacinth reaches 20% on epoxy resins as well as the addition of a filler rice husk. The tensile strength of the epoxy resins materials has decreased with the addition of water hyacinth and rice husk. The value of the maximum attainable tensile strength on the composition of the filler is 20%. With increasing levels of water hyacinth and rice husk in epoxy resins, the nature of the material brittle epoxy resins increase or an increase in the hardness of epoxy resin resulting in fragility.

1. Introduction

The development of industry with the advancement of technology has contributed greatly to the Indonesia’s economy. On the other hand it also has an impact on the environment due to industrial waste as well as the increasingly intensive resource exploitation in industrial development. Material and energy efficiencies in utilization, processing and recycling result in competitive advantage and economic benefits. An environmental issue that must be considered one of them is pollution in water bodies. Eutrophication is one of the causes of contamination it is water pollution caused by the emergence of excessive nutrients into the aquatic ecosystem. Based on the above, the industrial development should be coupled with environmental management efforts in the form of waste handling that released or by searching for industrial raw materials environmentally friendly as an alternative material, material water hyacinth (Eichornia crassipes) and rice husk are alternative materials for high voltage isolation. Water hyacinthis a type of water plant that has a high growth rate, so it is considered as a weed that can disrupt aquatic ecosystems[1].

Appropriateness of Water Hyacinth and Rice Husk as Filler Materials for Resin Polymer Insulation

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Problems arising from the high population of water hyacinth: the decrease of the amount of water aquatic diversity, the occurrence of siltation, the decrease of water quality due to the decrease of oxygen due to decreasing the intensity of sunlight entering the water body, the increasing of disease vector, irrigation disturbance, transportation, and the decreasing of aesthetic value in water [1,2]. Lignocellulose is also contained in agricultural waste, one of which is rice husks. Rice husk is an agricultural residue whose availability is very abundant and can produce bio-ethanol because it contains lignocelluloses structure. Rice husks contain 24.3% hemicelluloses, 34.4% cellulose, and 19.2% lignin [3]. One example of a polymer that can be used as a base material of outer mounting insulator in the electrical field is resin epoxy. Resin epoxy material has several advantages including: epoxy fluid has a low viscosity that is easily mixed (thermoset stage) in the manufacture, but resin epoxy resin has a combination of: low viscosity properties, easy to form, low shrinkage, high adhesiveness, high mechanical properties, high electrical insulation, good chemical resistance (4). Cellulose and lignin is one of the criteria that demonstrate the power of fibre. Cellulose is the major constituent of the cell wall and including glucose polymer with 1.4-β Glycoside bond in the chain length of the straight. The cellulose chains are connected by hydrogen bonds and van der walls [5]. Lignin is a component that is very difficult degraded. Polymer composition comprising lignin aromatic units linked by ether bonds and carbon. The main function of lignin in plants is strengthening the structure of plants [6]. Lignocellulose is also contained in agricultural waste, one of which is rice husks. When the rice husk is burned the ash content obtained is 17-26%, much higher than other fuels (wood 0.2-2%, coal 12.2%). Rice husks have an average high calorie value of 3410 kcal / kg and can be used as one of renewable energy sources [7]. Rice husks are only used as primary or additional fuel in the brick making industry, seed planting medium, while the ashes are small for rubbing and others are thrown away. In fact, if the rice husk ash is heated above 500°C temperature during 105 minutes or more will give optimum amorphous silica content of at least 86% [8]. Isolator as one of the electrical equipment plays an important role in the process of electrical energy distribution. Popular outer mounting insulators developed today are polymer insulators, because polymeric materials have many advantages over porcelain and glass materials. Among these are high hydrophobic properties, have lower mass densities, are easy to manufacture because they do not require very high temperatures in the manufacturing process, and have a high degree of adhesion [9].

2. Experimental Procedures

2.1 Material

Resin epoxy used in this study is epoxy glue with a type of RTV (Room Temperature vulcanization) or vulcanized/harden at room temperature. It is obtained from PT. AVIA AVIAN, as for trademark is Avian 2 component consists of two parts, namely resin and hardener.

Water hyacinth and rice husks are used as filler for insulating material resin epoxy. Water hyacinth and rice husk are obtained from the waters of Makassar city while rice husk is obtained from Sidrap district. The composition of chemical compounds contained in water hyacinth and rice husk are used have been analyzed using XRF (X-Ray Fluoroscent) and the results can be seen in the following below.
Water hyacinth obtained from the waters of Makassar city before use is cleaned first by using running water to remove impurities, after cleansing leaves is dried for 7 days in open room that is not directly exposed to sunlight. After cleaning the mixture is then inserted into the vacuum chamber to remove the air bubbles trapped in the mixture when mixing. The mixture is printed using a mold with a depth of 3 mm so that the material will be produced with a uniform thickness. After the material is hardened, it is conditioned on the material by keeping the material in the test chamber for 3 days with humidity reaching 85% and a temperature of 25°C. By doing this, no further diffusion of water vapor is expected to material from the humidity of the air around which the diffusion process is concerned may affect the data obtained. After the conditioning process is complete, the material is ready to be tested for characteristics. The material is prepared with different water hyacinth and rice husk levels to investigate the effect of addition of water hyacinth and rice husk on the characteristics of resin epoxy material. The composition of filler and resin epoxy tested can be seen in the following table:

### Table 1. Chemical composition of rice husk ash

| No. | Compound Name | Percentage (%) |
|-----|---------------|----------------|
| 1   | SiO₂          | 97.99          |
| 2   | P₂O₅          | 0.50           |
| 3   | CaO           | 0.496          |
| 4   | K₂O           | 0.491          |
| 5   | MnO           | 0.268          |
| 6   | Cl            | 0.179          |
| 7   | Fe₂O₃         | 0.038          |
| 8   | ZnO           | 0.0124         |
| 9   | Rb₂O          | 0.0076         |
| 10  | SiO₂          | 97.99          |
| 11  | P₂O₅          | 0.50           |

### Table 2. Lignicellulose composition of eceng gondok

| No. | Compound Name | Percentage (%) |
|-----|---------------|----------------|
| 1   | Lignin        | 3.97           |
| 2   | Selulosa      | 23.54          |
| 3   | Hemiselulosa  | 28.19          |

### Table 3. Sampling code and percentage of water hyacinth and rice husk ash levels

| No. | Sample Code of Water Hyacinth | Percentage (%) (based on weight of resin epoxy) | No. | Sample Code of Rice Husk Ash | Percentage (%) (based on weight of resin epoxy) |
|-----|-------------------------------|-----------------------------------------------|-----|-------------------------------|-----------------------------------------------|
| 1   | SEG 0                         | 0                                             | 6   | SSP 0                         | 0                                             |
| 2   | SEG 1                         | 10                                            | 7   | SSP 1                         | 10                                            |
| 3   | SEG 2                         | 20                                            | 8   | SSP 2                         | 20                                            |
| 4   | SEG 3                         | 30                                            | 9   | SSP 3                         | 30                                            |
| 5   | SEG 4                         | 40                                            | 10  | SSP 4                         | 40                                            |

Each composition is made up of 3 samples to provide more accurate data.

3. Material Preparation

Water hyacinth obtained from the waters of Makassar city before use is cleaned first by using running water to remove impurities, after cleansing leaves is dried for 7 days in open room that is not directly exposed to sunlight. After dry the leaves are refined and sieved to provide uniformity in the particles. Rice husks obtained from Sidrap district in the form of ash are first sieved to provide uniformity in the particles.

Resin epoxy is then mixed with filler each using a technique of hand lay-up mixing. The mixture is then inserted into the vacuum chamber to remove the air bubbles trapped in the mixture when mixing. The mixture is printed using a mold with a depth of 3 mm so that the material will be produced with a uniform thickness. After the material is hardened, it is conditioning on the material by keeping the material in the test chamber for 3 days with humidity reaching 85% and a temperature of 25°C. By doing this, no further diffusion of water vapor is expected to material from the humidity of the air around which the diffusion process is concerned may affect the data obtained. After the conditioning process is complete, the material is ready to be tested for characteristics. The material is prepared with different water hyacinth and rice husk levels to investigate the effect of addition of water hyacinth and rice husk on the characteristics of resin epoxy material. The composition of filler and resin epoxy tested can be seen in the following table:
4. Characterization

The testing process is based on ASTM standard. The standard test used can be seen in the following table:

| Name Of Testing | Method of testing |
|-----------------|-------------------|
| Tensile Strength | ASTM 638          |
| Surface resistivity | ASTM 257        |
| Volume resistivity | ASTM 257        |

Testing is done as much as 1 to 10 times. The final value of each test type is the average of the tests performed so that the data obtained is more accurate. Testing of surface and volume resistivity and volume were performed using the Kyoritsu insulation tester with electrode configuration and procedures based on the ASTM D257 standard. On surface and volume resistivity measurements, the voltage used by the test equipment is 5000, with ambient temperature of 25°C and humidity 81%. Testing of tensile strength was performed using tensile testing machine based on ASTM D 638 standard.

5. Results and Discussion

Volume resistivity

Volume resistivity of material has been tested and the results can be seen in the following figure:

![Testing result of volume resistivity on various composition of resin epoxy and eceng gondok and rice](image)

**Figure 1.** Effect the addition of water hyacinth and rice husks in resin epoxy to the volume resistivity of the material

In figure 1, can be seen that the addition of water hyacinth resin epoxy increases the volume resistivity of resin epoxy to the filler 20% composition. In addition, the addition of water hyacinth will make the volume resistivity of resin epoxy to be decreased then not linear. In filler 20% composition the increased volume resistivity of Resin epoxy material is about 87.68% compared with resin epoxy without filler. The addition of rice husk in resin epoxy increased the volume resistivity of the resin epoxy to the filler 40% composition without decreasing. In the filler 40% composition the increased volume resistivity of resin epoxy material was about 234.384% compared with resin epoxy material without filler. There are several factors that can affect the volume resistivity of material especially if the material is tested at high-voltage DC impulse. Mineralogy of fillers, chemical bonds, molecular distributions and many other chemical factors will contribute to the resistivity of the material.
Surface resistivity

Surface resistivity of the material has been tested and the results can be seen in the following Figure 2.

![Testing result of surface resistivity on various composition of resin epoxy and eceng gondok and rice husk](image)

Figure 2. Effect the addition of water hyacinth and rice husks in resin epoxy to surface resistivity of the material.

In Figure 2, it can be seen that with the addition of water hyacinth in resin epoxy, the surface resistivity of resin epoxy is increased. Increased surface resistivity continues until the water hyacinth level reaches 20% in resin epoxy.

The addition of rice husk level to resin epoxy, surface resistivity of resin epoxy has decreased compared to resin epoxy without filler. Increased surface resistivity increases in the addition of filler 20%. The resistance value of a material will depend on the type of voltage/field applied to the material. In materials with high semi-conductive particle content, the resistance of resin epoxy will change depending on the size and type of voltage/field given. At a voltage magnitude/field given of material, the resistance value may change depending on the band gap width between the valence band and the conduction of the constituent compounds.

Tensile strength

The tensile strength of material tested can be seen in the following figure:

![Effect the addition of eceng gondok and rice husk on tensile strength of resin epoxy material](image)

Figure 3. Effect the addition of water hyacinth and rice husks in resin epoxy to tensile strength of resin epoxy material.
In figure 3 can be seen that there is a tendency to decrease the tensile strength of resin epoxy material, the addition of water hyacinth and rice husks. The maximum tensile strength value is achieved in the water hyacinth 20% composition of 1 kgf/mm². In the composition, the tensile strength increase is 20% compared to the resin epoxy composition without filler. Also, figure 5 can be seen that initially there is a tendency to increase the tensile strength of the Resin epoxy material by increasing the water hyacinth content in the material until it reaches its peak in the water hyacinth 20% composition. After that is a non-linear tensile change in composition above 30%, the tensile strength of the Resin epoxy material initially decreases to the water hyacinth 10% composition. After that is an increase of tensile strength at 20% composition. It can be seen that with increasing levels of water hyacinth and rice husk in the resin epoxy, the elasticity of resin epoxy material is reduced or an increase in hardness of resin epoxy. The presence of some minerals in water hyacinth and rice husks in resin epoxy makes the stretching of interpersonal distance and the range of bond angles smaller between the monomers on Resin epoxy so that the tensile strength and elasticity between the monomers become weakened. As a result elongation of resin epoxy composite material and water hyacinth and rice husks decreases with increasing levels of filler in resin epoxy.

6. Conclusions

The conclusions that can be drawn from this research as follows:

1. In general, the utilization of water hyacinth and rice husk as fillers in resin epoxy can improve some parameters of Resin epoxy material.
2. In general, the maximum increase of electrical and mechanical parameters is achieved at water hyacinth composition by 10 - 40% of the weight of resin epoxy.
3. Esting of surface resistivity and permittivity, the parameter values increase with increasing addition of water hyacinth and rice husks in the resin. There is characteristic irregularity in the result of tensile test. This may be due to an incomplete sample preparation caused by the nature of the resin epoxy material itself, which is difficult to be molded.

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