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Physical Properties of Composite Based on Sugar Palm Stem Powder

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ABSTRACT

Composite based on sugar palm stem powder has been made through conventional technique of mold and press from the sugar palm stem powder reinforced by matrix polyester resin, epoxy resin, and polyurethane resins. The composition of sugar palm stem powder were varied with 2;4;6;8 and 10% wt mass fraction also the 90;92;94;96 and 98 % wt mass fraction are enhanced by the polyester resin, epoxy resin and polyurethane resins in 300 MPa pressure treated with temperature of 120°C for polyurethane resin and temperature of 70°C for polyester resin and epoxy resin for 20 minutes. The test result of physical properties generates 1.19 gr/cm³ of the density optimum number, 1.83% porosity, and 2.83% water absorption. The study shows the physical properties which meet the Standard JIS A 5905 : 2003, that is 0.3 – 1.3 gr/cm³ density.

Keywords : Sugar Palm Stem Powder, Composite, Physical Properties

I. INTRODUCTION

Sugar palm stem is one of the abundant and renewable natural resources in Indonesia,Sumatera Utara is one of the provinces with wide sugar palm (*Arenga pinnata Merr)* forest. According to the data from Plantation Agency of North Sumatera Province in 2017, North Sumatera has 6.101 Ha of sugar palm trees in immature plant category, producing plant category, non-producing plant category with 3.746 tons of production result.[5].

Composite is a material formed by two or more constituent materials. The constituent material has unique properties and characteristics and more superior than its constituent material. Some of the excellence of the composite are, flexible, strong, light but sturdy without forming, has good electric isolation, stainless and easy to combine with other material. The eco-friendly composite-based material on the natural fiber could be obtained in the surrounding environment. Today, natural fibers are often used because there are a lot of it and very cheap so it is often used as an enhancing material such as

kenaf, abaca, rosella, hay, and many other abundant and renewable natural fibers in Indonesia.[10]

This section contains information about matrix types and fiber types that are used in the fabrication of polymer composite components. It also gives detail about advanced composites and natural fiber composites. Polymer composites have been used extensively in aerospace, automotive, marine, building and construction, furniture, sports goods, telecommunication, and railway industries because of light weight, high strength, high stiffness, aesthetics, corrosion resistance and they ability to cope with extreme stresses over long periods. [14]

II. METHODS AND MATERIAL

A. Appliance and Materials Research

The applience used are 100 mesh sieves, oven, mixer, digital balance, moulding, beaker glass, hot plate, and hot press hydraulic. The material used is sugar palm stem powder, 2% and 17.5% NaOH, Aquadest, alcohol, polyester resin, epoxy resin and polyurethane resin

B. Research Variables

Research variables on the manufacture of composite materials include raw material composition and characterization.

TABLE 2.1. PERCENTAGE OF COMPOSITE BASED ON SUGAR PALM STEM POWDER AND MATRIX

Sugar Palm Stem Powder (%wt)	Matrix (%wt)
2	98
4	96
6	94
8	92
10	90

As for the characterization of composite materials include: physical properties (density, porosity and water absorption)

C. Research Procedures

Sugar palm stems are taken and chosen from the immature tree category. Then the stems are cut into 5 x 5 x 2 cm cubicles. The stems are cleaned by soaking it in alcohol then air-dried in the open space. After they dried, the stems are cooked with NaOH 17,5% solution in a 2500 mL beaker glass by using a hot plate for two hours in 100°C temperature to eliminate the lignin and then dried. The dry sugar palm stem is ground by blender then sifted with 100 mesh sieve to obtain the powder of sugar palm stem. Weighed with ingredient variation (2;4;6;8 and 10)% by using a digital analytic balance. The mold is cleaned from dirt. The metal plate is layered by an aluminum foil as the base and cover. Then the mold and metal plate are lubricated by wax to avoid the sample to become

sticky when removed from the mold. The matrix used is weighed with the variation (90;92;94;96 and 98)%. Mix it with the mixer until smooth, and pour the mix into the (10x2x1) cm mold. Then, the mold is covered with a metal plate layered with aluminum foil and put it on the hot press in temperature of 120°C temperature in polyurethane matrix and temperature of 70°C polyester resin and epoxy resin matrix for 20 minutes. Then the sample is removed from the mold and ready to be physically tested for its density, porosity, and water absorption.

III. RESULTS AND DISCUSSION

A. Physical Properties of Composite (Density)

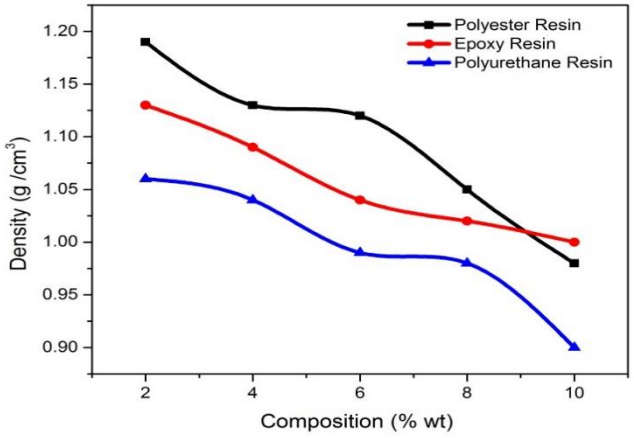

Figure 3.1. The density versus variation of sugar palm stem powder composition

Density is one of the physical characteristics that shows the comparison between object mass against the volume or the amount of matter mass per unit volume. From Figure 3.1 the score of density obtained is (0.9 – 1.19) gr/cm^3 and shows that there is a decline caused by the addition of palm sugar powder. Based on JIS A 5905:2003, the composite of test sample is qualified 0.3 – 1.3 gr/cm^3.

B. Physical Properties of Composite (Porosity)

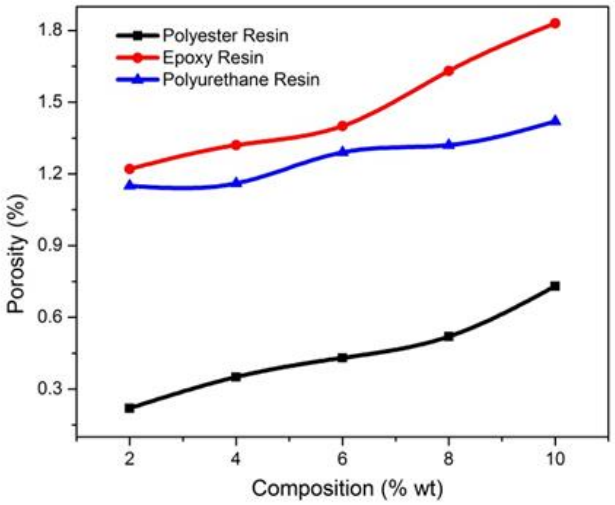

Figure 3.2. The porosity versus variation of sugar palm stem powder composition

Porosity can be defined as a comparison between the volumes of pore against total volume of composite. From Figure 3.2 the highest score of porosity is 1.83% on epoxy resin matrix and the lowest is 0.22 % on polyester resin matrix. So, by the addition of palm sugar powder the value of porosity is escalating and if there is no addition of palm sugar powder, the value of porosity is declining. Composite of styrofoam waste, asphalt, nut fiber and black sand was value 12.36%.[18]

C. Physical Properties of Composite (Water Absorption)

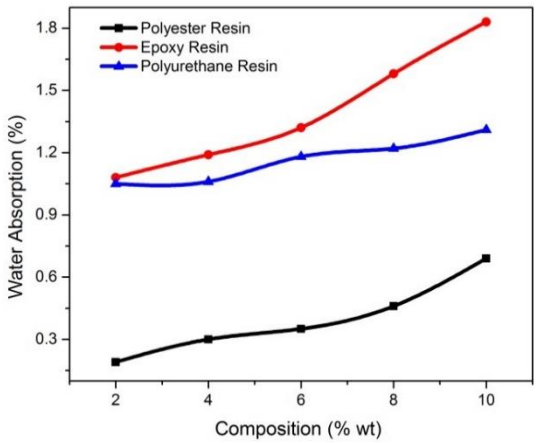

Figure 3.3 Water Absorption versus variation of sugar palm stem powder composition

Water absorption test is conducted to determine the amount of water absorbed by the sample soaked for 24 hours in room temperature. On Figure 3.3, the value of water absorption obtained is around (0.19 - 1.83) %. Water absorption test is directly proportional with porosity test which can be stated that the more amount of palm sugar stem powder added to the sample composition, the score resulted is escalating and inversing with the density test.Result of composite with corn husk fibes was value (0.75 - 3.55) %.[9]

IV. CONCLUSION

In this work,by the addition of palm sugar stem powder the value of density is declining. On the other hand, the value of porosity and water absorption are increasing. However, the value of porosity and water absorption are declined. The measurement of physical characteristics of palm sugar stem powder composite results in optimum value of density of 1.19 gr/cm^3, porosity of 1.83%, and water absorption of 1.83%, The result of this research shows the physical characteristics that qualify the Standard of JIS A 5905 : 2003 which is density of 0,3 - 1,3 gr/cm3 . It is due to lignin, hemicellulose, and alpha cellulose contained in palm sugar stem powder appropriate in making composite and combined with the binding matrix.

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