

Synthesis of Composit From Bamboo Fiber, Zeolite and Epoxy for Room Separation

Dhany Raihan Muhammad,¹ Kris Tri Basuki,¹ Bangun Wasito,¹ Suroso²

¹Nuclear Technochemistry Study Program, Polytechnic of Nuclear Technology – National Nuclear Energy Agency, Jalan Babarsari KP6101 YKBB Yogyakarta 55281

²Technophysics Study Program, Polytechnic of Nuclear Technology – National Nuclear Energy Agency, Jalan Babarsari KP6101 YKBB Yogyakarta 55281

Email: dhany_raihan@yahoo.com.sg

Abstract This research aims is to search a substitute of the asbestos for the separator rontgen room using bamboo fiber filled with zeolite; which harden using epoxy it is all caused because the hazard of the asbestos to the human body. Bamboo stem degenerated using NaOH (20%) to get the bamboo fiber. Bamboo fiber added with CS₂ (10 mL) to form xanthate cellulose. Xanthate Cellulose mixed with filler zeolite and harden of epoxy, layer by layer until getting the right width. The variant of the mass composition is 3: 0:1; 3: 0.25:0.75; 3 :0.5:0.5; 3: 0.75:0.25; 3: 1:0, and the variant of the temperature 28 °C; 40 °C; 60 °C; 80 °C; and 100 °C. The sample tested using microscopic method, impact test with Charpy method, corrosivity method, Electricity conduct method, thermal conduct method, and radiation resistance or attenuation method. The result shown the optimum composition of the composite it is at the variant 3 :0.5:0.5, with the optimum temperature is 40°C with the density of the sample is 1.5789 g/cm³. Impact resistance of the sample is 44 Joule. The Radiation resistance is 0.46, with the thermal conductivity of the sample is 0.016 Kkal/ m.s.c. it shown that the sample is isolator. From the result is shown that the sample is can be a substitute for asbestos as material of the separator in the Rontgen room. Key word: Composite, Epoxy, Bamboo, Zeolite, Xanthate cellulose

1. INTRODUCTION

Current technological developments are beginning to lead to environmental problems in order to reduce the negative impacts of synthesis materials. Such technologies include the manufacture of composites that utilize natural fibers. The development of natural materials can slowly replace other materials to meet human needs. Material from nature is expected to be a solution because it is easy to obtain, cheaper, environmentally friendly and can be degraded by nature.

Generally, iron and asbestos are used as the basic material of space divider, but there are many studies that indicate a weakness in their use. Iron weakness is heavy, expensive, and quite difficult to degrade by nature while asbestos produces harmful asbestos dust.

Bamboo can be used as wall barrier material, has strong rod, flexible, straight, and light so easy to be processed for various products. The addition of zeolite filler and epoxy hardener is expected to produce a strong and light composite. Bamboo is a low cost biomass (poor man's timber). However, as most of bamboo is produced by smallholder farmers, collection costs and logistical costs may be high [1]. The researchers used natural fiber composite as a superior product in accordance with its specialties. Although not fully shifting synthetic fibers, the use of environmentally friendly natural fibers is a wise move to save the environment [2].

Application of bamboo fiber composite as a radiation wall boundary material needs to be tested radiation attenuation value. Attenuation of radiation is the ability of the material to withstand the intensity of radiation



2. EXPERIMENT

2.1 Chemicals and instrumentation

Chemicals used for this research it is, Epoxy, NaOH, HCl, CS₂ and Bamboo cellulose. Instrumentation applied for analysis it this research it is Impact test, Microscope, Multimeter, Thermometer, Geiger Counter

2.2 Synthesis of Bamboo fiber

Making bamboo fiber is done by cutting bamboo fiber and softening the bamboo fiber using NaOH, after that Grind the bamboo fiber and for the last it is to form the fiber cellulose xanthate using CS₂.

2.3 Synthesis of zeolite powder

Making zeolite powder is by pounding zeolite with mortar until it becomes smooth. To add the zeolite surface area value so it is expected to be more easily grooved and blend with the composite later, with the hope of increasingly zeolite surface area, the smaller the zeolite volume so that it can more easily be absorbed and bound by bamboo fiber and epoxy hardener.

2.4 Synthesis of the composite

Preparation of composites in this study is to combine bamboo fiber, with epoxy mixed zeolite filler with fiber ratio: zeolite: epoxy which will be varied with composite making method of Hand layup. The process of manufacture by this method is by pouring resin by hand into woven-shaped fibers, cloth, then give pressure as well as leveling it using rollers or brushes. The process is repeated until the desired thickness is reached.

2.5 Destructive test

Destructive test is a test method of the material is tested until the material becomes damaged and will be compared with the standard material to be replaced later. Here are all kinds of broken tests performed. Impact test was testing the load to the sample, to know the form of fault and the ability to withstand momentum. Corrosion test was test immersing samples in HCl 5N per time to know the rate of material corrosivity. Microscope test was the test looks at the sample surface in a micro-way to see the shape of the sample arrangement.

2.6 Non-destructive test

Non-destructive test is a method of testing the material not being damaged and the state is maintained at its original state. Here are the various nondestructive tests performed. Test of conductor resistance was test by giving current to see the value of sample resistance to electric current. Thermal conductivity test was test through the provision of heat flow to determine the value of the ability of materials in conducting heat. Test of radiation resistance was test to determine the ability of the material to withstand radiation through the giving of an intensity from a previously known source.

3. RESULT AND DISCUSSION

3.1 Radiation resistance test

If known, the initial intensity in the sample is obtained on the test data that has been done to determine the value of the blank and the initial intensity, performed using gs detector with the Cs-137 source for 60 seconds. Table 1 is the data table of the blank test results with the initial intensity.

Table 1. Starter Intensity and Blanko

Data	Radiation resistance (CPM)
Io	2809.33 ± 134.82
Blanko	46.00 ± 15.10

The result of research for variation of composition, got sample test data calculated by using data of initial intensity and blank using formula as follows.

$$I = I_0 \times e^{-\mu t} \quad (1)$$

With (I) is intensity after being resist by the sample (CPS), (I_0) is background Intensity (CPS), (μ) is attenuation, and (t) is thickness (m).

3.2 Attenuation test for Variety of mass composition

Based on the formula is found Table 2 is the data attenuation value of variations in mass composition.

Table 2 . Variety of mass composition Counting data

Sample (bamboo(g))	CPM	Atenuation
Bamboo 0,25	1841,83	0,43
Bamboo 0,5	1797,17	0,46
Bamboo 0,75	1749,75	0,48
Bamboo 1	1712,33	0,51
Cement	1760,67	0,48

Based on Table 2, the attenuation value of bamboo compound 0.75 g and the bamboo composition of 1 g has been obtained with good attenuation that can equalize and exceed the cement. This suggests a connection between the presence of cellulose that absorbs gamma rays.

3.3 Attenuation test for Variety of Temperature

Based on the formula is found Table 3 is the data attenuation value of variations in temperature composition.

Table 3. Variety of temperature composition Counting data

Sample (Temperature °C)	Count (CPM)	Attenuation
Temperature 28 ⁰ C	1797.17	0.46
Temperature 40 ⁰ C	1788.42	0.46
Temperature 60 ⁰ C	1805.17	0.45
Temperature 80 ⁰ C	1712.50	0.51
Temperature 100 ⁰ C	1832.17	0.44
Cement	1760.67	0.48

Based on Table 3, the attenuation value of temperature 80⁰C obtained attenuation over cement. This is because of the relation between temperature gain and material density, so it is found that the best temperature to be used in composite manufacture is at 80⁰C.

3.4 Corrosivity Test

After the test results have been done that is by soaking the sample with the desitas average of the test material is 1.5789 into HCL 5N within a certain time then obtained data results shown by the graph in Figure 1.

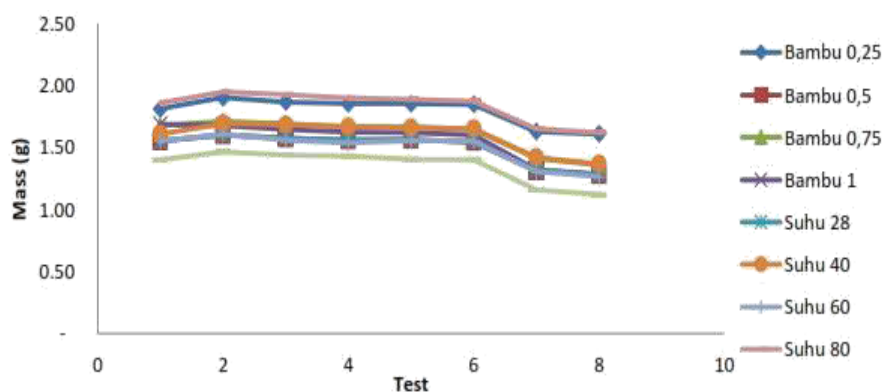


Figure 1. Total Data Korositas

In Figure 2, the color of the line indicates the type of sample, the sample used in the test is the Bamboo sample with the temperature composition variation in °C. The X axis in Figure 12 shows the test number in unit time. The Y axis in Figure 12 shows the mass value of the sample in grams.

Based on the graph in Figure 1 can be seen that the phenomenon that occurs in all samples is the same outline, so to further simplify can be taken one data that will represent the discussion of all the data sample of other test materials, for that will be taken one graph data on the variation of bamboo 0.25 g to represent the results of the test data.

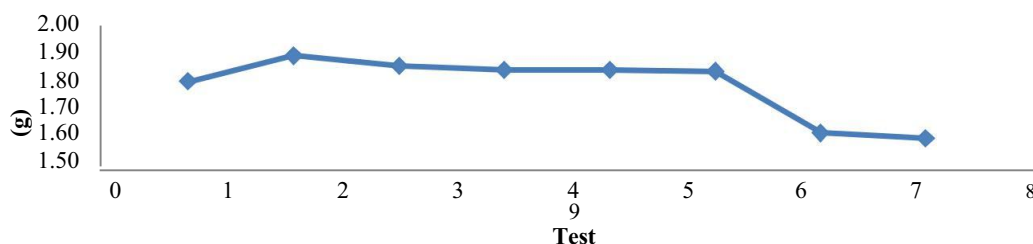


Figure 2. Corrosivity Variation of Bamboo composite 0,25

From Figure 2 it can be seen that the increase of mass that occurs at the time after the sample of the test material soaked is not in accordance with the existing theoretical basis. This is due to the presence of pores either macro or micro in the sample, these pores are significantly absorbed, so that the mass is the mass of the reduced sample plus the mass of the absorbed HCl into the sample, resulting in an very significant mass increase. Based on these results can be concluded that the calculation of the value of corosity rate is cannot be done.

3.5 Impact test (*charpy method*)

From the results of tests that have been done then obtained the test results of test material samples using Impact Charpy method.

3.6 Impact test for Variation of Composition

The result of composition variation test using Impact Charpy method is shown in Figure 3 as follows.

In the impact test, aluminum is used as a comparison on the results of data. Seen in the bamboo variation test sample 0.25 g showed an increase in the ability to withstand the impact of the aluminum value. This proves that with the addition of zeolite filler can add value of mechanical ability of more and more zeolite material tied to bamboo as filler material that can reduce the effect of momentum on the sample of test material.

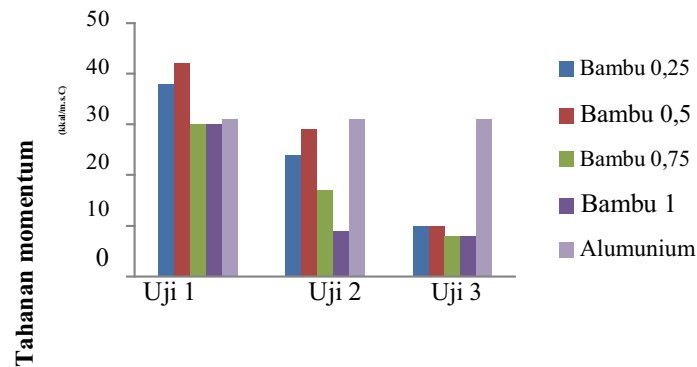


Figure 3. Impact test Composition Variation Result

3.7 Impact test for Variation of Temperature

The result of temperature variation test using Impact Charpy method is shown in Figure 4.

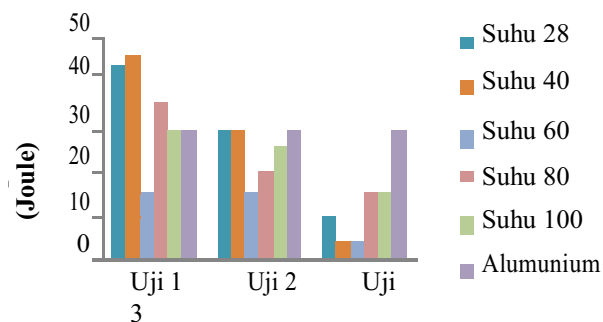


Figure 4. Result Impact test for Variation of Temperature

Based on the data in Figure 4 It can be seen that there is a capability retention in the impact resistance of the test material sample with the increasing temperature of the material making, this is due to the influence of the speed of composite formation with the higher the temperature used the faster the composite dries but on the other side will form many small particles so that it will be more easily broken than by using its optimum temperature at 40°C.

3.8 Electrical Conductivity Test

The electrical conductivity test found that the test result data using amperemeter is shown in Table 4.

Table 4. Electric conductivity test

Sample (g)	Arus (A)	Sampel (°C)	Arus (A)
Bamboo 0,25	0	Temperature 28	0
Bamboo 0,5	0	Temperature 40	0
Bamboo 0,75	0	Temperature 60	0
Bamboo 1	0	Temperature 80	0
		Temperature 100	0

Based on Table 4 shows the manufacture composite is a type of insulator material which is an electrical resistor, so no current is read by ampere meter. Therefore, this composite is well used to substitute materials that usually interact directly as a barrier between humans with electrical materials.

3.9 Microscopic Test

Based on the results of microscopic observations obtained results as follows.

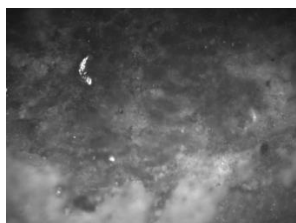


Figure 5. Microscope 20x Sample Bamboo
0,25 g



Figure 6. Microscope 20x Sample Bamboo 0,5
g

In Figure 5 it can be seen that the micro form of the sample there are silica granules that break down and form groups individually. In figure 5 it can be proven that the bonds do not occur micros but only occur physically and there are porosity values that affect the properties of the material. It is proven by the separation between each shiny material that means it did not create the chemical bond, only the physical material that wrap each other

Figure 6 shows the presence of opaque cellulose. This is because the three-dimensional cellulose form so difficult to get the focus of the image on cellulose. The image proves the presence of cellulose bonding which helps add properties to the material in the sample.

3.10 Thermal Conductivity Test

Sought value Thermal conductivity of the material by using Alumunium comparator to know the value of Q so that it can search the thermal conductivity value of materials using the formula.

$$Q = K A (\Delta T / \Delta x) \quad (10)$$

Where Q = heat flow rate (kkal/m s c); K = thermal conductivity; A = cross section (m³); ΔT = temperature changes (°C); and Δx = length (m); K for aluminium is 0.05 kkal/m s c.

3.11 Thermal Conductivity Test composition variety

Here is the data from the test results on the sample of the test material with the variation of the composition. The results of the test data are shown in Table 5.

Table 5. Change of temperature on composition variety sample sample

Bamboo (g)	K.heat flow rate (kkal/m.s.C)
0,25	0,018 ± 0,005
0,5	0,018 ± 0,003
0,75	0,016 ± 0,002
1	0,019 ± 0,004

From Table 5, it can be seen the optimum point of thermal conductivity value for composition variation is bamboo 1 composition without zeolite, with its thermal conductivity point is 0,019 kkal/ms.

3.12 Thermal conductivity test temperature variety

Here is the data from the test results on the sample of the test material with the variation of the composition. The results of the test data are shown in Table 6.

Table 6. Change of temperature on temperature variety sample Sample

Temperature (°C)	K. heat flow rate (kkal/m.s.C)
28	0,018 ± 0,003
40	0,016 ± 0,002
60	0,016 ± 0,002
80	0,016 ± 0,003
100	0,016 ± 0,002

From Table 6 data it can be seen that the optimum point of thermal conductivity value for temperature variation is at temperature 28°C with its thermal conductivity point is 0.018 kcal / m.s. Based on the calculation that has been done the sample of test material will be compared with conductivity value at cement which is the main material which is expected to be replaced by composite.

Table 7. Result of equation for thermal conductivity

Sample		k.Thermal (kkal/m.s.C)
Bamboo (g)	Bamboo 0,25	0,018± 0,005
	Bamboo 0,5	0,018 ± 0,003
	Bamboo 0,75	0,016± 0,002
	Bamboo 1	0,019± 0,004
Temperature (°C)	Temperature 28	0,018 ±0,003
	Temperature 40	0,016 ± 0,002
	Temperature 60	0,016 ±0,002
	Temperature 80	0,016 ± 0,003
	Temperature 100	0,016 ± 0,002
Data	Zeolit	0,016 ± 0,001
	Paint	0,015 ± 0,002
	Cement	0,043
	Alumunium	0,050

Based on the results of the data in Table 7 it can be seen that the sample of the test material in the form of bamboo fiber composite filler zeolite epoxy hardener has a thermal conductivity value that is still far below the cement and aluminum so it can be concluded that the test material sample is a good heat retardant material and resembles asbestos resistance. So with the similarity of composite materials with the properties of asbestos, composite materials are considered to replace asbestos materials due to its safety in fire retention due to the high value of heat resistance of materials that resemble asbestos.

From the result all of the data it will be gain the characteristhic of the material it is stronger than asbestos, the attenuation number is greater than asbestos, and included as isolator material. But on the other side the material it is only occur with physically bond.

4.CONCLUSION

Based on the results of research that has been done can be concluded that. The more the composition of bamboo in the composite will decrease the value of ability to impact resistance or momentum, and more zeolite will add value of mechanical ability of composite material. Increasing the amount of fiber in the composite composition has the effect of an increase in attenuation value. Based on these results, the optimum point in this experiment is the comparison of epoxy: bamboo: zeolite at point 3: 0.5: 0.5 with the value of mechanical resistance over aluminum, heat resistance approaching asbestos, and having attenuation resembling cement plaster.

Temperature variations affect the mechanical strength, the higher the temperature, the smaller the composite ability to withstand impact with rising temperature values will decrease the strength of the material holding impact. The optimum temperature in the manufacture of bamboo fiber composite, zeolite and epoxy is at 40°C. The thermal conductivity generated by the sample of the test material shows that the composite sample has a good enough resistance value near the asbestos, meaning that the test sample includes an insulator material which is not good enough to conduct heat.

The optimum variation in the manufacture of bamboo fiber composite, zeolite, and epoxy is by comparison of epoxy: bamboo: zeolite is at the point of comparison of 3: 0,5: 0,5 and at temperature 40°C. Based on the advantages of this composite material can be concluded this composite material can be used as a substitute for asbestos based on the properties obtained have many advantages compared to asbestos materials that will be replaced. The material properties at the optimum point it is the strength of the impact resistance is 44 Joule, with the value of radiation attenuation is 0.46, and the thermal conductivity is 0.016 Kcal / m.s.c which mean the material it is included into the insulator material and the density of the material is 1.5789 g/cm³.

ACKNOWLEDGMENT

Acknowledgment will be granted to prof. dr. Kris Tri basuki, Ir. Bangun wasito, and Suroso M.Sc as his excellency and guidance to make me able to finish this project.

REFERENCES

- [1] Poppens R, Dam J V, Elbersen W 2013 Analyzing the potential of bamboo feedstock for the biobased economy Netherlands.
- [2] Jamasri, Opportunities and Challenges of Development of Natural Fiber Composites in, Proceedings of National Seminar on Machinery and Industry (SNMI4) 2008 Tarumanagara University Jakarta, pp. 1-13 Indonesia
- [3] Filgueiras, T. S.; Gonçalves, A. P. S. A 2009 The Journal of the American Bamboo Society **18** pp 7-18
- [4] Widya F, Hermiati E 2006 *Fiber morphology analysis and physical chemical properties on six bamboo types as pulp and paper raw materials* Bogor Indonesia
- [5] Bowman, B.S 2003 *Microporous Mesoporous Materials* **6** pp 43-56
- [6] Guan, H., Bestland, E., Zhu, C., Zhu, H., Albertsdottir, D., Hutson, J., Simmons, C.T., Ginic - Markovic, M., Tao, X. and Ellis, A.V 2010 *Journal of Hazardous Materials* **183** pp 616-621
- [7] Idris A.A, Firmanti A, Purwito 1994 *Prosiding Seminar Strategi penelitian Bambu di Indonesia* Serpong: PUSPITEK.
- [8] Meijer R; Nazarpour K 2015 *Prosthetic* Falkirk Great Britain
- [9] Mehta, Bhavin, V; Setlock, Robert, J.; Sindelar, Betty; Bantle, John 2006 *Prosthetic Bone Implant*, Ohio, United State
- [10] Oishi M. 2012 *Bone Prosthetic Material*, Tokyo, Japan.
- [11] Wahyudi T 2015 Extraction of Fiber from bambu (*Gigantochloa Apus*) for raw material of creative industry