Comparison Mechanical Properties of Composites Polymer from Polypropylene with Various Sources α-Cellulose as Fillers

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ABSTRACT: Research on comparison of the mechanical properties of composites polymer with various sources α-cellulose as filler. α-cellulose used, among others, obtained from bagasse (Saccharumofficinarum), reeds (Imperatacylindrica) and cocofiber (Cocosnucifera). The study consisted of two phases. The first step is the isolation α-cellulose from bagasse, reeds and cocofiber made by the Okhamafe method is through immersion in HNO3 3.5%, bleaching using sodium hypochlorite 1.75% and purification with 17.5% NaOH. The second stage is the mixing of polypropylene and α-cellulose, PP-g-MA as coupling agent (polypropylene grafted maleic anhydride) and divinyl benzene (DVB) as a crosslinking agent and benzoyl peroxide (BPO) as an initiator. Characteristics of mechanical properties is done by the tensile test. The results showed that the polymer composite that has the best mechanical properties, namely with α-cellulose bagasse tensile test value 57.9114 N / m2 and elongation value of 8.9531%

KEYWORDS : α-Cellulose, Composite Polymer, bagasse, Cocofiber, Polypropylene, reeds

1. INTRODUCTION

The manufacturing industry is now widely used composite material as raw material. For that expected their composite materials that are environmentally friendly and can be recycled has become the current demands. The composite material is now widely reinforced with filler such as natural fibers and also provided a more environmental friendly properties. When added to thermoplastics, natural fibers give effect to its low cost, as the reinforcement that is renewable also improve the mechanical properties such as stiffness, strength and heat deflection under load.[1]

Many research about composite critically consider regarding the effective use of natural fibers in composite structures and a viable alternative fibers, which have the advantages of high toughness, ease in processing and separation, and biodegradability [2].

The effect of cellulose as reinforcement of thermoplastic mixed by moulding injection showed a significant increase in mechanical properties due to the adhesion of the polymer matrix[3]. Cellulose selected as a filler of a polymer based on several reasons, such as the price is relatively cheap compared to synthetic materials like glass fiber and its ability to be recycled so it does not cause environmental pollution [4].

[1] Clemons,C.M. 2002.Microstructural Effects on The Dynamic Fracture Toughness of Cellulose Fiber Reinforce Polypropylene. Ph.D. Disertation. USA : Univ. Of Wisconsin-Madison.

[2] Wang, S. 2006. Proceeding of International Conferences on Nanotechnology for The Forest Product Industry. Mariott Marquis : Atlanta

[3] Ganster, J. Fink, H.P., and Pinnow, M., 2006. High-tenacity man-made Cellulose Fibre Reinforced Thermoplastics-Injection Moulding Coumpounds with Polypropylene and Alternative Matrices. Fraunhofer Institute for Applied Polymer Science, Geiselbergstr, Germany.

[4] Eichhorn, S. J. 2001. Review Current International Research Into Cellulosic Fibres and Composit. Journal of Materials Science. Kluwe Academic Publisher : Menchester

α-cellulose empirically is a fraction of cellulose molecules with different molecular weights. High lignin content in the wood which is a source of α-cellulose must be eliminated first. Isolation of α-cellulose initially by determining of holoselulosa using chlorine and chlorite method then added alkali to remove hemicellulose. The residue of the process is α-cellulose[5].
α-cellulose used in this research of polymer composite was from plant waste such as bagasse (Saccharum officinarum), alang-alang (Imperata cylindrica) and coir fiber coconut (Cocos nucifera). Where the results of the research are expected to increase the economic value of the plant waste.

2. MATERIALS AND METHOD

A. Preparation of α-Cellulose

Each sample: bagasse, reeds and coconut coir fiber is cleaned by soaking in water for 2 hours then dried in the sun. Once dried mashed up into powder. 75 grams of each powder sample was added 1000 ml HNO3 3.5% containing 10 mg NaNO2. Immersed for 2 hours in a water bath at a temperature of 80^0 C and then washed and filtered. Digested with 750 ml 2% NaOH and Sulfites Na 2% at 50 ° C for 1 hour and then washed and filtered. Bleached with 500 ml of Na hypochlorite 1.75% for half an hour at 100 ° C, then washed and filtered again. Added 500 ml of 17.5% NaOH. And heated at a temperature of 80 ° C for half an hour. Washed with water until pH neutral. Bleached with 500 mL of 1.75% sodium hypochlorite at a temperature 100^0C for 5 minutes. Washed until the filtrate is clear, then filtered and squeezed. Dried at 60 ° C. Stored in a desiccator.

B. Formation of Polymer Composites

Weighed a 93% pure PP powder, 0.5% powder PP-g-MA, 0.5% BPO, 1% DVB and 5% α-cellulose powder bagasse (w / w). Mix in a glass beaker and stirred with a blender to be homogeneous. Then printed by hot press. Do the same procedure for cellulose reeds and coco fiber. Table I shows the variation of composition and mass of polymer composites.

Table 1. Variation of composition and mass of Polymer Composites (w / w)

No.	Komposisi dan Massa
1	PP: α-selulosa AA: PP-g-MA : BPO : DVB (93 :5 : 0,5: 0,5 :1)
2	PP: α-selulosa AT: PP-g-MA : BPO : DVB (93 :5 : 0,5: 0,5:1)
3	PP: α-selulosa SK : PP-g-MA : BPO : DVB (93: 5: 0,5 :0,5 : 1)

C. Test of Mechanical Properties

Testing of mechanical properties of the polymer composites made by the tensile test. Trimmed the specimen results films with a thickness of 0.2 mm to form the test specimen elongation (tensile test). Then is clamped the both end of specimen at elongation testing tool and note the change in length (mm) with great speed of 50 mm / min. Figure 1 below is a test specimen tensile strength based on ASTM D-638-72-Type IV.

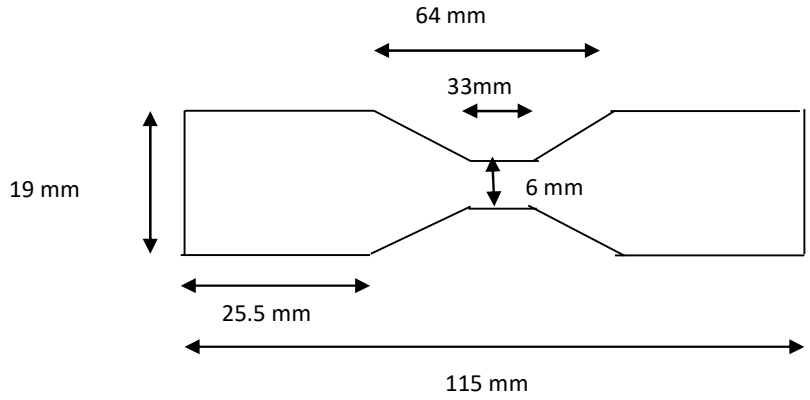

Figure 1. Specimen Tensile Strength Testing Based on ASTM D-638-72-Type IV

3. RESULT AND DISCUSSION

Results of testing the mechanical properties such as tensile tests on polymer composites can be seen in Table 2.

Table 2. Results Determining Tensile Strength and elongation Composite Polymers

[5] Yusuf, M. 2004. Perubahan Kadar Air, Ca, dan α-selulosa Tandan Kosong Sawir Selama Pengomposan Menggunakan Limbah Cair Pabrik Kapa Sawit. Tesis. Medan : USU

No.	Komposisi dan Massa	Kuat Tarik (σt) (N/m^2)	Kemuluran (%)
1	PP: α-selulosa AA: PP-g-MA : BPO : DVB (93 :5 : 0,5: 0,5 :1)	34,0407	14,3906
2	PP: α-selulosa AT: PP-g-MA : BPO : DVB (93 :5 : 0,5: 0,5:1)	57,9114	8,9531
3	PP: α-selulosa SK : PP-g-MA : BPO : DVB (93: 5: 0,5 :0,5 : 1)	51,9606	9,0625

Differences in tensile strength and elongation of each composite polymer with α-cellulose filler is supported by previous studies (Bledzki, 1999) which showed that the tensile strength varies greatly depending on the type of fiber under test [6].
Based on the determination of tensile strength and elongation result on the variation of composition and mass, the polymer composites which have a maximum mechanical when the PP: α-cellulose bagasse: PP-g-MA: BPO: DVB (93: 5: 0.5: 0, 5: 1), ie 57.9114 N / m2, and elongation values are low at 8.9531%.
If linked to the molecular weight of α-cellulose from each sample, indicating that the higher molecular of α-cellulose the less optimal bonding that occurs, so that when the load is given to the composite when the tensile test, the load can not be split evenly so that led to the decline in value tensile strength

4. CONCLUSION

Based on research conducted, polymer composites with PP ratio: α-cellulose bagasse: PP-g-MA: BPO: DVB (93: 5: 0.5: 0.5: 1) have high mechanical properties, which is 57.9114 N / m2 and elongation value is 8.9531%. The addition of α-cellulose as a filler that is reinforcement in polymer composites is suggested to strengthen the mechanical properties and produces environmental friendly polymer composites.

REFERENCES

[1] Clemons,C.M..Microstructural Effects on The Dynamic Fracture Toughness of Cellulose Fiber Reinforce Polypropylene. Ph.D. Disertation. USA : Univ. Of Wisconsin-Madison. 2002
[2] Wang, S.. Proceeding of International Conferences on Nanotechnology for The Forest Product Industry. Mariott Marquis : Atlanta. 2006
[3] Ganster, J. Fink, H.P., and Pinnow, M.,. High-tenacity man-made Cellulose Fibre Reinforced Thermoplastics-Injection Moulding Coumpounds with Polypropylene and Alternative Matrices. Fraunhofer Institute for Applied Polymer Science, Geiselbergstr, Germany.. 2006
[4] Eichhorn, S. J. Review Current International Research Into Cellulosic Fibres and Composit. Journal of Materials Science. Kluwe Academic Publisher : Menchester. 2001.
[5] Yusuf, M. Perubahan Kadar Air, Ca, dan α-selulosa Tandan Kosong Sawir Selama Pengomposan Menggunakan Limbah Cair Pabrik Kapa Sawit. Tesis. Medan : USU. 2004.
[6] Bledzki, A. K. , and Gassan, J. Prog. Polym Sci. 24 : 221-274. 1999

[6] Bledzki, A. K. , and Gassan, J. 1999. Prog. Polym Sci. 24 : 221-274