Journal of Materials Science and Chemical Engineering, 2015, 3, 190-195
Published Online July 2015 in SciRes. http://www.scirp.org/journal/msce
http://dx.doi.org/10.4236/msce.2015.37025

Environmental Friendly Lightweight Material from Natural Fibers of Oil Palm Empty Fruit Bunch

Andy Cahyaputra Arya[1], Rully Ario Dewanto Soeriaatmaja[2], Dorina Hetharia[1], Indra Surjati[1], Barlian Nasution[3], Revina Devi Rubijono[3], Yohanes Priadi[3]

[1]Fakultas Teknologi Industri, Universitas Trisakti, Jakarta, Indonesia
[2]Fakultas Seni Rupa dan Desain, Universitas Trisakti Kampus A, Jakarta, Indonesia
[3]PT. Regasis Dana Asia, Rasuna Office Park, Jl. H. R. Rasuna Said, Jakarta, Indonesia
Email: arya@trisakti.ac.id

Received 20 March 2015; accepted 9 July 2015; published 16 July 2015

Abstract

Indonesia is the most producer of crude palm oil (CPO) worldwide with production more that 25 million tons in 2013. Through increasing production of CPO the wastes generated are growing up as well. The empty fruit bunch of oil palm (EFB) is one of the solid waste (biomass) which is generated at the palm oil mill. Its amount is equivalent to the CPO production, but only about 50% of its weight are good fibers for further usage as industrial raw material. The EFB fiber consists an interesting honey comb/lightweight structure. By mixing the EFB natural fiber with bio binding agent based on potato the environmental friendly materials (biocomposites) can be produced which are 100% biodegadrable. The biocomposites with 2 mm thickness have strengthness about 7 GPa according to the 3 points bending test standard of DIN 53 457. After coating process the environmental friendly lightweight materials with density less than 0.4 g/cm^3 will be ready to be implemented for different technical applications.

Keywords

Biodegradable Material, Empty Fruit Bunch of Oil Palm, Honey Comb, Natural Fibers for Technical Applications

1. Introduction

By the production of crude palm oil (CPO) the empty fruit bunches (EFB) will be generated as solid waste (biomass) at the palm oil mill. The amount of EFB is equivalent to the amount of CPO production. It meaans, there was about 26.9 million tons of EFB available in Indonesia or about 54.39 million tons in the world [1] in year 2013. EFB is a potential raw material and the interest on using the biomass for the commercial and technical products must be awaken. This huge amount of EFB unfortunately still can not contribute an added-value as commercial and technical applications. The utilization of EFB are sofar such as for animal feed [2], compost

How to cite this paper: Arya, A.C., Soeriaatmaja, R.A.D., Hetharia, D., Surjati, I., Nasution, B., Rubijono, R.D. and Priadi, Y. (2015) Environmental Friendly Lightweight Material from Natural Fibers of Oil Palm Empty Fruit Bunch. *Journal of Materials Science and Chemical Engineering*, **3**, 190-195. http://dx.doi.org/10.4236/msce.2015.37025

[3], briquettes [4], particle board [5]. The utilization of this biomas fit to the issue of the restricted available raw materials and the increasing ecological issues. A simple technology to utilize this biomass is developed and already patented in year 2011 [6] where it consists of 3 main stages such as thee processing material definition/ characterization, the processing development, and the the pre-product or end-product characterization [7]. This natural fibers can be used as the base material for environmental composites which mixed with binding agent from potato and they can be implemented furthermore to be parts of interior, exterior vehicles, even bullet proof material and as filler for different appliances and as substitution for the synthetic, mineral, metal which are not renewable. The advantages of these products in comparasion to ceramic or synthetic where its manufacturing process is simple and consumes less energy but the composite has good mechanical properties such as modulus of elasticity (E) by more than 7 GPa (more than plastics) with temperature resistance until 230˚C and the natural characteristic to absorbe the noise [8]. The density of the composites can be produced by 0.4 g/cm^3, it is a lightweight material with good mechanical property.

2. Materials and Method

2.1. Materials

2.1.1. Raw Material of Empty Fruit Bunch of Oil Palm

The empty fruit bunch of oil palm (EFB) have been taken from palm oil mill at PTPN VIII, Kertajaya which is located in Lebak, Banten, Malimping, West Java. The EFBs are solid waste at that palm oil mill. After the thresing process which separates the fruits from the bunches as solid waste. The EFBs would be transported by using truck with load abot 7 - 8 tons to Jakarta. The EFBs will be fiberized manually. The burnt fibers, thorns, leaves, dust will be seperated. The only good fibers will be chosen as raw material.

2.1.2. Binding Agent

The binding agents are made from potato. The potato (1) will be firstly washed with water (2) and then cutted into slices (3). The slices will be blended to be mash potato in a blender (4). The mash potatos (5) will be dryed

Figure 1. EFB discharging.

Figure 2. EFB storage.

by using air conditioning condensor (6) (7) by about 60˚C fro about 24 hours. The dryed mash potatos will be blended again in ablender to be powder. The powder is the raw material for binding agent.


(1)


(2)


(3)


(4)


(5)


(6)

(7)

2.2. Methods

-SNI 03-2105-2006 Papan Partikel [9] is the standard which will be used to produce the samples for 3 points bending test.

-DIN 53 457 for 3 points bending test [10] where the test place is climated at 50% humidity, 24˚C room temperature by using climatic room equipment. The climated condition is with aims to avoid the reduction of material strength because of humidity absorption.

3. Developed Technology

The Empty Fruit Bunch (1) will be fiberized manually by hands (2) and will be separated from other components of bunch such as leaves, rest fruits, thorns, particle, dust and burnt fibers. Only good fibers (3) will be used as raw material for the composite production. From the potato powder will be produced binding agent (4) by cooking the powder in warm water. The mixed fibers with binding agent will be filled into forming box (5) and the pressed (6) to get a quader which is called as prepregs (7). The prepregs will be dried b using dryer at 90˚C for about 2 hours or under sunshine or again behind the aircon condensor for about 4 hours. By using hot press machine (10) the prepregs will pressed by temperature of 150˚C, by press duration of 5 minutes and a enviromental friendly composite (11) is the output.


(1)


(2)


(3)


(4)


(5)


(6)


(7)


(8)

(9)

(10)

4. Mechanical Property

Related to DIN 53 457 [10] would be run and at parameters as shown at **Table 1** below where the thickness of the samples by 2 mm.

The equation used to gain the test result in unit of GPa as Modulus Elasticity the formula is as followed

$$E = \frac{1}{4}\frac{F}{f}\frac{l_v^3}{b\,d^3}$$

where

F: Force [N];
lv: Span [mm];
f: Deflection [mm];
b: Width in mm;
d: Thickness in mm.

The 3 points bending test of the composites runs by using Zwick Machine which can be used for both tests tensile and press. Software testXpert V. 11.02 helps to record the test datas force and the deflection. The movement of the test will be displayed at the monitor and it shows a graph. The datas can be converted into other file format such as for MSExcel.

Figure 3. Bending Test Equipment (Zwick Machine, PC).

Table 1. Test Parameters of 3 Points Bending Test according to DIN 53 457.

Sample Thickness d (mm)	**Sample length** l_p (mm)	**Span** l_v (mm)	**Sample Width** b (mm)	**Radius of Crosshead** r_1 (mm)	**Radius of the support** r_2 (mm)
1.0 ≤ h ≤ 2.5	50	40	10 ± 0.5	5.0 ± 0.1	2 ± 0.2
>2.5 ≤ h ≤ 3.0	(20 ± 1) × h	(16 ± 1) × h	10 ± 0.5	5.0 ± 0.1	2 ± 0.2
>3.0 ≤ h ≤ 10.0	(20 ± 1) × h	(16 ± 1) × h	10 ± 0.5	5.0 ± 0.1	5 ± 0.2

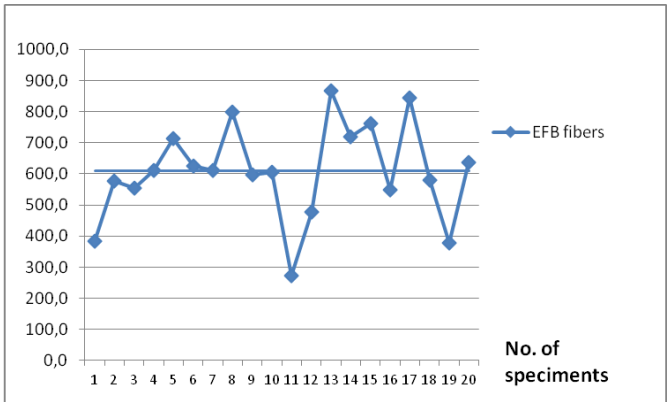

Figure 4. Bending test of environmental friendly composites from EFB fibers.

The Gauβ-Distribution method selected the valid datas where located outside position of 5% will be declared as invalid.

5. Conclussion

The environmental friendly composites produced have the strengthness by 7.3 GPa (in average) where its density (ρ) is by 0.4 g/cm^3. So that the results showed that the samples are very good material which can be implemented furthermore for parts of vehicles interior and exterior as well where they are light but robust. The composite produced are lightweight construction material where the fiber of EFB has a honey comb structure.

Acknowledgements

Please allow me to dedicate my acknowledgment of gratitude toward the following significant contributors. I would like to thank

-"Koordinasi Perguruan Tinggi Swasta Wilayah III, Kementerian Pendidikan dan Kebudayaan, Indonesia" for the research project "Riset Andalan Perguruan Tinggi dan Industri" (RAPID) with the title of "Pemanfaatan Serat Tandan Sawit sebagai Komponen Anti Peluru Kendaraan Patroli", research period 2013-2015 for the funding.

-Mr. Barlian Nasution as President Director of PT. Regasis Dana Asia and all colleguages at this company who have provided us with fruitful knowledge about armoured vehicles and supported us all out in real manufacturing processes.

-Prof. Dr.-Ing. J.-P. Majschak at the "Professur für Verarbeitungsmaschinen/Verarbeitungstechnik", Fakultät Maschinenwesen Institut für Verarbeitungsmaschinen und Mobile Arbeitsmaschinen, TU Dresden, Germany for the cooperation so that it was possible for the research team to use the equipments which are available in laboratories at TU Dresden, Germany.

I sincerely thank to my wife, parents, friends, all scientists member at our RAPID team, Prof. Agus Budi Purnomo as Director of Lembaga Penelitian Universitas Trisakti and all staffs as well as the university leaders (Rector, Vice Rectors) at Universitas Trisakti who encourage us, provide the advice and financial support. The product of this research paper would not be possible without all of them.

References

[1] FAO (2015) FAOSTAT Domains, Production; Crops Processed. http://faostat3.fao.org/download/Q/QD/E

[2] Rohaeni, E.S., Hamdan, A. and Subhan, A. (2005) Peluang Pemanfaatan Limbah Sawit Untuk Penggemukan Ternak Sapi. Lokakarya Pengembangan Sistem Integrasi Sawit-Sapi. Indonesia.

[3] Yunindanova, M.B., *et al*. (2013) The Effect of Maturity Level of Empty Fruit Bunch Compost and Mulch from Palm Oil Waste to Tomato Productivity in Ultisol Soil. *Sains Tanah—Jurnal Ilmu Tanah dan Agroklimatologi*, **10**.

[4] Bakar, N.A., *et al*. (2010) Briquetting of Empty Fruit Bunch Fibre and Palm Shells Using Piston Press Technology. MPOB Informatio Series. Malaysia.

[5] Amani, S.A.K., *et al*. (2001) Laporan Akhir Penyelidikan “Particleboard From Oil Palm Empty Fruit Bunch Fibers”. UiTM Syah Alam. Malaysia.

[6] Arya, A.C. (2011) Proses Pembuatan Material Komposit Ramah Lingkungan dari Serat Tandan Sawit dan Perekat Alami. Paten No. P00201000655. Universitas Trisakti. Indonesia.

[7] Arya, A.C., Erwinsyah, Goldhahn, H. and Guritno, P. (2002) Feasibility of EFB Fibers for Lightweight Construction. International Oil Palm Conference (IOPC), Bali.

[8] Arya, A.C. (1998) Utilization of Oil Palm Empty Fruit Bunches for Technical Application. International Oil Palm Conference (IOPC), Bali.

[9] SNI 03-2105-2006 (2006) Papan Partikel. Badan Standarisasi Nasional.

[10] DIN 53 479 (1976) Prüfung von Kunststoffen und Elastomeren.