

Effect of Liquid Rubber Compound on the Physicochemical Properties of Particle Board from Coconut Frond Powder

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ABSTRACT: Particle board research made from coconut frond powder with various concentration of liquid rubber compound has been done. First particle board was made by mixing 50 mesh of coconut frond powder with various concentration of liquid rubber compound there are 25; 30; 35; 40 and 45 % to obtain a particle board with the length, width and height of 5 x 10 x 7.5 cm and then dried by drying. Subsequently the particle board pressed to a thickness of 2.5 cm and then tested the modulus of rupture (MOR), the modulus of elasticity (MOE), the Screw Hold Strength and water absorption. The results indicated that the best condition was obtained on the use of 45 % of liquid rubber compound. In this condition, the value of MOR, MOE, screw hold strength and water absorption are 1436.16 g/ mm², 2354.38 g/ mm², 5.2708 N/ cm² and 41.85% respectively.

INTRODUCTION

The particle board is a board made of wood particles or other lignocellulose materials bonded with an adhesive and then heat-treated [1]. The advantages of this particle board is the size and density can be tailored to the needs in addition to the quality can be set. In addition, the particles used can be obtained from materials that are generally waste that has been no longer used [2-5].

One of the lignocellulose materials that can be used to make particle board is coconut fronds powder that has been separated from the coconut fronds [6-8]. Coconut fronds is widely available throughout Indonesia, which is the world's major coconut producer and is a largely untapped waste material. As the adhesive for the particle board manufacture in this research will use of natural polymer in the form of liquid rubber compound which is a mixture of concentrated latex with certain chemicals to improve its properties [9-11]. As a raw material of liquid rubber compound is concentrated natural rubber latex which is also very much available in Indonesia considering Indonesia is the second of natural rubber producer in the world, so the sustainability of the production of particle board derived from concentrated latex and coconut fronds for the long term will not experience raw material constraints.

The existing problem is research on particle board making by utilizing particle from coconut fronds powder and adhesive from liquid rubber compound so far has not been done, because coconut fronds is only seen as the waste material from coconut plant. So the research of production and characterization of natural composite polymer of coconut fronds powder and liquid rubber compound as alternative of particle boards become very interesting to do.

The purpose of this research was to study the effect of liquid rubber compound percentage on physicochemical properties of particle board. Determination of physical properties of particle board was done by determination the change value of the modulus of elasticity

(MOE), the modulus of rupture (MOR) and the screw hold strength. As for the chemical properties testing is done by determining the water absorption and testing with FTIR.

RESULT AND DISCUSSION

Modulus of Rupture (MOR) Test Result

The modulus of rupture (MOR) test results of particle board at various percentages of the liquid rubber compound are as shown in Figure 1.

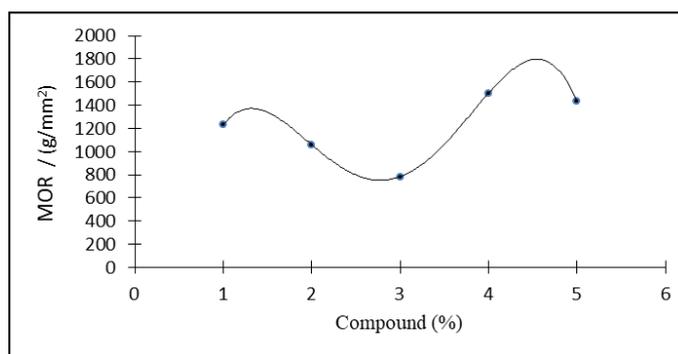


Figure 1. Modulus of Rupture of Particle Board at Various percentages of Liquid Rubber Compound

From the picture above shows that the value of the modulus of rupture (MOR) of the particle board increase on the greater percentage of liquid rubber compound, reaching maximum at the use of 45%. This indicates that the particle board made has the highest strength when 45% of the liquid rubber compound is used. This is because in this condition the reaction that occurs between polyisoprene in liquid rubber compound with cellulose from coconut fronds powder maximum so that the polymer formed becomes the strongest. At lower percentages, the bonds that have not been maximal. In this condition the value of MOR particle board is 1436.16 g / mm².

Modulus of Elasticity (MOE) Test Result

The results of modulus of elasticity (MOE) tests on various percentage of the liquid rubber compound are as shown in Figure 2.

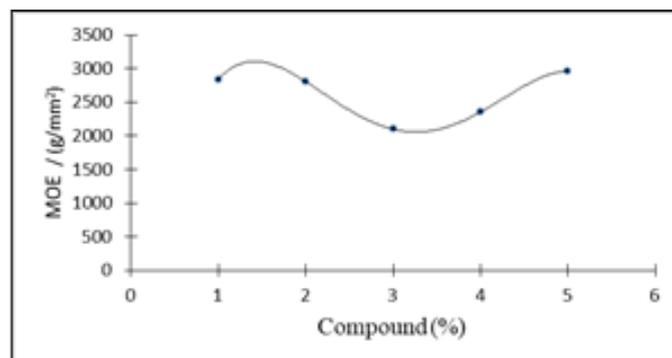


Figure 2. Modulus of Elasticity of Particle Board on Various percentages of Liquid Rubber Compound

From the picture above shows that the modulus of elasticity of the particle board increases with the greater percentage of liquid rubber compound used, reaching maximum on the use of liquid rubber compound by 45%. This is because in this condition the reaction that occurs between polyisoprene in liquid rubber compound with cellulose from coconut fronds powder is optimum so that the polymer formed becomes the most elastic. At lower percentage, the bonds that have not been maximized. This showed that at 45% of the liquid rubber compound percentage the particle board is made to show the highest flexibility. In this condition, the modulus of elasticity of the particle board is 2354.38 g / mm².

Test Results of Screw Hold Strength

The result of testing the screw hold strength on the particle board at various concentrations of the liquid rubber compound is as shown in Figure 3.

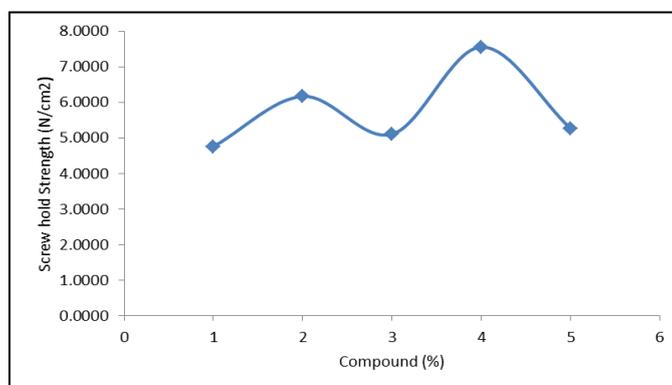


Figure 3. Screw Hold Strength of Particle Board on Various percentages of Liquid Rubber Compound

From the picture above shows that screw hold strength of particle board is increased on increasing the percentage of liquid rubber compound and reaching the maximum value on the use of liquid rubber compound of 40% then decrease at higher concentration. At the best conditions the value of screw hold strength is 7.5555 N / cm². This is because the higher the percentage of liquid rubber compound as an adhesive, the number of bonds that occur between polyisoprene from rubber and lignocellulose from coconut frond powder is increasing so that the bonds that occur are tighter and consequently can hold the screw better.

Water Absorption

The result of water absorption test on the particle board at various percentages of the liquid rubber compound is as shown in Figure 4. From the Figure 4, it can be seen that the water absorption capacity of particle board is getting smaller when using liquid rubber compound with a higher percentage. This is because the higher the percentage of liquid rubber compound used, the bond that occurs between polyisoprene and lignocellulose is getting tighter and this results in a smaller number of water molecules that can enter between these bonds, so that the particleboard is more resistant to water.

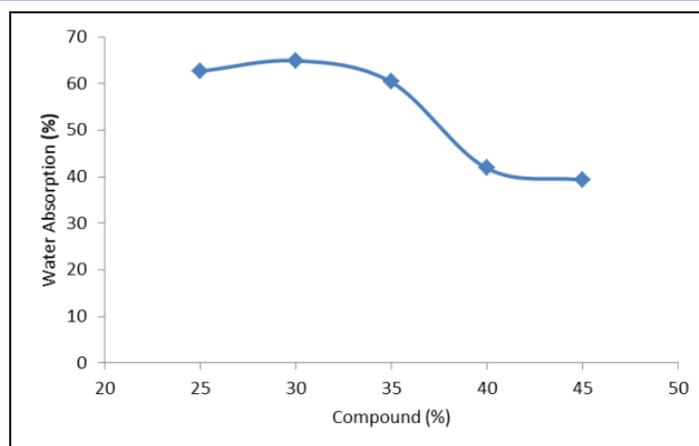


Figure 4. Water Absorption of Particle Board on Various percentages of Liquid Rubber Compound

FTIR Test Result

The result of FTIR test on the particle board at various percentages of the liquid rubber compound is as shown as spectrum in Figure 5. From the FTIR spectrum of particleboard made from coconut frond powder with liquid rubber compound above, it can be seen that there are several functional groups derived from the bond between lignocellulose from coconut frond powder and polyisoprene from liquid rubber compound. The wide and sharp absorption peak at a wavenumber of about 3400cm^{-1} is the absorption of the hydroxyl group from lignocellulosic coconut frond powder. Strong absorption at wavenumber around 2900 cm^{-1} which is strengthened by absorption at 1350 cm^{-1} and 1400 cm^{-1} is the absorption of the C-H bond. The presence of strong absorption at wave numbers around 1050 cm^{-1} indicates the presence of C-O bonds. The presence of strong absorption at wave numbers around 1600 cm^{-1} indicates the presence of a C=C bond.

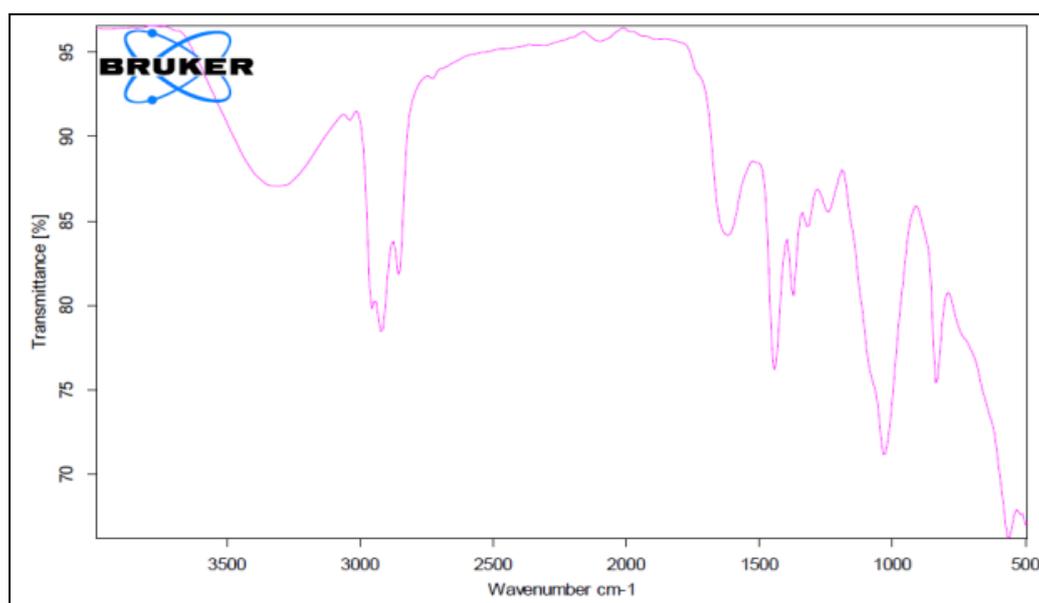


Figure 5. FTIR Spectrum of Particle Board on Various percentages of Liquid Rubber Compound

CONCLUSION

The percentage of liquid rubber compound greatly affects the chemical and mechanical properties of particle board. The best condition was obtained on the use of liquid rubber compound with percentage of 45%. Under the best conditions the value of MOR, MOE, screw hold strength and water absorption are 1436.16 g/ mm², 2354.38 g/ mm², 5.2708 N/ cm² and 41.85% respectively.

MATERIAL AND METHOD

The experiment begin with the separation of coconut fronds powder from coconut fronds, then continued to the coconut frond powder filtration process to obtain a 50 mesh powder. Then the particle board test pieces with a size of 10 x 5 x 7.5 cm were made by mixing coconut fronds powder with liquid rubber compound in various percentages namely 25%, 30%, 35%, 40% and 45% then dried. The next step is to test the mechanical and chemical properties of particle board that have been made include modulus of elasticity (MOE), modulus of rupture (MOR), screw hold strength, water absorption dan FTIR in accordance with SNI 03-2105-2006 with prior pressing particle board to obtain a thickness of 2.5 cm. The experiment of making particle board and testing about water absorption dan FTIR were done in chemistry laboratory, Faculty of Mathematics and Natural Sciences, University of Bengkulu, while for testing of MOR, MOE and screw hold strength were done in laboratory of material, Faculty of Mechanical Engineering Gadjah Mada University Yogyakarta.

DECLARATION

There is no conflict of interest from authors for this research.

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REFERENCES

- [1] Wulandari, F.T., (2013) *Composite Board Products Using Non-Wood Waste*. Media Bina Ilmiah, 7(6), 1-4
- [2] Mawardi, I., (2009) *Quality of Particle Board from Palm Wood (PSC) Based on Polystyrene Adhesive*. Jurnal Teknik Mesin, 11(2), 91-96.
- [3] Setyawati, D.; Hadi, Y.S.; Massijaya, Y.; dan Nugroho, N., (2008) *Quality of Particle Board from Palm Wood (PSC) Based on Polystyrene Adhesive*, Jurnal Penelitian Universitas Tanjungpura, X(2), 88-101
- [4] Wahyudi. H. A.; Wiradarya, T. R.; dan Iskandar, M.I. (2005) *Particleboard Mechanical Properties of Fleece, Sawdust, and Sengon (Paraserianthes falcaria) Wood Shavings*, Skripsi, Departemen Ilmu Produksi dan Teknologi Peternakan, Fakultas Peternakan, IPB, Bogor
- [5] Sunariyo, (2008) *Characteristics of Polypropylene Thermoplastic Composites with Coconut Coir Fiber as a Substitute for Wooden Pallets*, Tesis, Sekolah Pascasarjana USU, Medan.
- [6] Chekmae, S., (2016) *Utilization of Waste Coconut Trunk Powder as Raw Material for Particle Board with Citric Acid Adhesive*. Tesis. Universitas Gadjah Mada. Yogyakarta.
- [7] Sutanto, T.D.; Banon, C.;Trihadi, B.; dan Damayani, N.F., (2021) *Effect of Grain Size Coconut Frond Powder on The Strength of Particle Board*, Journal of Physics: Conference Series. , 1940 (2021) 012043 doi:10.1088/1742-6596/1940/1/012043 IOP Publishing
- [8] Sudarsono; Rusianto, T.; dan Suryadi, Y., (2010) *Manufacturing of Particle Boards Made from Coconut Coir with Natural Binders (Copal Glue)*, J. Teknologi, 3,1,22-32.
- [9] Anom I Dewa K., (2009) *Cocofoam Production and Characterization from Coconut Fiber*. Laporan Penelitian Mahasiswa S3 Kimia UGM, Inpress.
- [10] Subiyanto, B.; Saragih, R.; dan Husin, E., (2003) *Utilization of Coconut Coir Powder as Water and Oil Absorbing Material in the Form of Particle Board Panels*, J. Ilmu dan Teknologi Kayu Tropis, 1,1, 26-34.
- [11] Kanmani, P.; Karuppasamy, P.; Pothiraj, C.; and Arul, V., (2009) *Studies on Lignocellulose Biodegradation of Coir Waste in Solid State Fermentation using Phanerocheate Chrysosporium and Rhizopus Stolonifer*, Afr. J. Biotechnol., 8, 24, 6880-6887.