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Mechanical Properties of Oil Palm Trunk By Reactive Compregnation Methode with Dammar Resin

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Abstract: The research about compregnation reactive of oil palm trunk (OPT) has been done. The aim of this research is to achievement the quality of reactive compregnation OPT with the dammar resin. This research has been made in several steps such as preparation of the sample of OPT, resin preparation, the process of compregnation of OPT and characterization of OPT by using mechanical test, FTIR, SEM and TGA. Compregnation of OPT with dammar resin was done by using various concentration. Dammar resin with different concentrate has been diluted in methanol and was compregnation in OPT pore which shape 15x2x2 cm3 whichlaid in modified compregrator which has -0.2atm pressure for about 5 minutes. According to mechanical test of OPT, it has resulted that the mechanical properties optimum of OPT for the 20% dammar resin the value modulus of elasticity (MOE) 195,829 MPa. From the test of TGA is seen that the nature of OPT thermal is achieved. It can be seen from degradation of palm oil trunk from 200^0C to 250^0C with 20% dammar resin. From the analysist of SEM, morphology of OPT after compregnation become closer and solid because the pore of OPT has been fulfill with dammar resin. From the mechanical test and thermal gravimetry analisys, it has been found that OPT from the result of compregnation has higher mechanical nature and thermal stability compare to OPT before compregnation.
Key Words: Oil Palm Trunk, mechanical properties, reaktive compregnation, dammar resin.

1. Introduction

Palm oil plantation in Indonesia has produce many solid waste OPT, mean while the utilization of this waste still limited and in low quality, not homogenous and easy to be broken because of weather and insect [1]. During the rejuvenation plants there are many OPT have been provided [2]. It makes the availability of OPT will be every year because the rejuvenation of plant oil palm has done continuously. OPT has potential as substitute of furniture industries or wood carpentry. The use of OPT as substitute of convensional wood should be considered because OPT has big potential and oil palm trunk has already identification as one of potential biomass for industy based wood [3].

[4] has done impregnatitation on solid wood by using polyethylene and saying that pressure and temperature can give significantly contribution to polimer retention and hardnes. [5] has done impregnatitation to find the power of the wood and saying that the elasticity of the wood has achieved. Liquid such as water and compound with molecular weight can be absorp in the wood's cell [6], so that resin can be penetrate inside cell. As a result it can paste and fill the empty pores [7].

Dammar is a pure resin which produce from *Dipterocarpaceae* and *Burseraceae*. Dammar is used in many industries such as paint fabrication, wax, plastic, insulator material,mix, material varnis, food industry and medicines [8]. Tradisionally, resin has been used as adhesive material and dye. It also has been used for

caulking the boat since resin is not soluble in the water. Resin from cat's eyes type has been used for adhesive materal for boat.

2.Experimental

2.1 Materials

The main object for this research is OPT which has been taken from the adult one (year 25 above) and it has height 2-7 meteres. It has cut by using radial machine from the outside,from Aek Pancur plantation of North Sumatera. The type is Dura, which is mostly 10 metres and it has 35 cm of the dimetre. Dammar resin and Methanol (Merck).

2.2 Preparation of Oil Palm Trunk (OPT)

Sample of OPT can be divided from outer, middle and core. The sample which use for this research is taken from the edge of the middle part as mention in Fig.1, this sample has been dried in the open air for 30 days. The sample specimen has been cut which suitable with the measure of ASTM D360.

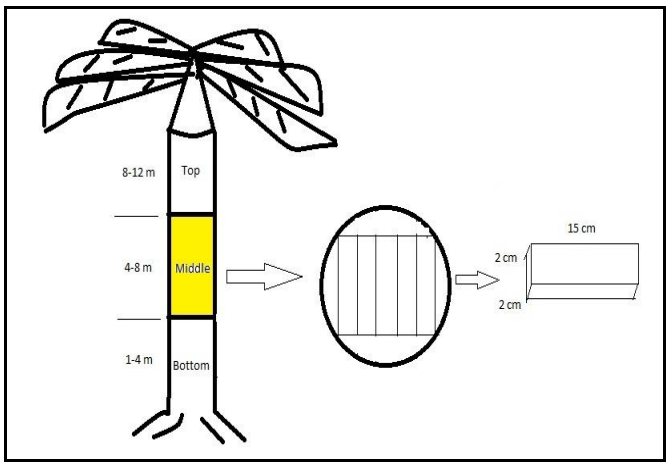

Fig. 1. Sceme of radial cutting of OPT

2,3. Preparation of dammar resin

There are 20 gram dammar dissolved in 80 gram of methanol stir until immerse, precipitate for a night and then it filtered. This method also used for dammar resin of 30% and 40%.

2.4. Reactive Compregnation Oil Palm Trunk

The edge of OPT which already shaped as a specimen 14x2x2cm was infused inside the chamber compregnation's tool. Resin has poured to the oil palm trunk so that this oil palm trunk will be drown about 1cm from the surface of oil palm trunk . The compregnation has covered with the lit so that it will vacuum and it clamps so that the lit will be stable in its position. Then it vacuum to put the resin in the pore of oil palm trunk for a certain time and it arrange a certain time for the operation of compregnation where the various of the resin are 10 %, 20%, 30% and 40%, with a stable time and pressure. OPT the result of compregnation out from the chamber and it will be characterized.

2.5. Characterizations

The testing performing were Mechanical Analysis for modulus of rupture (MOR)and modulus of elasticity (MOE), Fourier Transform Infrared (FTIR) and Scanning Electron Microscopy (SEM) for structure and morphology analysis, Thermal Gravimetry Analysis (TGA)

Specimen of KKS before and after compregnation will characterise its nature of mechanic which include test of MOR and MOE. By having pull tested device,Universal Testing Machine Gotech AL-7000 M, with speed test 5 mm/minutes. Thermal Gravimetry Analysis (TGA) by using SDT Q600 V20.9 Build 20, the analysis of accidence and Scanning Elektron Microscopy (SEM)used TM 3000 and cluster of analysis funcion (FT-IR)with Perkin Elmer Spektrum Version 10.03.07.

3. Results and Discussion

3.1 Mechanical Analysis

3.1.1. Result characterization of mechanical properties OPT-Dammar resin

The mechanical properties of wood usually discuss about modulus of rupture (MoR) and modulus of elasticity (MoE). Stress-strain graph of OPT-dammar resin can be seen in Fig. 2 which shows that the optimum conditions for dammar resin is 20%, because it gives the highest value of modulus of elastisity of 195.83 MPa (Table 1).

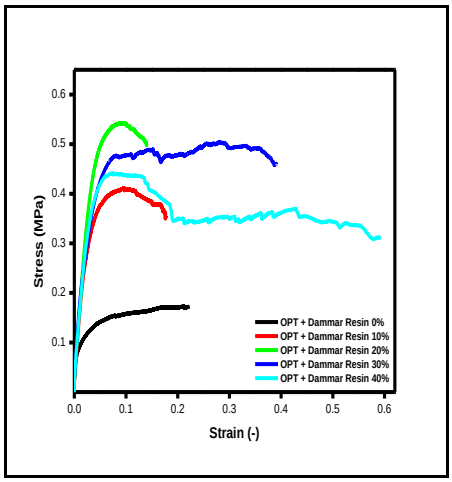

Fig. 2. Stress- strain graph of OPT compregnation at various concentration dammar resin

Modulus of Elasticity determines the rigidity of wood, where high rigidity caused the wood is not easy to be elastic during the process in the machine so that the accuracy of the wood product can be higher. The dynamic characteristic of wood also determine from the modulus of elasticity. The wood which easy to be vibrated during the process of machinery will cause the surface of the wood become rough [9]. The value of modulus of Rupture (MoR) and modulus of elasticity (MoE) from OPT-dammar resin can be seen in Table 1.

Table1. Mechanical properties of OPT-dammar resin, the comppregnation of dammar resin variation to modulus of rupture and modulus of elasticity of OPT

No	Dammar Resin (%)	MoR (MPa)	MoE (MPa)
1	OPT - dammar resin 0%	2,417	113,538
2	OPT - dammar resin 10%	2,997	140,217
3	OPT - dammar resin 20%	4,074	195,829
4	OPT - dammar resin 30%	4,619	164,705
5	OPT - dammar resin 40%	2,627	139,441

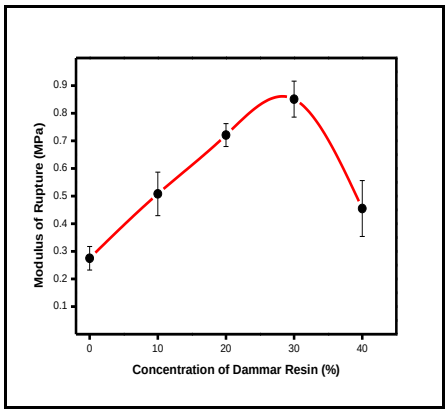

Fig. 3. Graph of the influence of concentration dammar resin to modulus of rupture (MoR) OPT before and after compregnation

From Fig. 3 it can be seen there is a high value of modulus of rupture of OPT compare to OPT before the compregnation. The highest of modulus of rupture at concentration of dammar resin 30%, when the composition is become better and spread better in the OPT which ful filled the empty pores in the cell. It makes the palm oil timber become harder and stable. It is caused the increasing modulus of rupture value of POT and in the concentration the value modulus of rupture 4,619 MPa.

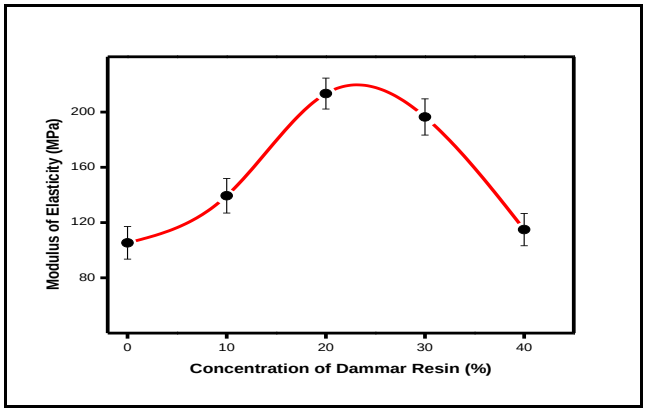

Fig.4. Graph of the influence of dammar resin consentration to modulus of elasticity (MoE) of OPT before and after compregnation

From Fig 4, it can be seen is higher value of elasticity modulus OPT compare OPT before compregnation. Higher modulus of elasticity can be found from dammar resin concentration 20%. In this composition, resin compregnation is spread better to the palm oil timber which make the cell is fulfill and it become solid and it increases the value modulus of elasticity from OPT. In this concentration, the value of modulus of elasticity is 195,829 MPa.

3.2. Structure analysis characterization of OPT and OPT-dammar resin by FTIR

FTIR spectra of OPT- dammar resin performed to detect the occurrence, the loss or shift peaks that can be associated with the treatment process. Spectrum of OPT and OPT-dammar resin in the range of 4000-800 cm^{-1}can be seen in Fig. 5.

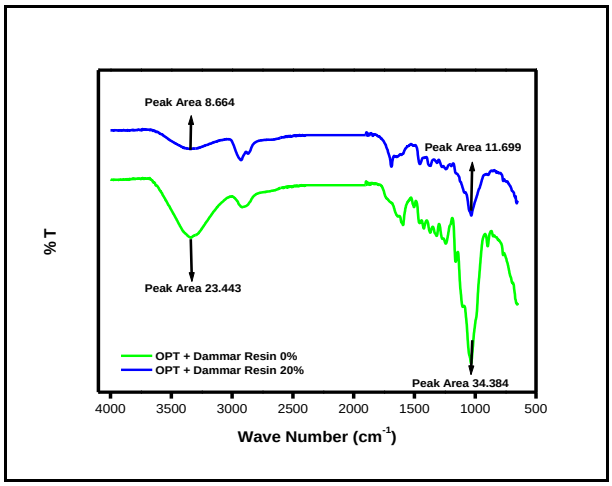

Fig.5. Fourier Transform Infrared (FTIR) test for OPT and OPT-dammar resin.

The number of the wave which come up depends on the contain of chemical compound in the OPT such as a cluster of functions that dominant is C-H,C-O, O-H, C-C and after OPT has resin compregnation it can be seen in the frequent of 3339,39-3337,61 cm^{-1} which an area where O-H cluster drop %T between OPT before compregnation with OPT compregnation. There is a cluster of O-H shows that POT has a hidrofil value by adding dammar resin which shows that %T has drop. It can be seen that hidrofil value of OPT has drop because the dammar resin has hidrofobik. From this characteristic of group function it can be seen that there is a physic interaction between POT with dammar resin. There is no displacement in the top in the POT compregnation. It is only the large of curve become drop which shows its physical interaction.

3.3. Thermal Characterization of OPT and OPT-dammar resin by TGA

The technique in thermal analysis method is termogravimetric analysis (TGA) which based on weigh changing because of heating up. Thermal method analysis is useful to know the result formula of thermal decomposition. This technique is used when the atmosphere has nitrogen. The themperature is used for this technique is 35°C until 800°C with the rate of the heating is 10°C/minutes. Thermogram from OPT before and after compregnation with dammar resin can be seen in Fig. 6.

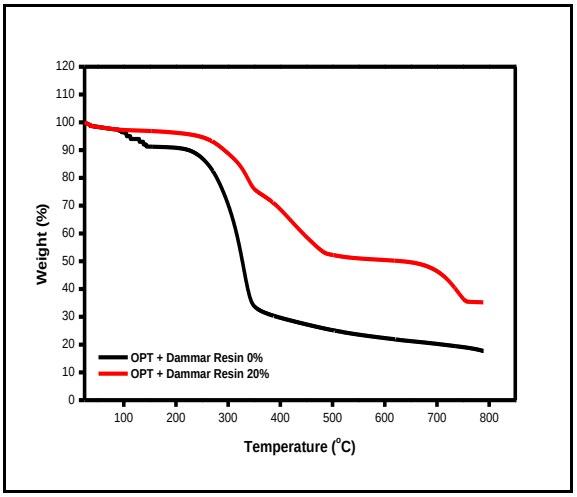

Fig. 6. Thermogram of POT and POT-dammar resin

Fig. 6. Shown thermogravimetric analysis (TGA) of POT and POT-dammar resinis. TGA can be used to characterize any material that shows the material weight change upon heating and to detect change due to decomposition. TGA curve of POT has three types of mass changes, the first area is from the temperature 100°C until 200°C there is decrease amount of mass because of evaporation. With the remaining earlier residue of POT at 92% and residue of POT-dammar resin compregnation 97%. The second area is started from 200°C until 400°C, POT before compregnation in the temperature 400°C with residue 30% and POT after compregnation in the temperature 400°C with residue 68%. The third area is in the temperature 750°C until 800°C POT has a decomposition of thermal slowly with the residue of POT as 17% and residue POT-dammar resin as 35%. Compregnation of POT-dammar resin has increased thermal stability.

3.4. Morphological characterization of OPT and OPT-dammar resin by SEM

Morphology of POT has been characterized by using *Scanning Electron* Microscopy (SEM) to see cavity of POT pores before compregnation and after POT has fulfil with dammar resin. Figure of morphology of OPT untreated compregnation and OPT treated compregnation with dammar resin can be seen in Fig. 7.

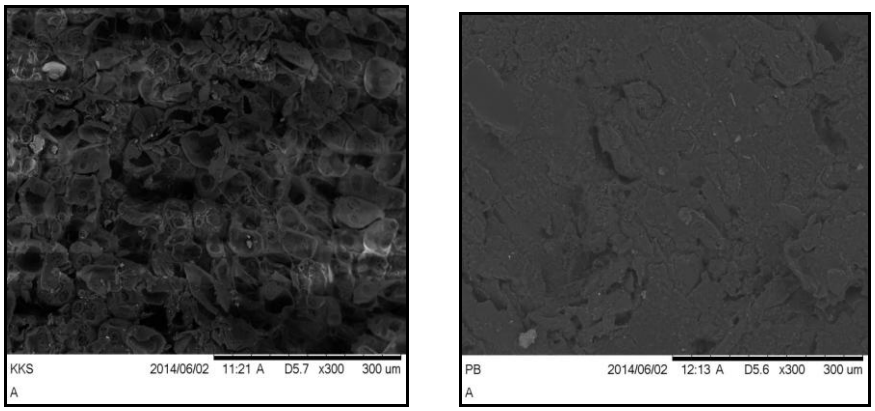

Fig.7. Scanning electron microscopy (SEM) image of OPT -(a) untreated OPT (b) OPT-dammar resin treated compregnation

Accordingly to Fig.7. Scanning electron microscopy (SEM) image of OPT -(a) untreated OPT, SEM of OPT can be seen that OPT untreated compregnation with resin which has fibre and vascular bundles which

surrounded by parenchyma so that OPT has a spatially hydrophilic with many pores. OPT that has parenchyma tissue tend to hygroscopic so that OPT easy to be ruin because it will absorb water and fungi easy to grow, or because of the parasite which easy to be grow in the moist place. The existence of pores is the characteristic of OPT morphology, low density of OPT caused OPT unstable. It is easy to be shrink and expand because of the changing of the air and mechanical peoperties POT is low.

Fig 7. (b) the figure of morphology is treated compregnation with dammar resin. It shows that OPT pores has well fulfill with the dammar resin which is hidrophobic so that the higrosphobic become down, the pore become small and the mechanical properties has increased.

Conclusion

From this research, it can conclude that dammar resin can be compregnation to OPT. The process of compregnation can increase the nature of physical and mechanical properties OPT. The result of mechanical test for OPT, the highest Young' s modulus found 195,829 MPa in the dammar resin concentration 20%.

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