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The Characteristic of Binderless Com-Ply Made from *Paraserianthes falcataria*

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The Characteristic of Binderless Com-Ply Made from *Paraserianthes falcataria*

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Abstract. Oxidation treatment to activate the chemical components of wood to be able to produce bond formation between the particles have been successfully applied in the manufacture of binderless particleboard. Produced particleboard has a high internal bond strength, however, it has a low modulus of rupture. To improve the bending strength, addition of veneer layers on both surfaces are needed. This product is called as com-ply. Because of low accessibility of chemical component of veneer layer compared to particles, then the possibility activation of the chemical components of veneer is still questioned. This study was aimed to investigate the possibility application of oxidation treatment to produce com-ply and to determine the optimum oxidant proportion between particles as the core layer and veneer as surfaces layers. Wood species that used to produce both of particle and veneer were sengon (*Paraserianthes falcataria*). Oxidant levels proportion that used were; 1 : 2, 1 : 3, 1 : 4, 1 : 5, 1 : 6, 1 : 7, and 1 : 0 w/w (veneer : particle). The results showed that the manufacturing of binderless com-ply using oxidation treatment was possible to be applied. Optimum oxidant level proportion between veneer and particle was 1 : 6 w/w. The produced com-ply fulfill the JIS A 5908 2003.

1. Introduction

Development of binderless particleboard technology is one of the attractive way to overcome the problems posed by the use of adhesives, in particular formaldehyde emission problem. Some researchers have been intensively developed a variety of methods by utilizing various wood or other woody plant species as raw materials. The methods including; steam injection [1], or enzymatic activation of particle [2]. In recent years, development of direct hot pressing method using oil palm have been reported by several researchers [3-5]. The other attractive method to produce binderless particleboard using oxidation treatment to activate particle [6]. The produced board has several advantages including high dimensional stability, modulus of elasticity, and internal bond strength. Unfortunately, the modulus of rupture relatively low. This paper is reporting the development of oxidation method in producing binderless panel.

The most common technique to overcome problems related to low modulus of rupture is addition a veneer layer on both of surfaces panel. The products are known as com-ply. The modulus of rupture of com-ply may increases due to the presence of veneer layers. It was occurred, because when the panel receiving bending load, the outer layers will receive highest tensile load. The existence of a thin layer on the outer panel will enhance the boards ability to withstand bending loads significantly. It has been proven that indicated the addition of a layer of thin veneer (20 % of the total thickness of the board) is able to increase the strength of the board almost twice compared to board without veneer layer [6].

This work was focussed on developing high strength and resinless com-ply products using oxidation method. Nonetheless, the feasibility of oxidation method application to produce com-ply is still questioned. Due to oxidation process need to access the chemical component of wood, so there is no assurance that solid size material such us veneer can be oxidized. This study aimed to evaluate the



possible application of oxidation treatment in the manufacture of com-ply and determining the optimum oxidant proportion between veneer and particles.

2. Materials and Method

Binderless com-ply was produced from air-dried sengon wood (*Paraserianthes falcataria*) particles and veneer. Sengon chips were air dried later converted to a particle with size of 10 mesh passed of sieve using wood mill refiner. Veneer was produced using spindleless rotary veneer. Com-ply was produced by oxidizing the particles and veneer. Before oxidizing, particles and veneer were weighted to produce com-ply with a density target of 0.75 g/cm³ with dimensions of 30 x 30 x 0.7 cm. Particle and veneer then oxidized with hydrogen peroxide 15% based on dry particles and veneer weight and 7.5% of ferrous sulphate based on weight of hydrogen peroxide [6]. Oxidized particle and veneer were conditioned for 15-30 minutes before forming into a mat. The sheets were then hot pressed for 12 minutes at a temperature of 180°C with a pressure of 25 kgf/cm². The produced com-ply were conditioned for 2 weeks at room temperature, before cutting into samples size according to Japanese Industrial Standard (JIS) A 5908 2003 [7]. Seven types of binderless com-ply were produced in this study based on proportion of oxidant between veneer and particle, namely 1 : 2, 1 : 3, 1 : 4, 1 : 5, 1 : 6, 1 : 7, 0 : 1 (w/w).

3. Result and Discussion

The characteristics of com-ply were presented in Figure 1-7. Com-ply density as shown in Figure 1 indicated that only com-ply that produced with the oxidant proportion of 1 : 2 were able to meet the target density of 0.75 g/cm², while the six other types of com-ply were below the density target. The variability of actual board density is a common phenomenon in the manufacture of composite boards. In some cases, the actual density exceeds the density target while in other cases is lower. Nevertheless, the fact that there is no board that has a density above the target density indicated that the 10% allowance of raw material for producing com-ply is not enough to reach the density target, so the allowance should be increased about 15%. The allowance is intended to anticipate the wasted particles during it handling. Nevertheless, it seems that plenty particles were eliminated when oxidation treatment due to there were particle burned. This is possible occurred due to the exothermic reaction takes place in a high temperature and cause evaporation of water in particle or veneer.

Moisture content of particleboard is presented in Figure 2. It's shows that the overall of com-ply have low moisture content relatively, although its still fulfill the JIS A 5908 [7]. In JIS A 5908 [7], moisture content that allowed of 5-13%. Apparently, oxidation treatment has led to modification of the chemical structure of the raw materials that implicated to hygroscopicity decreases, so the moisture content tend to be lower. In terms of variability of moisture content among of com-ply types, it appears that there is no particular trend that can be attributed to moisture content of com-ply that produced using different variation proportion of oxidant for veneer and particle. This means that differences in the distribution of the oxidant levels in veneer and particle layers did not affect the moisture content.

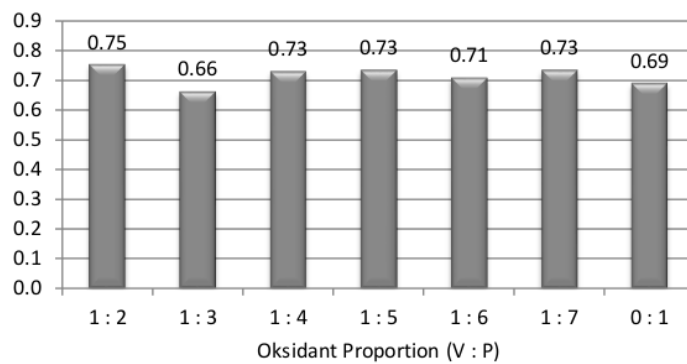


Figure 1. Density of Com-ply (g/cm²).

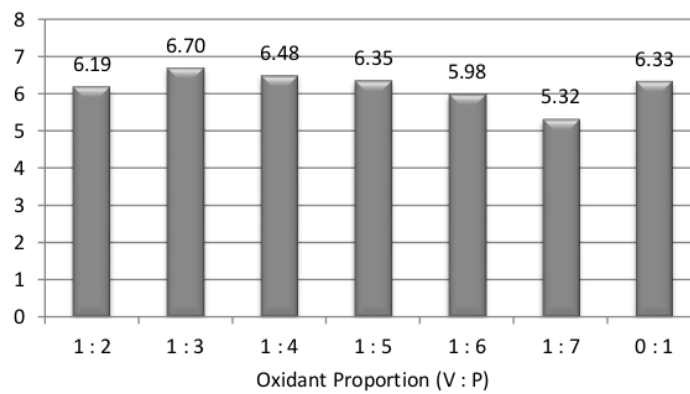


Figure 2. Moisture content of Com-ply (%).

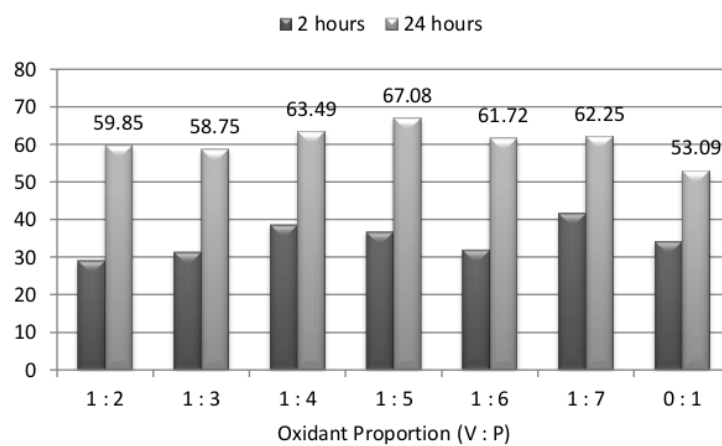


Figure 3. Water Absorption of Com-ply (%).

Water absorption of com-ply as presented in Figure 3 shows the similar phenomenon with moisture content. There is no particular trend related to the proportion of oxidant materials in veneer and particle layers. By the time, a lot of oxidant amount relatively in veneer (1 : 2), water absorption is relatively low and then increased when oxidant proportion in veneer decreases until ratio of 1 : 5. However, after the ratio, water absorption of com-ply tend to decrease again when oxidant in veneer layers increases. This phenomenon illustrates that the level of oxidizing materials in the particles and veneer did not directly related to water absorption.

The data in Figure 3 also shows that the water absorption when the com-ply was immersed for 24 hours indicated that the water absorption range of twice compared with the water immersion for 2 hours. This means that the process of water absorption of com-ply is slow relatively. In general, water absorption within 2 hours of immersion is still much more to fill the empty spaces between the particles than as free water in the cell lumen. In other words, the water takes considerable time to reach the cell wall so that the difference between the water absorption in the immersion for 2 hours and 24 hours is quite large. If the water filling the lumen and cell walls in shorter time, then water absorption differences when immersing for 2 hours and 24 hours may be small. This indicates that the chemical modification due to oxidation treatment has occurred resulting decline hygroscopic materials.

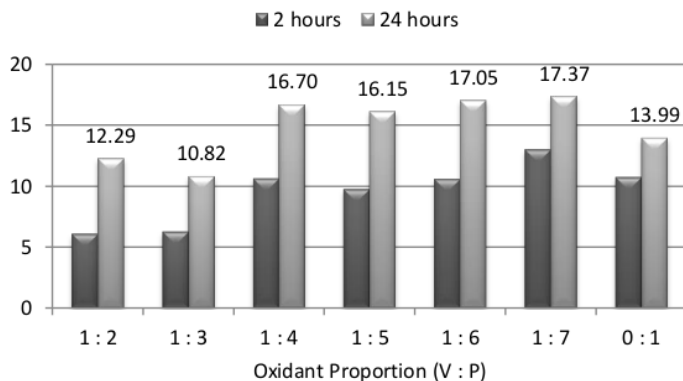


Figure 4. Thickness Swelling of Com-ply (%).

Phenomenon of com-ply thickness swelling similar to that occurring in water absorption, whereas thickness swelling tend to be low when oxidant proportion in veneer is plenty and tend to increase when oxidant in veneer decreases until proportion of 1 : 7. In generally, the relationship between the thickness swelling with water absorption is linear generally. In other words, high water absorption will also result in the high thickness swelling. Based on the data of thickness swelling of produced com-ply, it appears that only com-ply with oxidizing proportion of 1 : 3 between veneer and particles that has a thickness swelling under the maximum limit specified in JIS A 5908 [7] i.e. a maximum of 12 %. This indicates that the dimensional stability of produced com-ply is still quite low. The high thickness swelling seems to be influenced also by the existence of a layer finir. Perhaps, in the process of hot pressing, veneer or particle layers undergo collapse but when immersing in water for 24 hours, so that the cell shave recovered that implicated on high thickness swelling.

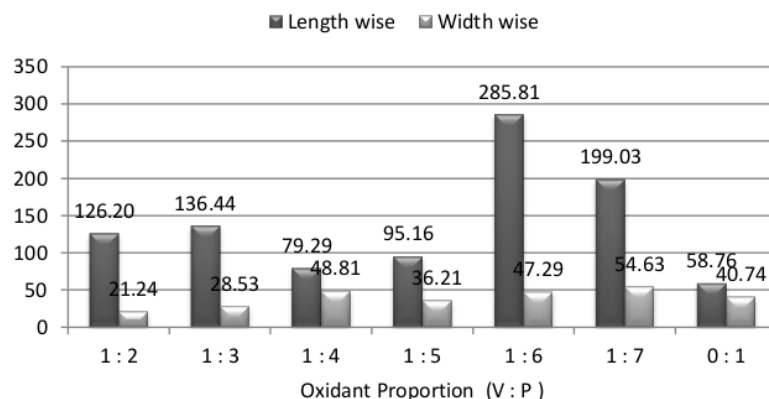


Figure 5. MOR of Com-ply (kgf/cm²)

In contrast to the facts that found in the physical properties of boards (density, moisture content, water absorption, and dimensional stability) whereas no certain oxidant proportion that has the best characteristic in all physical parameters, in mechanical properties, there is a same tendency in all parameters tested. Com-ply that produced using 1 : 6 oxidant proportion between veneer and particle has the best mechanical properties. The resulting values for all mechanical properties including modulus of rupture, modulus of elasticity and internal bond strength parameters are always highest in that proportion compared to other proportion.

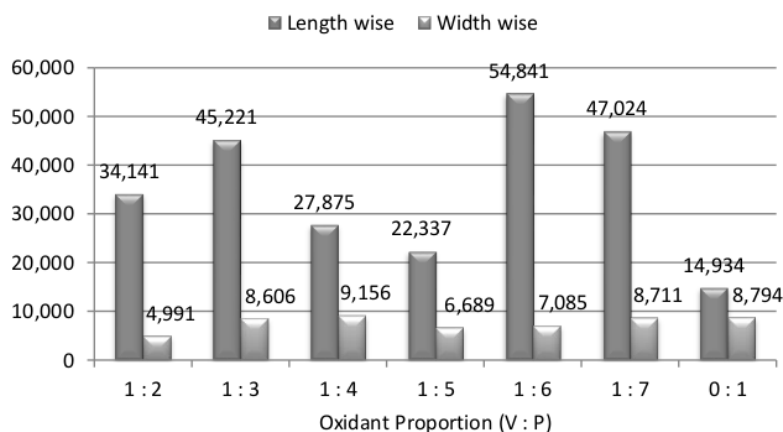


Figure 6. MOE of Com-ply (kgf/cm²)

MOR and MOE of the produced com-ply are quite high. The produced sengon binderless particleboard showed that the MOR values that can be achieved just 90 kg/cm² and MOE of 30,000 kg/cm² [6]. However, in this study, addition of veneer layer with a thickness of 1 mm for each surfaces to produce com-ply able to produce a high MOR and MOE extremely. The com-ply has three times MOR and almost two times MOE values compared to the binderless particleboard. It is an interesting phenomenon, because then, the addition of a thin layer on the both surface of the board was able to very significant increases of the strength and stiffness of the board.

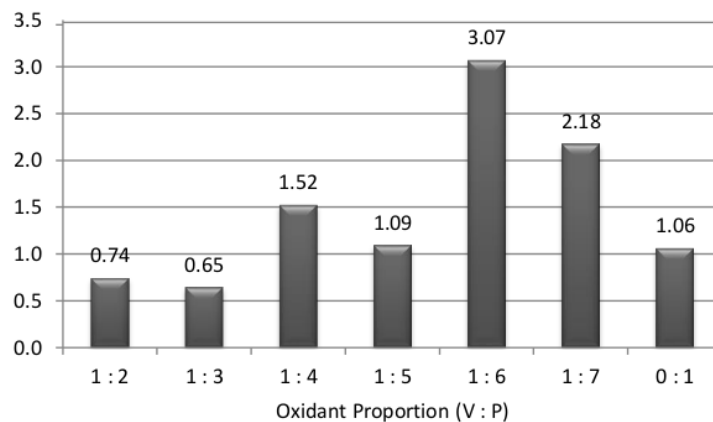


Figure 7. Internal Bond of Com-ply (kgf/cm²)

As with MOR and MOE, best oxidant proportion to produce com-ply with high internal bonding strength is the com-ply that produced using oxidant proportion of 1 : 6. Based on the mechanical properties data, the com-ply that produced with 1 : 6 proportion meets JIS A 5908 2003 [7]. It can be concluded that in order to produce com-ply the best oxidant proportion between veneer and particle is 1 : 6. However, future effort are still needed to improve dimensional stability of the com-ply. The result of this work indicated that application of oxidation method to produce com-ply is possible to be developed. By using temperature under 200°C, this method seems quite promising compared with other direct hot pressing methods that developed by using very high temperature. Study about producing binderless particleboard using hot press with temperature more than 200°C [3, 4]. However, similar temperature was used 180°C [5].

4. Conclusion

Oxidation treatment to produce binderless com-ply is possible to apply. The best combination of oxidant distribution between veneer and particle is 1 : 6 (w/w). The produced board has high mechanical properties including modulus of rupture, modulus of elasticity and internal bond strength. They fulfill JIS A 5908 2003 [7]. However, the dimensional stability of the com-ply still quite low.

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Aknowledgment

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