The Making of Particleboard from Palm Oil Fiber and Dust Wood with Epoxy as a Resin

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Abstract: Particleboard has been widely used in producing products such as cabinets, furniture and various home use products. In this study, epoxy resin has been used as a binder for replacing urea-formaldehyde (UF) resin which is widely used in the production of existing particleboards. Epoxy resin has strong binding properties in composing composite materials. Epoxy resin also does not release any gas as carcinogenic formaldehyde released by UF resin. The basic materials used in the production of this particleboard are palm oil fiber obtained from the Charuk Putting Palm Plant, Temerloh and dust wood obtained from the timber factory around Kuantan. The main purpose of the research scientifically known is to reduce the forest logging activities in addition to utilizing waste materials. There are 2 different size of particle material used in this study which are < 2.36mm (particle A) and 2.36mm < x < 4.75mm (particle B). The particleboard that has been produced was tested ith Universal Tensile Machine (UTM) for looking to the Modulus of Elasticity (MOE) and thickness swelling (TS). From the result, it shown that the value of Modulus of Elasticity (MOE) for particle A was 16,364 MPa while particle B was 35,578 MPa. The value of thickness swelling (TS) for particle A was 0% when it immersed for 2 hours compared o particle B which was 1.7% in the same duration. As a result of experiments, all tests have passed the minimum level of particleboard based on the Japanese Industrial Standard (JIS), 2003. Therefore, particleboard of a mixture of palm oil fiber and dust wood with epoxy as a resin can be used as a new alternative in the production particleboard for furniture industry in the future.

Keywords: Homogeneous particle board, palm oil fiber

I. INTRODUCTION

The particleboard is a board item produced under strain from particles of wood with a glue as its mixture [1]. The increasing of demand for the particleboard nowadays is because of the increase in furniture industry and housing construction. Nowadays, the particleboard is typically applied as flooring, wall and ceiling panels, office dividers, bulletin boards, furniture, cabinets, counter tops, and tabletops 2]. Because of that, depletion of forest resources has increased to fulfill demand for these kinds of products. As of late, there is a developing inclination towards reusing of the waste and utilizing it for delivering the composite wooden items like molecule board. Utilization of inexhaustible materials for assembling particleboards contributed the arrangement of crude material deficiency for the particleboard business [3]. Innovation for molecule board make has grown with the goal that sawdust, factory deposits and reused wood can be utilized. Other non-wood lignocellulose materials have likewise been utilized in particleboard assembling, for example, watermelon strips [4], bamboo waste [5], Kenaf [6], walnut/almond shells [7], palm trunks [8] and Kelempayan [9].

Palm oil or scientifically known as Elais Guineensis is believed to originate from the West Indian region of Central America. It is an equipped, unbranched, monoecious palm up to 15-30 m tall with a terminal crown of 40 – 50 leaves. Palm oil tree delivered 500 to 3000 natural products together in firmly stuffed packs up to 50 cm long and 35 cm wide [10]. Palm oil is utilized in numerous eatable items, for example, cooking oils, margarine, vegetable ghee, shortenings, singing fats, bread kitchen and roll fats, potato crisps, baked good, ice cream parlor, frozen yogurt and flavors. The vacant bundle stalks, mesocarp filaments after oil extraction and the shells from the opened nuts are utilized as fuel for the boilers of the palm-oil plant. Different squanders from the palm-oil factory might be changed over into composts and other important items [11].

The term epoxy has been adapted for many uses beyond its original use for fiber-reinforced polymer composites. For example, epoxy resin was used as the binder in countertops or coatings for floors. Because of its toughness and strong adhesion, epoxy resin is used widely in industrial applications. This study is conducted to develop particleboard from the combination of the palm oil fiber and dust wood, with epoxy resin as a binder. The physical and mechanical properties of this composite particleboard are assessed according the Japanese Industrial Standard (JIS), 2003 [12].

II. MATERIAL AND METHOD

A. Materials

Before the materials can be used, the palm oil fiber the increase the drying process. Sun drying is very simple to practice to dry the fiber. This process is to ensure that the palm oil fibre is not moistened which will affect the strength of the particleboard. After drying process, the palm oil fiber must be shredded to reduce the size before it was sifted using a sieve machine. The fiber Must pass the size of below 2.36 mm (sample A) and 2.36mm <x <4.75mm (sample B) sieve. This shredding process makes the handling of fiber ease for the Particle Board making. The same process applies to wood dust.

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B. Manufacturing Particleboard

Particleboards were produced in the Material Laboratory, Kolej Kemahiran Tinggi MARA Kemaman, Terengganu following standardized procedure of Japanese Industrial Standard (JIS), 2003. The mixture ratio of palm oil fiber and dust wood was fixed at 50:50. While the percentage of epoxy resin used was 80%, hardener was 10% and filler was 10%. In the process of producing particleboard samples, the particleboard density was determined between 0.7g / cm^3 to 0.8g / cm^3. The sample size was determined based on the suitability of the test carried out in accordance with the JIS 2003 standard. The sample sizes were shown in Table I.

Table I: Dimension and number of Particleboard sample

Types of Testing	Dimension of mold	Number of sample
Modulus of Elasticity (MOE)	200 mm x 50 mm x 10 mm	3(A), 3(B)
Thickness swelling (TS) and Water absorption (WA)	50 mm x 50 mm	3(A), 3(B)

The mixture of these materials is incorporated into the mold with different sizes. The zinc sheets were placed at the bottom and the top of the mold. Then, the sample of particleboard was fabricated using a Hot press machine with the molding temperatures, pressing times and molding pressures were, respectively, 160ºC, 5 min and 60 Pa. Fig. 1 below shows the process of producing the sample of particleboard.

Fig. 1: Specimen of particleboard

C. Test Procedure

1) Water Absorption Test

For water absorption test, the sample must be weighted first. This weight was recorded as initial weight. Then, the sample was immersed in distilled water at room temperature of 20-30°C. The weight of sample must be recorded as final weight after the 2 hours, 12 hours and 24 hours' immersion process. The water absorption of each sample was calculated by the weight difference as shown in equation below.

$$Water\ absorption(\%) = \frac{final\ weight - initial\ weight}{initial\ weight}\ x\ 100\%$$

2) Thickness Swelling

Normally thickness swelling was conducted together with water absorption test. The moisture and absorption properties in particleboard will affect the value of thickness swelling. After the sample dimensions of 50 mm x 50 mm were taken out from water, the sample must be dried up using dry cloth. Then, the thickness at the middle of the sample was measured using the suitable measurement instrument. The thickness of the sample must be obtained after 2 hours, 12 hours and 24 hours' immersion process. The Thickness swelling result (TS) was determined from the following formula:

$$Thickness\ swelling(\%) = \frac{final\ thickness - initial\ thickness}{initial\ thickness}\ x\ 100\%$$

3) Modulus of elasticity (MOE)

Modulus of elasticity is an important test because it measures the stiffness or resistance to bending when stress was applied to the sample. About 6 samples of particleboard with dimension of 200mm x 50mm x 10mm were tested using the universal tensile machine. Obtained results are tabulated in a graph.

III. RESULT AND DISCUSSION

A. Physical Properties of Particleboard

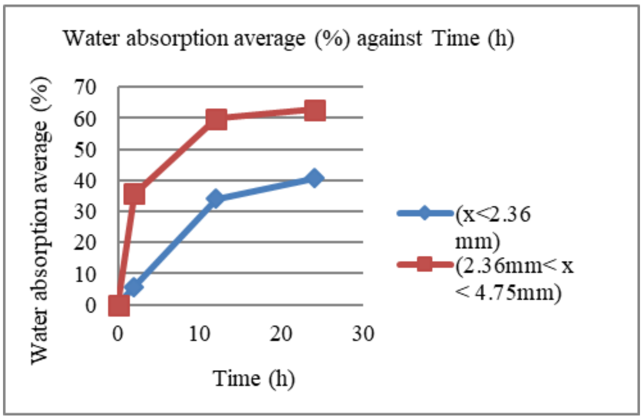

Fig 2: Graph of water absorption against time.

Fig 2 above shows the result of water absorption of sample A which the particle size less than 2.36 mm and sample B which the particle size between 2.36 and 4.75 mm. The graph shows the increasing of water absorption within 2 hours to 24 hours for both samples. However, the result of sample A was much better because percentage average water absorption was lower than sample B. Even though the ratio of material used was same for both samples, the results indicated that the fine particle size had lowest water absorption compared to medium size of particle.

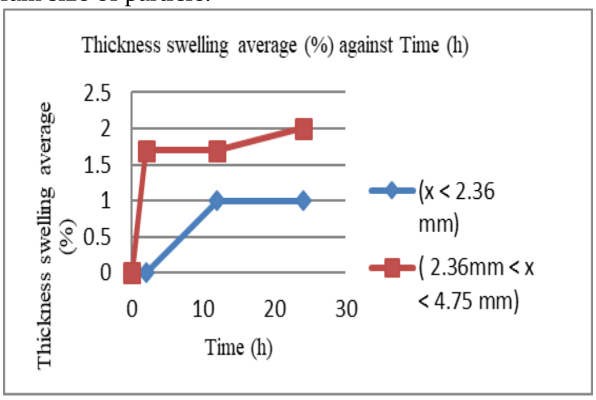

Fig 3: Graph of Thickness swelling against time.

The result in Fig 3 shows the percentage of thickness swelling after immersion in water for both sample A and B increased within 2 hours to 24 hours. It shows that when the sample immerse in the water for 2 hours, sample A remain zero swelling compared to sample B which indicate 1.7% of swelling. At duration of 12 hours, sample an increase to 1% of swelling while sample B maintained at 1.7% swelling. From the result, it can be concluded that sample a gives out better result than sample B. However, all results comply with the Japanese Industrial Standard (JIS), which stated that the thickness swelling must not be more than 12%.

B. Mechanical Properties of Particleboard

Table II: The value of Modulus of Elasticity (Modulus Young) for the particle size less than 2.36 mm.

Specimen	*Time at break (s)*	*Load at Break (kN)*	*Maximum load (kN)*	*Modulus Young (MPa)*
1	8.200	-0.170	0.112	15344.946
2	31.600	0.658	1.124	16254.132
3	35.700	0.868	1.388	14972.338
Mean	25.167	0.452	0.875	15560.472

Table III: The value of Modulus of Elasticity (Modulus Young) for the particle size 2.36 mm <x< 4.75 mm

Specimen	*Time at break (s)*	*Load at Break (kN)*	*Maximum load (kN)*	*Modulus Young (MPa)*
1	40.300	0.860	1.372	14165.385
2	52.000	2.604	3.261	35578.860
3	17.800	-0.202	-0.015	------
Mean	36.700	1.087	1.539	24872.122

Average mean values of experimental particleboard sample for Modulus of Elasticity was presented in Table II and III. According to JIS standard, the minimum requirement for MOE is 3000 MPa for both general uses and manufacturing. From the table, the result of MOE for sample A and B were very stimulating which results in a mean value of 15,560.472 MPa and 24,872.122 MPa respectively. The summary of all the results was concluded in Table IV below.

Table IV: The result of Particleboard made from the palm oil fiber and dust wood

Sample	Particle size (mm)	Density (g/mm^3)	MOE (MPa)	WA (%)	TS (%)
A	X <2.36		15560.472	40.7	1
B	2.36<x<4.75	0.7	24872.122	62.81	2
JIS: 2003		**0.4 – 0.9**	**3000 Min**	**-**	**12 max**

IV. CONCLUSION AND SUGGESTION

In this study, the palm oil fiber and wood dust were used to make a homogenous particle board as an alternative to prevent the raw material from facing scarcity. The physical and mechanical properties of sample were examined according to the Japanese Industrial Standard (JIS), 2003. From the result, it can be concluded that the use of palm oil fiber and wood dust in particleboard manufacturing results in a successful outcome in terms of water absorption (WA) test, thickness swelling (TS) test and Modulus of Elasticity (MOE).

The result also indicated that a particle size of less than 2.36 mm shows the better result than the size more than 2.36 mm in every test conducted. As a conclusion, the above results suggest that the palm oil fiber can be commercialized as raw material to produce particleboard in the future.

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