A Preliminary Study on the Properties Oil Palm Board: Effect of Resin Content

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ABSTRACT

Three-layer oil palm boards were produced using urea formaldehyde resin. Face and back layer particles were sprayed with 10%, 12% and 14% resin while the core was maintained at 10% resin content. The oil palm board was hot-pressed at 165°C for 6 minutes at a pressure of 120 kgcm^{-2}. With increasing resin content, all the mechanical and physical properties improved significantly. However, all board properties did not meet the minimum requirement of the BS 5669.

Keywords: *oil palm board, resin content, urea formaldehyde resin*

Introduction

Malaysia has a total of 4.05 million hectares of oil palm trees producing 14.96 million tonnes of crude palm oil and 1.84 million tonnes of crude palm kernel oil in 2005. Besides the oil, the industry also generates massive quantities of oil palm trunks (OPT), oil palm fronds (OPF) and empty fruit bunch (EFB) available from replanting and though routine field and mill operation. Assuming a 25-year rotation of replanting regime, it is estimated that more than 70,000 hectares of oil palm will be due for replanting every year. This would involve the felling of approximately 9 million palms. Hence, the amount of oil palm trunk (wet weight) that is available annually is estimated to be 13.92 million tonnes or 21.63 million cubic meters. Mohd Basri et al. (2006) reported that with the huge quantities of OPT still available, they could make very substantial contribution to the production of palm-based composites for a wide range of application without depleting the nation's fibre resources from the natural forest and forest plantations.

At present, the trunks are usually burnt or left to rot and decay to produce immediate fertiliser regenerating oil palm saplings (Lim & Gan, 2005). The most practical solution is to use the oil palm trunks as raw materials to produce particles for the production of particleboard. This will provide an alternative raw material to the particleboard industry and also preserve a clean environment as well as to achieve a zero-waste strategy. The objectives of the study are to determine the properties of three-layer oil palm boards and effects of resin content on the oil palm board properties.

Materials and Methods

Field Procedure

Oil Palm trunks were supplied by Malaysian Oil Palm Board, Serdang in the form of sawn blocks (4' x 10" x 10") after bark removal. The blocks were further cut into smaller 8" x10" x10" blocks for processing using a disc flaker. The particles produced were, then, dried and screened (2.0 mm) to remove the fines. Particles were, then, redried in the oven at 80°C for at least 48 hours before board manufacturing.

Board Manufacturing

In the manufacturing of three-layer particleboard, urea formaldehyde resin was used. The resin was made available by a local resin company and was formulated according to commercial use. The resin specifications are given in Table 1.

Table 1: Specifications of Urea Formaldhyde Resin

Property	Urea Formaldehyde
Viscosity (p) 30°C	2.50
pH	8.44
Density at 30°C	1.28
Gel Time (sec.)	46
Free Formaldehyde (%)	0.44
Solid Content (%)	65.0

Three-layer boards were produced with screened particle (>2.0 mm) as core material and 0.5 mm (75%) and fines (25%) as surface furnish. The surface was maintained at 10%, 12% and 14% and the core resin content at 10%. The hardener used was ammonium chloride solution with a concentration of 20% which is equivalent to 3% of the weight of the resin solution used.

For board manufacturing a weighted amount of particles was placed in the particle glue mixer and sprayed with a resin mix containing resin and hardener. The glue mixture was sprayed as a fine mist at an air pressure of 1.8 MPa to obtain an even distribution of resin over the oil palm particles. After spraying, the sprayed particles were, then, manually laid in a wooden mould over a caul plate with a dimension of 35 cm x 35 cm and, then, pre-pressed at 3.5 MPa for 30 seconds. The wooden frame was removed and two metal stops of 12 mm were placed near the sides of the consolidated mat before another caul plate was laid on top of it. The consolidated mat was, then, finally pressed to the required thickness of 12 mm at 165°C for 6 minutes and the maximum pressure at the metal stops was set at 120 Pascal. The target board density was approximately 600 kgm^{-3}. A total of two boards were produced for each condition.

Sample Cutting and Conditioning

All the boards produced were cut according to a cutting plan made to obtain a random selection of samples throughout the board size of 350 mm x 350 mm. The sizes of the tests samples are shown in Table 2.

Table 2: Test Sample Sizes

Property	Sample sizes	No. of test pieces/board
1. Internal bond (IB)	50 x 50 mm	5
2. Modulus of rupture (MOR) and modulus of elasticity (MOE)	320 x 50 mm	3
3. Thickness swelling and Water absorption	50 x 50 mm	5

The cut samples were left in a conditioning room with a relative humidity of 65 ± 5% and a temperature of 20 ± 2°C as required by the British Standard Method (BSI, 1989) with a moisture content of below 10%.

Board Evaluation

The tests samples were tested for its mechanical properties namely; modulus of rupture (MOR), modulus of elasticity (MOE), internal bond (IB) and dimensional stability properties, water absorption (WA) and thickness swelling (TS). The mechanical tests were conducted using an Instron Universal testing machine model 4204. The test results were, then, compared with the mean quality values as given in the British Standards (BS 5669:1989).

Results and Discussions

Mechanical and Physical Properties

The mechanical and physical properties of oil palm board at different resin content are shown in Table 3. Oil palm board with 10% resin content has the lowest value of all board properties tested while boards with 14% resin content had the highest value. However, all boards did not meet the minimum requirements of the BS 5669, especially for TS values.

Table 3: Mechanical and Physical Properties of Oil Palm Board According to Resin and Wax Content

Resin Content (%)	Wax (%)	MOR (MPa)	MOE (MPa)	IB (MPa)	WA (%)	TS (%)
10	0	9.49	1225	0.10	99.50	38.22
12	0	12.26	1558	0.17	81.77	27.27
14	0	12.28	1701	0.20	76.56	23.32
BS		>13.8	>2000			< 8

Values are averages of 6 determinations

Statistical Significance

A summary of the analysis of variance of resin content on the board properties is shown in Table 4 and shows significant effect on all the board properties tested.

Table 4: Analysis of Variance on the Oil Palm Board Properties

Source	Df	MOR	MOE	IB	WA	TS
Resin Content	2	16.09*	34.16*	19.09*	72.57*	249.57*

Note: * F-value are significant at p < 0.05 level

Effect of Resin Content on the Mechanical Properties

The effect of resin content on the mechanical properties is shown in Figure 1. Increments of resin content showed significant effects on the mechanical properties. Increasing the resin content from 10% to 14% increased the MOR by 29%, MOE by 39% and IB by 100%. The increase in the mechanical properties is due to the higher resin available for bonding. Similar observations on the mechanical properties-resin content relationship were also reported by other work on wood (Talbott & Maloney, 1957; Moslemi, 1974), bamboo (Chew et al., 2003) and oil palm fruit bunches (Shaikh et al., 1997).

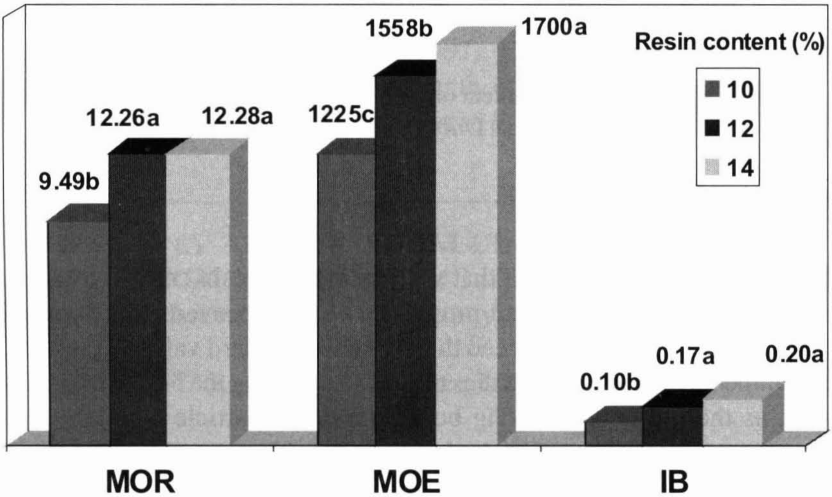

Figure 1: Effects of Resin Content on the Mechanical Properties Means having Different Letters Differ Significantly at p < 0.05

Effect of Resin Content on the Physical Properties

The effect of resin content on the physical properties is shown in Figure 2. Increasing the resin content from 10% to 14%, improved the water absorption (WA) by 23% and thickness swelling (TS) by 39%. The improved WA and TS values are due to the higher amount of resin available for bonding.

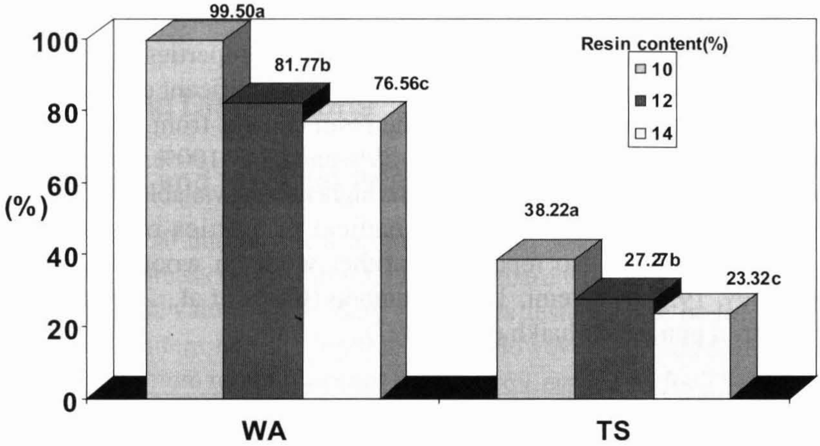

Figure 2: Effect of Resin Content on the Physical Properties Means Having Different Letters Differ Significantly at $p < 0.05$

Conclusion

From the study, it is evident that with increasing resin content used, all the mechanical and physical properties were improved. However, all board properties did not exceed the BS 5669 Standard values. It is, thus, recommended that further studies towards improving the board properties such as the effects of varying board densities, particle geometry and homogenous board be conducted.

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