PRODUCTION OF MEDIUM DENSITY FIBREBOARD (MDF) FROM EMPTY FRUIT BUNCH (EFB) WITH WOOD FIBRES MIX

ZAWAWI IBRAHIM; ASTIMAR ABDUL AZIZ; RIDZUAN RAMLI; ANIS MOKHTAR; SIJOON LEE; ROSMAZI OMAR and AHMAD SIRAJUDDIN TABARI

672

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Medium density fibreboard (MDF) is a bio-composite widely used particularly in furniture and building products. In Malaysia, most MDF plants use rubberwood (RW) as raw material, and of late the industry is facing a problem with the inconsistency in supply and the price hike of RW. Other materials such as mixed tropical hardwood (MTH) are used as part of raw materials to substitute RW for MDF production. The industry has to find an alternative material which is abundantly available, renewable and price competitive compared with normal wood. The palm oil mill produces about 22% of empty fruit bunch (EFB) from the fresh fruit bunch (FFB) being processed, and in 2013 there was about 8 million tonnes (dry weight) of EFB produced in Malaysia. Although EFB is a fibrous material, it has characteristics that are similar with other wood or lignocellulosic materials. The MDF from EFB blended with RW and MTH was produced at a pilot scale and results were very promising particularly on the mechanical properties. Optimum results were obtained for blending ratio up to 20% EFB fibres. The swelling property declined beyond the acceptable limit with higher loading of EFB fibres. All properties are below the minimum standard requirements (EN 622-5,2006) for MDF panel produced from 100% EFB fibres.

THE PROCESS

Shredded EFB collected from the palm oil mill contain about ±100% and <3% of moisture and residual oil, respectively. The blending process was done after the shredding process, with the MTH ratio fixed at 30% while EFB fibres ratio at 10%, 20% and 30%, and the balance consisted of RW fibres. During the refining process, the shredded EFB, RW and MTH were treated with steam at a pressure of 5 – 6 bars for 300 s in the inclined digester. The materials were converted into refined fibres at the refining zone before discharged through cyclone into the fibre bin. The fibres were blended with urea formaldehyde resin and emulsion wax using a mechanical blender before being formed into a mat. The final step was hot pressing where the mat was pressed at 200^{0}C for 300 s. The manufacturing process of MDF from blended EFB fibres with RW and MTH is illustrated in *Figure 1*.

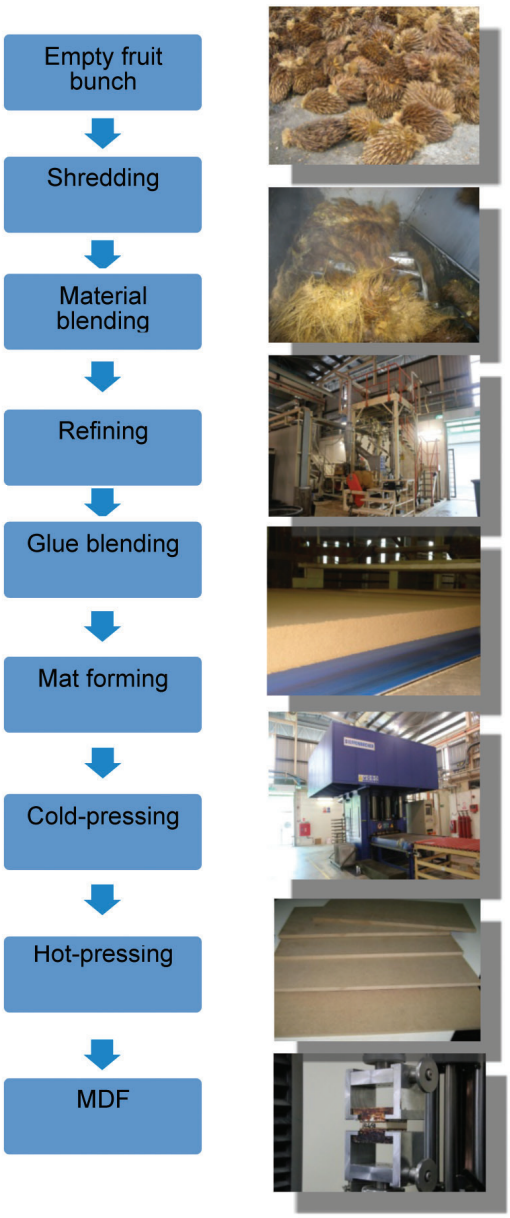

Figure 1. Process flow of MDF production from mixing EFB fibres with RW and MTH.

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Figure 2. Refined EFB fibres for MDF production.

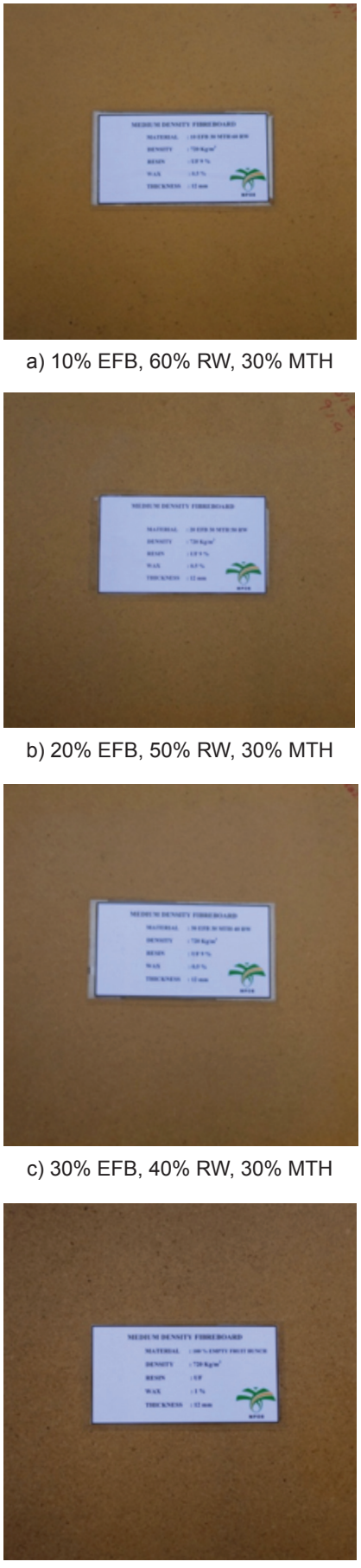
THE MDF PRODUCTS

MDF was produced at the MPOB pilot plant using different ratios of EFB fibres blended with RW and MTH. The process parameters for production of MDF are shown in *Table 1*. The flow of manufacturing process in preparing the boards was similar to the setting parameters in commercial plants.

Panels produced from all ratios of EFB fibres exhibited excellent results in bending strength and internal bonding tests as indicate in *Table 2*. The products are suitable for load bearing applications due to their high bending properties. Generally, all test results including swelling properties, declined with the higher loading ratio of EFB fibres. The average value of mechanical and physical properties of boards produced from 10% and 20% loading ratio of EFB fibres fulfilled the requirements as stipulated in the European Standard (EN 622-5,2006). Higher amount of wax content is required to retard the water intake into boards for MDF produced from EFB fibres particularly for

TABLE 1. PROCESS PARAMETER FOR MDF PRODUCTION FROM EFB FIBRES BLENDED WITH WOOD FIBRES

Constant parameters	Value
Steam pressure (refining)	5-6 bar
Cooking time	300 s
Glue content	12%
Wax content	0.5%



a) 10% EFB, 60% RW, 30% MTH

b) 20% EFB, 50% RW, 30% MTH

c) 30% EFB, 40% RW, 30% MTH

d) 100% EFB fibres

Figure 3. Prototype MDF produced from 100% EFB fibres and different mixing ratios with RW and 30% MTH fibres.

TABLE 2. PROPERTIES OF MDF FROM DIFFERENT RATIOS OF EFB BLENDED WITH WOOD FIBRES

EFB blending ratio	MOE (N mm^{-2})	MOR (N mm^{-2})	IB (N mm^{-2})	TS (%)
10%	3 129.07	40.44	0.98	13.88
20%	3 034.71	38.24	0.82	14.31
30%	2 987.66	37.10	0.72	16.10
100%	1 977.19	22.15	0.54	23.43
EN STD (622-5,2006)	≥2 500	≥22	≥0.6	≤15

Note: MOE = modulus of elasticity, MOR= modulus of rapture, IB= internal bonding, TS= thickness swelling. Board density = 720 kg m^{-3}, resin content = 12%, wax content = 0.5%.

higher loading ratio of EFB fibres. Resin content is required at higher percentage for MDF from EFB compared to existing wood panels. It could be due to the presence of residual oil in the EFB, which encapsulates the fibre surface from the adhesive penetration during glue blending process, which can lead to a lack of bonding between the fibre surfaces.

PRICE ANALYSIS

Price analysis of this technology is focused on the pre-treatment and mobilisation of shredded EFB fibres. The estimated cost of delivered shredded EFB to MDF plant within a 50 km radius is RM 50 t^{-1} whereas for delivered RW, the average price is at RM 130 t^{-1}. The total processing cost in converting EFB to shredded EFB is estimated at RM 30 t^{-1}. *Table 3* shows the comparison of the estimated material cost between shredded EFB with RW.

Shredded EFB has a lower material cost compared to RW, *i.e.* cheaper by RM 89.50 t^{-1}. For instance, at 20% EFB blending ratio, it was estimated that for an MDF plant with daily production capacity of 400 m^3 (total raw material required: 600 t), the material cost savings will be RM 10 740 per day (at 60% M.C.).

TABLE 3. AVERAGE ESTIMATED MATERIAL COST FOR SHREDDED EFB AND RW

	Shredded EFB	RW
Initial M.C. (%)	110	60
RM t^{-1} (green)	50	130
Dry weight (t)	0.476	0.625
Dry tonne price (RM)	105	208
Loss (%)(debarking + fine chip)	10	20
Dry yield (t)	0.429	0.500
Price after loss (RM t^{-1})	117	260
Weight at 60% M.C. (t)	0.686	0.800
Price at 60% M.C. (RM t^{-1})	73	162.50
Price difference (RM t^{-1})	±89.50	-

Note: M.C. = moisture content, calculation based on 1 t (green).

For more information, kindly contact:

Director-General
MPOB
6 Persiaran Institusi, Bandar Baru Bangi,
43000 Kajang, Selangor, Malaysia.
Tel: 03-8769 4400
Fax: 03-8925 9446
www.mpob.gov.my