PROPERTIES OF KERUING BELIMBING-POLYPROPYLENE COMPOSITES

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ABSTRACT

Malaysian wood industries are producing a lot of waste. These wastes are currently less utilized, thus, creating a problem to the environment. Thus, to reduce these wastes, a study was conducted to include it as filler in thermoplastic composite. The use of scrap-wood derived fillers for thermoplastic has become more accepted by the plastics industry in the recent years. Wood derived fillers have several advantages over their inorganic counterparts. The objectives of the study are to assess the suitability of Keruing Belimbing sawdust as filler in thermoplastic composite manufacture, and to study the effect of particle size and filler content on the composite properties. The findings show that Keruing Belimbing sawdusts are suitable and can be used as filler in manufacturing thermoplastic composite.

INTRODUCTION

The use of scrap-wood derived fillers for thermoplastic has become more accepted by the plastics industry in recent years. Wood derived fillers have several advantages over their inorganic counterparts such as lower density and lower volumetric cost. They are also less abrasive to processing equipment and are derived from renewable resources (English et al. 1996). In a Forest Products Laboratory research study, polypropylene filled with three inorganic fillers commonly used by the plastics industry (talc, calcium carbonate, and fibreglass) was compared to polypropylene filled with wood flour on wood fibre derived from demolition wood. The result suggests that wood-derived fillers do have a place in the filler market. The performance characteristic of plastics with wood fillers was generally similar to those of talc-filled plastics. One of the most commonly used wood-derived fillers is wood flour. Wood flour is commercially produced from post-industrial sources such as planer shavings, and sawdust. The scrap wood is selected for species purity and then ground to specific particle size distributions, which are typically fairly large (Stark and Berger 1997).

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a. to assess the suitability of Keruing Belimbing sawdust as filler in thermoplastic composite manufacture; and b. to study the effect of particle size and filler content on the composite properties.

MATERIALS AND METHODS

Sample preparation

Keruing belimbing sawdust was collected during the saw-milling process. The sawdust was, then, dried in an oven at 105^0C for about 48 hours. After that, screening was done to separate them into the required size (20, 40, 60, 100 mesh size). The polypropylene was, first, melted in the Dispersion Mixer at a temperature of about 180^0C within 30 minutes. Maleated anhydride polypropylene (MAP) was added as the coupling agent. When the PP melts, the sawdust was gradually filled in slowly and blended further to produce a homogenous mixture. Then, the mixture was cooled and the thermoplastic granules produce is ready for board manufacture. Figure 1 shows the thermoplastic making process.

Bending samples were produced using a chrome-plated mould with dimensions of 150mm x 150mm x 6mm. The pellets weighing about 30grams was used to produce a single bending test sample. On the other hand, for tensile and water absorption samples, the required pellets were 245grams. The mould was, then, placed in a hot press and pressed for about 3 to 4 minutes with a temperature of 185^0C. All the test specimens were prepared and conditioned in accordance with the BS 2782 (Anonymous 1992). The test specimens were tested for their mechanical and water absorption properties using a Testometric testing machine.

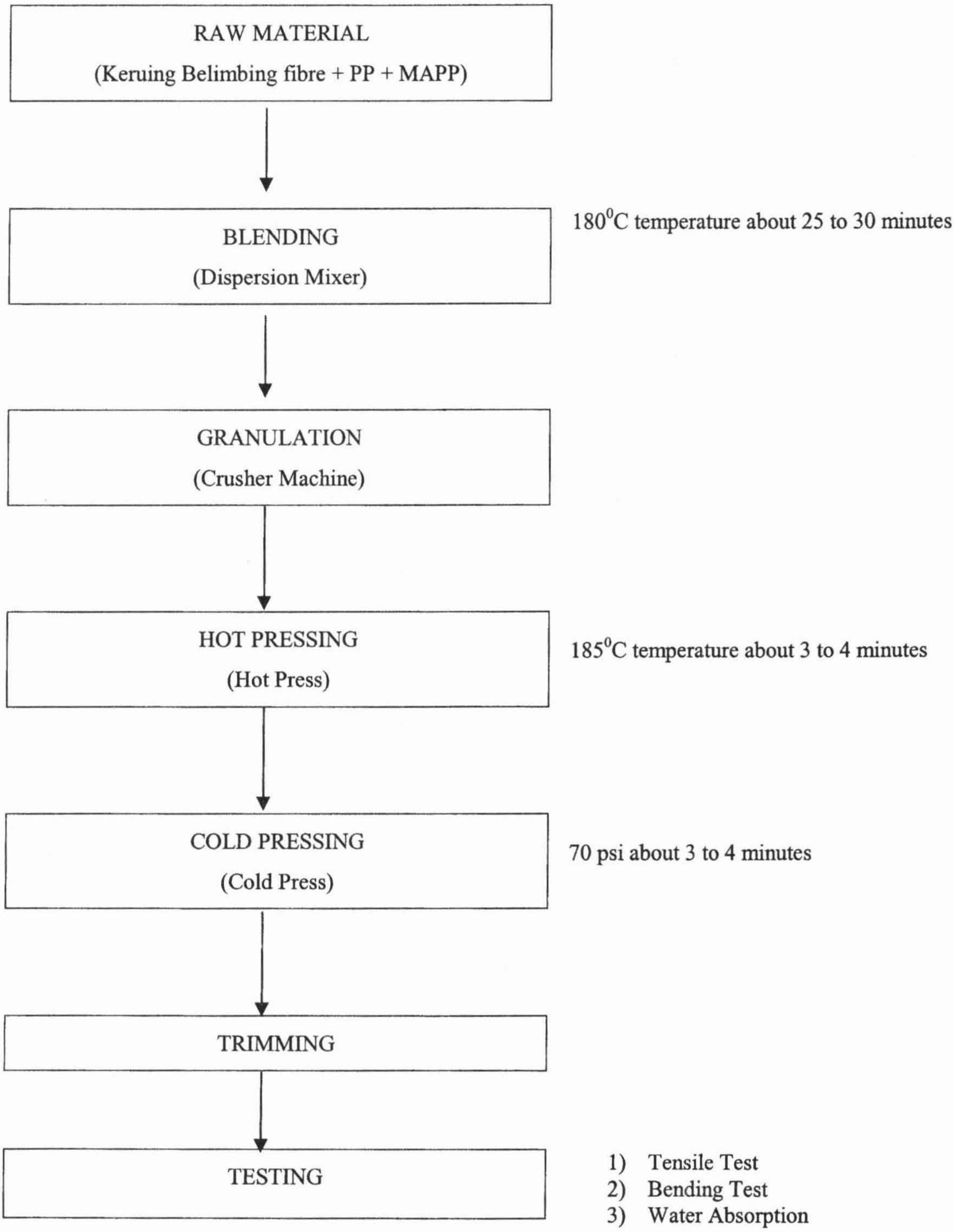

Figure 1: Flowchart of thermoplastic making operation

RESULTS AND DISCUSSION

Strength and Physical properties

The mechanical and water absorption properties of keruing belimbing sawdust-polypropylene composite are shown in Table 1.

Table 1: Strength and physical properties of Keruing Belimbing thermoplastic according to particle size, filler, and MAPP addition

PS	Filler	MAP	MOR	MOE	TEN	TMOE	ELONG	WA
20	10	3	33.28	2202	24.87	2064	7.20	0.14
	30	3	33.12	2423	19.90	3430	4.05	0.75
	50	3	29.87	2549	13.05	3165	2.94	4.09
40	10	3	34.52	2190	23.84	1651	8.13	0.15
	30	3	41.69	2411	18.74	3486	3.95	1.09
	50	3	31.29	2461	13.46	2909	2.95	2.79
60	10	3	40.07	1840	23.50	1963	7.74	0.12
	30	3	29.41	2418	19.04	3120	4.44	0.62
	50	3	27.22	2515	12.44	2668	2.57	5.16
100	10	3	40.83	2205	24.90	1651	8.94	0.08
	30	3	40.98	2208	17.53	2852	3.97	0.46
	50	3	25.05	2274	12.09	3138	2.71	2.13

Notes; PS- particle size, MAPP-Maleated anhydride polypropylene, MOR- modulus of rupture, MOE- modulus of elasticity, TEN- tensile strength, TMOE- tensile modulus of elasticity, ELONG- elongation at break, WA- water absorption

Statistical Significance

Table 2 shows the analysis of variance of particle size and filler content on the composite properties. The particle size (PS) was shown to have significant effects on MOE, TMOE and WA. Filler content showed significant effects on the MOR, MOE, TEN, TMOE and WA. The interaction effect of PS x F on the MOR, MOE, TMOE, ELONG and WA value were shown to be significant.

Table 2: Analysis of variance on the effects of particle size and filler content on the properties of composite.

SOV	df	MOR	MOE	TEN	TMOE	ELONG	WA
PS	3	2.178ns	4.227*	2.488ns	3.669*	1.133ns	11.239
Filler	2	26.901*	28.924*	463.815*	115.807*	281.005*	235.57
PS x F	6	7.796*	4.703*	1.976ns	3.076*	2.429*	11.222

Notes; df- degeree of freedom, MOR- modulus of rupture, MOE- modulus of elasticity, TEN- tensile strength, TMOE- tensile modulus of elasticity, ELONG- elongation at break, WA- water absorption

Effect of Particle Size

The effect of particle size is shown in Figure 2. Modulus of Rupture (MOR) increased as the particle became smaller. An increase of about 11% was achieved when the particle size was reduced from 20 To 100 mesh. However, for MOE and TMOE value, bigger particle size shows higher results. For water absorption, smaller particle size gives the lowest water absorption. Smaller particle sizes are easily mixed with the matrix leading to better adhesion.

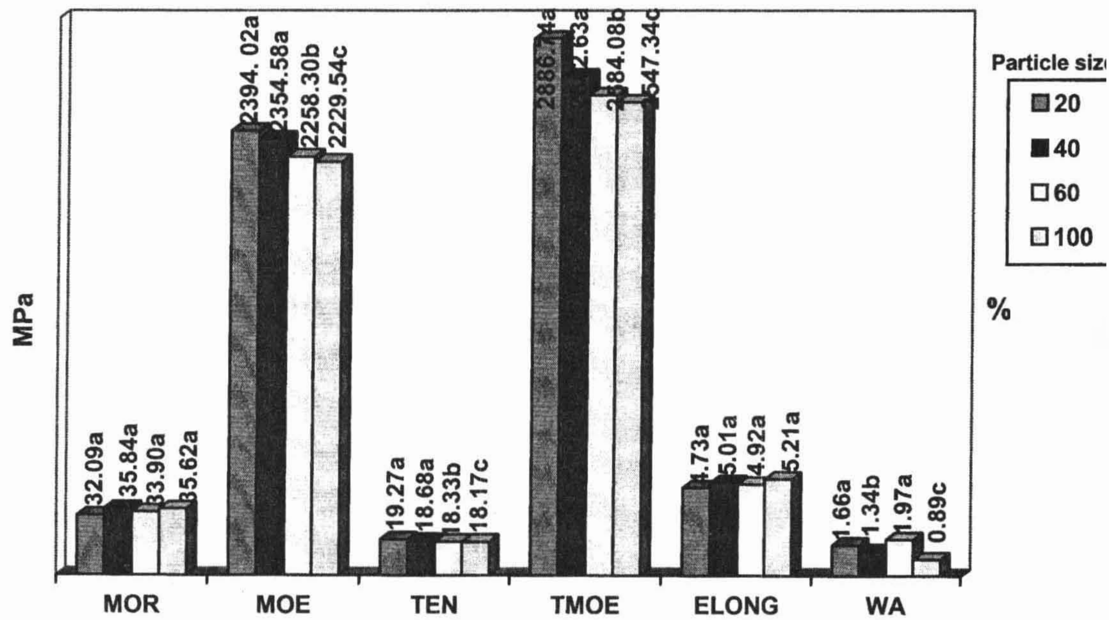

Figure 2 : Effect of Particle Size on the thermoplastic composite properties

Effect of Filler

Figure 3 shows the effect of filler content on the composite properties. Modulus of Rupture (MOR) and TEN decreased with higher filler content. The higher filler content makes the composite more brittle. However, for both MOE of bending and tensile, they increased with the higher filler content. The higher filler content also increases the water absorption. From the figure, we can see that water absorption was increased tremendously with increasing amount of filler content.

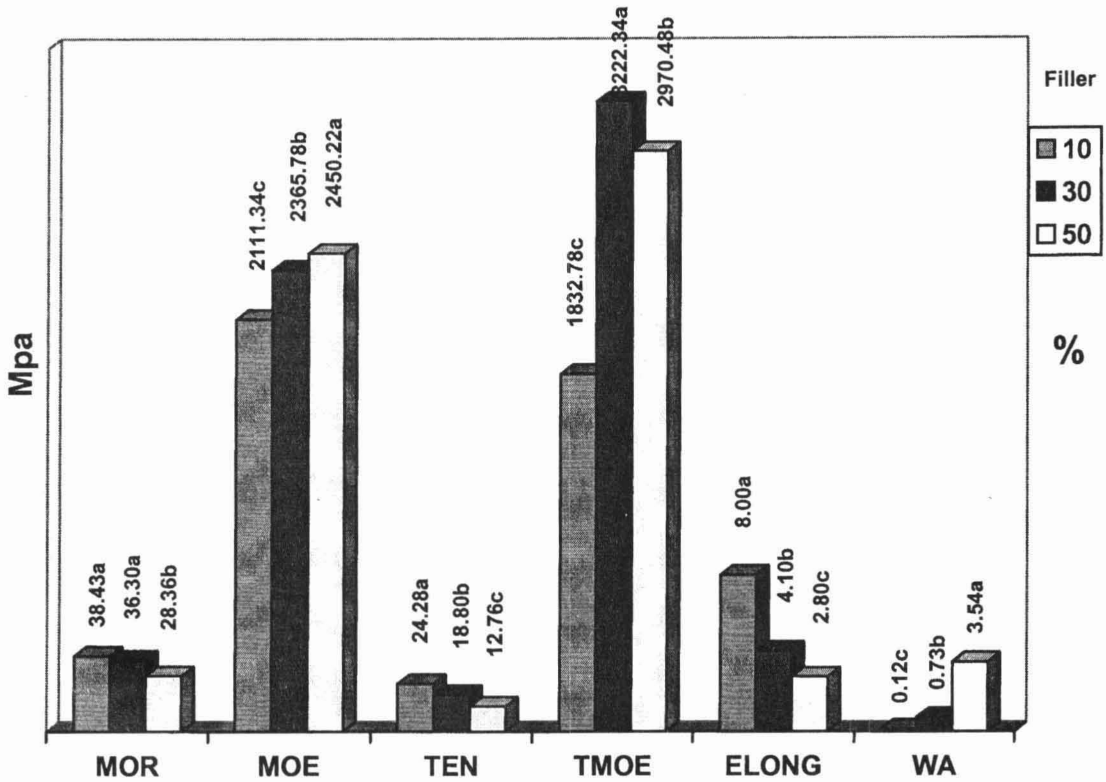

Figure 3 : Effect of filler on the thermoplastic composite properties

CONCLUSION

From the study, we can conclude that the MOR and ELONG properties of thermoplastic composite increases with the smaller particle. While bigger particles increases the TEN, modulus of elasticity and water absorption. The strength properties (except for the modulus of elasticity) decreases, however, the water absorption increases with the higher filler content. As the conclusion, Keruing Belimbing sawdusts are suitable and can be used as filler in manufacturing thermoplastic composite.

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