Preliminary Results of Wood Plastics Composite: An Innovative Eco-friendly Product

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Abstract: The eco-friendly wood plastics composite (WPC) made of low density polyethylene (LDPE) as the matrices and 80-mesh wood powder as the filler have been produced in various percentage composition, namely 85/15; 90/10; and 95/5 (w/w) using compounding process with xylene as the solvent of the plastics. Physical and mechanical properties have been investigated according to Japanese Industrial Standard (JIS) A 5908 for particleboard. In this contribution, emphasizing on the WPC as the eco-friendly product has been discussed through their capability to degrade after grave yard test. Even though the result of weight loss for the WPC's samples after buried in the soil for 50 days were very light, these results indicated that WPC has capability to decompose. In other words, products of WPC were environmentally friendly because they will deteriote after certain time buried in the soil although the composition of the plastics was majority.

1 INTRODUCTION

Wood plastics composite (WPC) is made by thoroughly mixing hydrophobic plastics as the matrix and hydrophilic wood as the filler (Suzuki, 2014). The types of wood filler are consisted of wood particle, wood flour, and wood pulp having different dimensions (size and shape) and aspect ratio (Kim, 2014). Initially, application of WPC can be found in automotive industry for interior parts such as door inner panels and seatbacks (Ozdemir & Mengeloglu, 2008) but to date, the use of WPC are more expand including in housing components such as decking, fencing, flooring, railings, moldings, and roofing (Caufield et al., 2005); and also infrastructure such as marine and boardwalks (Homkhiew et al. 2015).

Numerous investigators have been studied the manufacturing process of WPC (Ozdemir & Mengeloglu, 2008; Rahman et al., 2013); compatibility of hydrophobic plastics as the matrix and hydrophilic wood as the filler (Bledzki et al., 1998; Catto et al. 2014); properties of resulted WPC (Rahman et al., 2013; Catto et al. 2014); but only limited reports were found in durability of WPC (Schrip et al., 2008). Therefore in this contribution, investigation on degradation of WPC was reported.

The WPC was intended to be manufactured with predominant plastics in their composition in order to encapsulate the wood filler with the plastics. In this circumstance, if an organism like termite attacks the wood filler for feed, the matrices plastics should be broken first either physically or biologically. Termite will bite the surface of WPC to get the wood filler for feed. Physically the WPC will be broken down and biologically presumably the termite eats some part of plastics accidentally.

In this report, weight loss of the WPC after buried in the soil will be revealed. Others results such as micro-morphology of the WPC after grave yard test, spectroscopy test of termite's guts after WPC's feeding, and physical and mechanical properties of WPC will be declared elsewhere in upcoming publications. Therefore, the aim of this study was to observe step by step WPC alteration after decomposing in the soil particularly from weight loss point of view.

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2 MATERIALS AND METHODS

2.1 Preparation of Raw Materials

Commercial granule thermoplastics of LDPE (low density polyethylene) with specific gravity of 0.93 g/cm^3 and the melting point of 110°C, was used as the matrix. Wood filler was obtained by sieving industrial sawdust of durian-wood (*Durio* sp.) collected from local mills to 80-mesh particle size. The wood particle was then dried in an convection oven for 24 h at (105$\pm$2)°C. Xylene as the solvent of the plastics was reagent grade and purchased in local chemical store in Medan city.

2.2 Manufacturing Process

Here, compounding process was applied in this work. The process can be described as blending process which consists of mixing, kneading, and shearing, respectively prior to manufacturing products (Kim, 2014). Hence, in WPC, the compounding process is normally done to blend WPC compositions. Blended and compounded ingredients are formed into pellets for future processing. The compositions of the raw materials were shown in Table 1.

Table 1. Compositions of the raw materials for making WPC

Composition LDPE:wood filler	Amount of LDPE (g)	Amount of wood filler (g)
85:15	186	33
90:10	197	22
95:5	208	11

In this regards, traditional method of dissolution of the plastics was applied (Achilias et al., 2007). The solvent was placed in the reactor and then the mantle heater was heated up to 110°C. Subsequently, a certain amount of plastics were added and the mixture was heated under reflux for 25-30 minutes until the plastics had reached their melting temperature. After all of the plastics dissolved, wood filler was added and stirred gently approximately 10 minutes. The mixture in the form of pellets then was conditioned in fume hood for 24 h in order to evaporate the solvent.

The resulted pellets then was flat-pressed in 105°C using laboratory hydraulic hot press for 6 minutes for converting into board with size dimension of 25 cm x 25 cm and 0.5 cm in thickness with target density of 0.7 g/cm^3.

2.3 Durability Test

Prior to undergo test of durability, the WPC was cut into samples with size dimension of 5 cm x 5 cm as shown in Figure 1.

Figure 1. Specimen of respective WPC for durability testing in various proportions of plastics and wood filler (85:15, 90:10, and 95:5)

The specimens were buried in the soil for 50 days and they were weight every 10 days for measuring the weight loss. The resulted data were tabulated and the discussion regarding this data was presented. In order to avoid the influence of moisture content, the specimens were dried in convection oven for 24 h at (105$\pm$2)°C prior to balance. Observation of their alteration in micro-morphology before and after grave yard test will be reported in upcoming publications.

3 RESULTS AND DISCUSSIONS

Typical WPC in this research was shown in Figure 2. The WPC showed distinguish parts between LDPE matrices and wood filler under bright field microscope. Further advance micro-morphological characterization is needed to ensure clearly identify wood particle was encapsulated with the matrix in the WPC system, for instance previous work of one the author (Singh et al., 2013) in using FE-SEM (field emission scanning electron microscope) for resolving particle-matrix interfaces in the WPC.

In addition, wood filler appeared covered with LDPE plastics thus wood degrading organisms like termite will attack the plastics first before reach the edible wood. This condition is very important for investigating further such as behavior of termite in reaching edible wood; spectroscopy of termite's guts whether it contains plastics or not, and description of the micro-morphology of the WPC prior and after durability test whether the changes occurs only on the surface or into inner part of WPC.

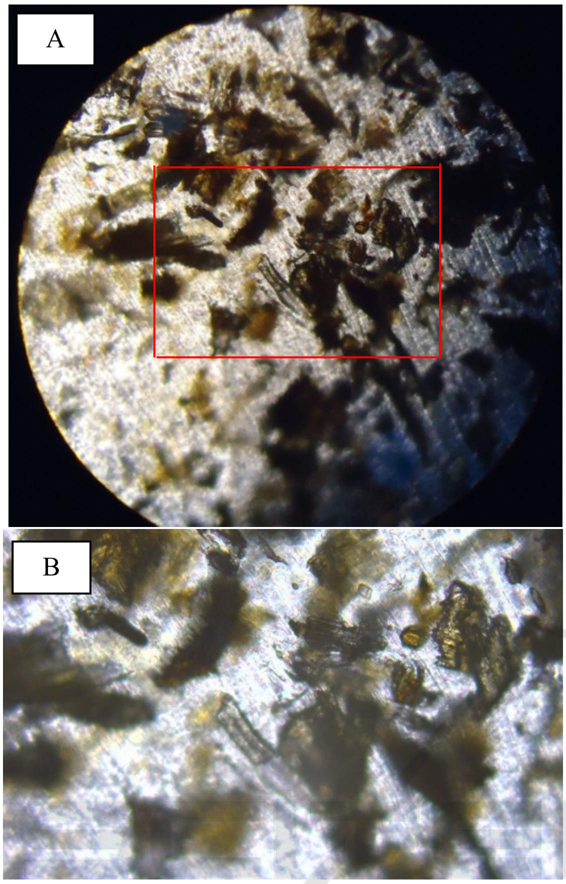

Figure 2. Typical wood filler which was covering LDPE matrices in specimen WPC with proportion of plastic and wood of 85:15. (A) under bright field microscope with 4x magnification and (B) with higher 10x magnification view of the red box in Fig.A

The weight of the WPC samples prior and after grave yard test in certain periods was shown in Table 2.

Table 2. Data of weight of the WPC samples before and after buried in the soil in certain days

Type of WPC / Weight (g)	WPC 85:15	WPC 90:10	WPC 95:5
Initial	8.67 (0.32)	8.36 (0.77)	8.48 (0.77)
10th day	8.62 (0.31)	8.31 (0.78)	8.46 (0.76)
20th day	8.56 (0.32)	8.25 (0.78)	8.42 (0.76)
30th day	8.52 (0.32)	8.21 (0.80)	8.39 (0.75)
40th day	8.47 (0.31)	8.16 (0.80)	8.35 (0.76)
50th day	8.42 (0.31)	8.11 (0.81)	8.30 (0.76)

Remarks: the parentheses is the standard deviation

From the data presented in Table 2, there was a consistent tendency of the weight loss. The longer buried in the soil, the weight of the WPCsample decreased. Although plastics can hinder wood filler from organisms attacks, the weight loss of the sample were occurs and inevitable. According to the best knowledge of the authors, wood can easily degrade *vice versa* with the plastics; they are very difficult to be decomposed. Therefore, they were factors made of the WPC deteriorate and they need investigate further, such as wood decaying fungi or symbioses between mold and termite as the agent of degrading wood.

4 CONCLUSIONS

Products of WPC were environmentally friendly because they will deteriote after certain time buried in the soil although the composition of the plastics was majority.

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