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Short-Term Water Absorption and Thickness Swelling Behavior of Recycled Polyethylene Reinforced with Bagasse Flour

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Abstract: Composite materials were made from bagasse flour and recycled high density polyethylene (rHDPE), by using injection molding. Short-term physical properties were investigated with water immersion. The bagasse flour contents were 30, 40 and 50% by weight. It was found that the water absorption and thickness swelling increase with bagasse content increase.

Key words: Bagasse Flour % Thickness Swelling % Polyethylene % Water Absorption

INTRODUCTION

In recent years natural fibers composites have found an increasing number of applications [1-3]. These composites have shown special interest in interior components for automotives such as seat frames, side panel and central consoles [4-5]. Advantages of natural fibers are low cost, low density, high specific properties, biodegradable and non-adhesive characteristics. The main disadvantages of natural fibers are low permissible processing temperatures, the tendency to form clumps and the hydrophilic nature [6]. Sugarcane bagasse is a plentiful lignocellulosic waste typically found in tropical countries that process sugarcane, such as Brazil, India, Cuba and Iran. Approximately 4.3 million tons of bagasse is produced annually in Iran that is mainly centered in the southwestern province of Khuzestan [7]. The chemical compositions of pure bagasse fiber bundles are cellulose (52.42%), lignin (21.69%), hemicellulose (25.8%), ash (2.73%) and ethanol/dichloro methane extract (1.66%) [8]. Water absorption and thickness swelling are the most important physical characteristics of wood plastic composites (WPCs) exposed to environmental conditions and thus, determining their end use applications [9]. Water absorption can deteriorate both mechanical properties and dimensional stability in such composites. Therefore, hygroscopic characteristics have to be taken into account as limiting parameters in the design of WPCs with regard to their final applications [10, 11]. The aim of this study was to investigate the short-term water absorption and thickness swelling behavior of recycled polyethylene reinforced with bagasse flour.

MATERIALS AND METHOD

Fiber: Bagasse flour (BF) was from Choob Plastic DEZ Co. (Iran). The particle size of bagasse flour was 100 meshes.

Polymer Matrix: Polyethylene (PE) was obtained from Arak Petrochemical Company (Iran). Polymers used for making composites were recycled high-density polyethylene (rHDPE) in the form of granul. The rHDPE has melt flow indices of 23.037 g/10 min at 190°C and density of 0.956 g cmG^3.

Coupling Agent: Maleic anhydride poly-ethylene (MAPE) was used as coupling agent.

The first, bagasse flour and MAPE were dried in an oven at (65 ± 2)°C for 24 h. Then the components of each sample (rHDPE, MAPE and bagasse flour) were pre-mixed to prepare homogeneous compounds according to formulations given in Table 1. And were blended in a counter-rotating twin-screw extruder (Dr. Collin System)

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Table 1: Composition of the Studied Formulations

Code	Recycled polyethylene Content (Wt. %)	Bagasse Flour Content (Wt. %)	Coupling Agent Content (Wt. phc)
A	70	30	3
B	60	40	3
C	50	50	3

at a screw speed of 50 rpm at 175°C. The compounded materials were then grinded to prepare the granules using a grinder (WIESER, WGLS 200/200 model). The mix was removed from the mixing bowl, cooled in water and granulated into pellets. The pellets were dried at 105°C for 24 h before injection molding. Test specimens were prepared by an injection molding machine (Imen Machine, IRAN) at 190°C and a pressure of 10 MPa according to standard ASTM D638.

Measurements: Water absorption and thickness swelling tests were carried out according to ASTM D-7031-04. Five specimens of each formulation were selected and dried in an oven for 24 h at 102±3°C. The weight and thickness of dried specimens were measured to a precision of 0.001 g and 0.001 mm, respectively. The specimens were immersed distilled water for 24 h at room temperature. Then, the excess water on the surface was wiped off by blotting paper. The values of the water absorption in percentage were calculated using the following equation 1.

$$WA(t)\frac{w(t)-w(o)}{w(o)}\times 100 \quad (1)$$

Where WA (t) is the water absorption at time t, W_o is the oven dried weight and W (t) is the weight of specimen at a given immersion time t.

The values of the thickness swelling in percentage were calculated using equation 2.

$$TS(t)\frac{T(t)-T(o)}{T(o)}\times 100 \quad (2)$$

Where TS (t) is the thickness swelling at time t, T_o is the initial thickness of specimens and T (t) is the thickness at time t.

RESULTS AND DISCUSSION

Figures 1 and 2 shows the short-term values of the water absorption and thickness swelling for the composites. Generally, the water absorption and thickness swelling increased with the bagasse flour content. The bagasse flour content induced significant water absorption and thickness swelling. These result are similar to those reported by Pecina *et al*. [10] for wood/plastic (polypropylene) composites as well as by Carvajal *et al*. [11], Owen De G *et al*., (2004) for bagasse particleboard and Talavera *et al*. [12]. Adding 3 phc coupling agent (MAPE) to the composites significantly reduced the water absorption this was true for areas being covered by the polymer during compounding the addition of the coupling agent increases the ester linkages between the hydroxyl groups of wood flour and the anhydride part of MAPE. Therefore, the amount of free OH^- in the wood cellulose is reduced because some of them are interacting with succininc anhydride.

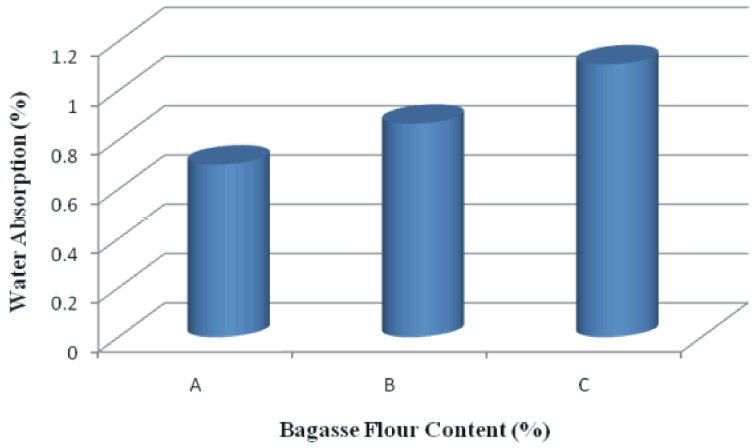

Fig. 1: Effect of bagasse flour content on the water absorption

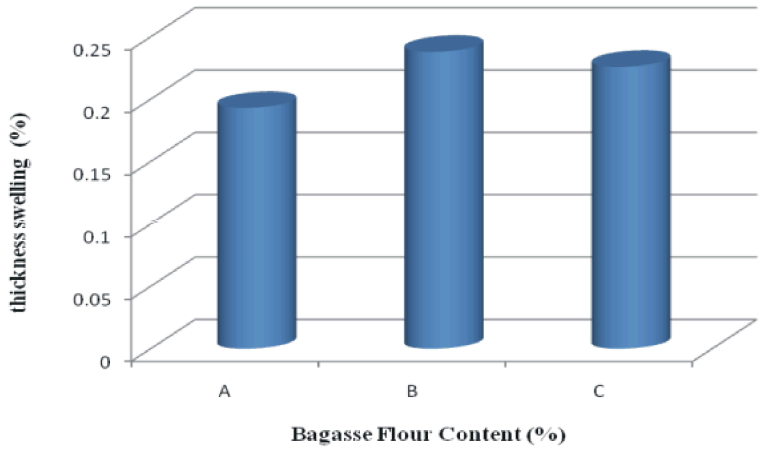

Fig. 2: Effect of bagasse flour content on the thickness swelling

CONCLUSION

The water absorption and thickness swelling of composites was lowered with the decrease in bagasse flour content. This paper investigated the short-term water absorption and thickness swelling (TS) properties for the injection molding composites made of bagasse flour recycled polyethylene.

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REFERENCES

1. Facca, A.G., M.T. Kortschot and N. Yan, 2007. Predicting the tensile strength of natural fiber reinforced thermoplastics. Compos Sci. Technol., 67: 2454-2466.
2. Abdelmouleh, M., S. Boufi, M.N. Belgacem and A. Dufresne, 2007. Short natural-fibre reinforced polyethylene and natural rubber composites: effect of silane coupling agents and fibres loading. Compos Sci. Technol., 67: 1627-1639.
3. Georgopoulos, S.T., P.A. Tarantili, E. Avgerinos, A.G. Andreipoulos and E.G. Loukios, 2005. Thermoplastic polymers reinforced with fibrous agricultural residues. Polym Degrad Stab., 90: 303-312.
4. Farag, M.M., 2008. Quantitative methods of materials substitution: application to automotive components. Mater Design, 29: 374-380.
5. Zah, R., R. Hischier, A.L. Leo and I. Braun Curaug. 2007. Fibers in the automobile industry - a sustainability assessment. J. Cleaner Prod., 15: 1032-1040.
6. Liu, C.F., R.C. Sun, A.P. Zhang, J.L. Ren, X.A. Wang, M.H. Qin, *et al*., 2007. Homogeneous modification of sugarcane bagasse cellulose with succinic anhydride using a ionic liquid as reaction medium. Carbohyd Polym., 342: 919-926.
7. Najafi, G., B. Ghobadian, T. Tavakoli and T. Yusaf, 2009. "Potential of bioethanol production from agricultural wastes in Iran," Renewable and Sustainable Energy, 13(6/7): 1418-1427.
8. Rezayati-Charani, P. and J. Mohammadi-Rovshandeh, 2005. Effect of pulping variables with dimethyl formamide on the characteristics of bagasse-fiber, Bioresource Technol., 96: 1658-1669.
9. Kazemi Najafi, S., M. Tajvidi and E. Hamidinia, 2007. Effect of temperature, plastic type and virginity on the water uptake of sawdust/plastic composites. Holz Roh Werks J., 65: 377-382.
10. Pecina, H., G. Kuhne and J.P. Stephan, 1998. Holzspanplatten mit Sekundar-polypropylene Bindung. Holz als Roh Werkstoff, 56(2): 114.

11. Carvajal, O., J. Puig, J.A. Leal and M.E. Rodriguez, 1985. Influencia del contenido de meollo sobre la calidad los tableros de particulas Revista ICIDCA 29(3): 19-24.

12. Talavera, F., S. Silva Guzman, H.G. Richter, S. Duenas and R. Quirarte, 2007. Effect of production variables on bending properties, water absorption and thickness swelling of bagasse/plastic composite boards. Industrial Crops and Products, 25: 1-7.