Investigation on Physical Properties of a Composite Made from Bagasse Flour and Recycled High Density Polyethylene

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Abstract: Bagasse flour was used as reinforcement of recycled high density polyethylene (rHDPE) in order to make composite material. Reinforcement was mixed in 20, 30 and 40 wt% levels with RHPP. Maleic anhydride polyethylene was also employed as chelating agent. The resultant composite was produced by injection molding technique. Results indicated that time durations of 2 and 24hr have yielded the least water absorption and thickness swelling for bagasse flour content of 20%.

Key words: Reinforcement · Composite · Chelating agent · Thickness swelling

INTRODUCTION

Sugar cane is an important agricultural crop in Iran [1]. The cane stalk consists of an inner pith that contains most of the sucrose and an outer rind with lignocellulosic fibers. Cane processing crushes the entire stalk to extract the sucrose, from which refined sugar is produced. Large quantities of the bagasse, containing both crushed rind and pith fibers, remain after sugar extraction. Disposal of this byproduct from the sugar industry is so far still inefficient [2-3].

One of the most remarkable features of composite materials is their relatively low water absorption in comparison to wood materials. This is one of the few properties which make composites advantageous against wood lumbers, especially in terms of dimensional stability and durability of these materials such as resistance to bacterial degradation [4].

When a piece of wood is immersed in water, it’s weight increases by about 25% after 24hr. In other words, wood will absorb water 25% of it’s own weight in this time. On longer exposure times, wood is able to double it’s own weight (100% water absorption) [5].

Moisture content varies for different trees between 30 to more than 200 wt.% [6]. Wood-Plastic Composite (WPC) materials absorb water 0.7-2 wt%, 1-5wt.% and 18-22wt.% after a day, a week and months, respectively.

Water absorption and thickness swelling characteristics of composite materials have been studied recently including pulp fiber/wood flour [7], waste newspaper fiber/wood flour [8], recycled newspaper fiber/paper flour [9] and jute nut fiber [10].

The aim of this research was to find out physical properties of composite materials produced from bagasse flour and rHDPE.

MATERIALS AND METHODS

Materials: In Iran, urban waste is not scheduled to be separated; dealers of once used containers are unaware of their constituents; and some impurities exist in raw materials of these containers. Therefore, it was decided to produce recycled high density Polyethylene (rHDPE) in this study by laboratory methods instead of collecting used bottles of milk to avoid any mistake and to have further accuracy. Thus, high density Polyethylene with
melt flow index of 23.037g/10min was procured from Arak Petrochemical co. It was melted twice in a spiral extruder and then granulated.

Bagasse flour was gained from Dez Wood-Plastic Company and it was screened by laboratory sieves. The flour remained on Mesh 60 sieve was used as reinforcement. Also, chelating agent of MAPE was used up to 2% in order to increase consistency between rHDPE and bagasse flour.

Mixing Procedure: Mixing was carried out in two spiral extruder at 40 rpm and 180°C. The extruded samples were then transformed to granules in the crushing apparatuses.

Making Experimental Samples: After mixing, the crushed materials were cast by injection molding apparatuses to yield the experimental samples. Physical examinations for studying water absorption and thickness swelling were run followed by 2 and 24hr immersion according to ASTM D-1037.

Statistical calculations were done using SPSS software. Results of this section were evaluated within an experimental form completely randomized, while Duncan test was applied to conduct comparison between average values.

RESULTS

Water Absorption after 2 and 24hr Immersion: Effect of different levels of reinforcement materials on water absorption characteristics of the composites, has been proved significant at 99% reliability being soaked for 2 and 24 hours. Water absorption is increased after 2 and 24 hr with higher amounts of reinforcement materials added. Although the lowest content of absorbed water after 2hr immersion is related to 20% reinforced, the highest content of absorbed water after 24hr associates with 40% reinforced (Figures 1). It should be noted that the percentage of water absorption is also increased generally when more reinforcement materials are used which can be attributed to hydrophilic nature of lignocelluloses materials. However, once composed with polymer matrix materials, water absorption of the composite is decreased due to hydrophobic nature of these polymeric materials.

Thicknes Swelling after 2 and 24hr Immersion: Effect of different levels of reinforcement materials on thickness swelling of the composites, has been shown significant at 99% reliability being soaked for 2 and 24 hours. Thickness swelling is increased after 2 and 24 hr with higher amounts of reinforcement materials. Although the lowest content of thickness swelling after 2hr immersion is related to 20% reinforced, the highest content of thickness swelling after 24hr associates with 40% reinforced (Figures 2). Noteworthy is that functional groups of hydroxyl existing in the reinforcement phase and there is some bondings between these materials and polymers. Once the composite is exposed to water, it’s connections or bondings will break and form new connections, which can lead to increased water absorption and thickness swelling as well.

DISCUSSIONS AND CONCLUSIONS

Results of this study have uncovered that bagasse flour is an appropriate material for being used as reinforcement of rHDPE. Water absorption after 24hr
immersion had the lowest value when some 20% reinforcement was consumed in bagasse flour/rHDPE composites. Mahlberg and Gaulfield investigations (2003) have demonstrated that the samples are prone to absorb water and be swelled in thickness when wood fibers are used to a greater extent in making the composite [11]. His findings were in accordance by the results of Maadani pour and Hemmasi (2008) [12]. Further, thickness swelling after 2hr immersion had the lowest value when some 20% reinforcement was consumed in bagasse flour/rHDPE composites. Kerzisick and Yanguist (1999) have also discovered that the thickness swelling would be decreased with lower content of cellulosic fibers [13]. Rawel and Daniel (2002) have found that using maleic anhydride as absorbent will lower water absorption due to the strong chemical bondings between the fibers and the plastic material [14].

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**REFERENCES**