Fabrication of Untreated and Treated Betel Nut Fiber Reinforced Polypropylene Composites and Their Physical Properties

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Abstract— Untreated and treated betel nut fiber reinforced polypropylene (PP) composites were prepared using compression molding at 170°C and several weight percentage of these composites namely 0%, 5%, 10% and 15% were used. The physical properties of the composites were studied and compared for treated and untreated betel nut fiber. The physical properties measured includes bulk density, water absorption for potential application furniture, mat etc. Water absorption of the untreated fiber reinforced composites was higher than that of treated fiber composites.

Index Terms— Polymer composite, Polypropylene, Betel nut fiber, Physical properties, Natural Fiber, Reinforced Polymer Composites.

1 Introduction

THIS is important to realize that advancement of modern civilization, mostly depends on the field of material science. Conventional metals, alloys and polymeric materials are being replaced by the composite materials, because of their unusual good properties, which are extremely helpful for the human civilization [1-5]. Composite materials taking the place of popularity because of their strong applications in the fields of aerospace underwater, transportation and space investigation etc. Every day we are using many products made from monolithic materials or alloys. Composite materials are those which consist of more than one individual materials (individual materials are distinguishable) [6]. A common example could be concrete [7-8]. For this investigation, our total intension is to make, natural fiber reinforced composite material which will be cost effective as well as biodegradable and will have good physical and mechanical properties etc. [9-11]. Few common properties of natural fibers, can be mentioned, such as, very good strength properties, good heat, and sound and electrical insulating properties, Combustibility, Biodegradability, Dimensional stability, Reactivity etc. Present work is focused to use betel nut fiber as reinforcement for block copolymer composites.

Conventional composite fabrication done through simple method. Modern technology and experiments reveal, great advantages than traditional monolithic materials. Composite materials, opened a new horizon, because of their wide applications from our daily life to space investigation [13 -15]. Aim of this work is to prepare betel nut fiber reinforced PP composites and compare physical properties between untreated nut fiber/PP and treated/PP composites and to make high performance application materials, which can be used for household and Industrial applications.

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2 Materials and Methods

2.1 Methods

Instruments that have been used during the experiment were Paul-Otto Weber press machine, Universal testing machine, electric balance, woven etc.

2.2 Raw Materials

The chief raw materials used for the sample preparation are betel nut fibers and polypropylene (PP). All of these materials are collected from the local market as shown in figure 1.

2.3 Composites Preparation

Fiber Extraction

Selected areca fruit husks were used to prepare the composite. Dried areca husk was soaked in deionized water for about ten days. The soaking process loosens the fibers, which then can be extracted out easily. Finally, the fibers were washed again with deioned water and dried in a woven for about 24 hours at 50 °C temperature. The dried fibers were designated as untreated fibers.

Alkali Treatment

First the areca fibers were treated in a solution of 10% NaOH (Sodium hydroxide), where the total volume of solution was 15 times the weight of areca fibers. The fibers were kept in this alkaline solution for 1 hour at a temperature 30 °C; they were thoroughly washed in running water to remove the last traces of acid sticking to it, so that the pH of the fibers was approximately 7(neutral).Then they were dried in an woven for about 24 hours at 50 °C temperature to obtain treated fibers.

Fabrication of Composites

At first about 20gm of raw polypropylene granules were taken to make PP sheets. To make each PP sheet, the Weber-presser hydraulic press was used. Firstly about 20gm PP was placed between two molds and then pressed to heat and pressure in a single stoke. This was accomplished by placed the molds between two steel plates of 350 KN Weber-press. Then the two plates were heated at temperature which was set at 170º C around 33 minutes under 100 KN pressure. After reaching the set temperature, the holding time was taken about 10 minutes.

Fig. 1. Raw materials for composites (betel nut fiber and polypropylene).

TABLE 1
COMPOSITION OF DIFFERENT PERCENTAGES OF PP, NUT FIBERS IN COMPOSITES

Composites	PP (in gm)	Nut fibers (in gm)	Weight (in %)
C 1	30	0	0
C 2	30	2	5
C 3	30	3	10
C 3	30	6	15

(Betel nut fibers were sandwiched between two pp sheets according to different wt. %)

Then the pressure was increased up to 100 KN and stopped the heating system. Then the system was allowed to cool. Cooling was done by tap water through the outer area of the heating plates of the Paul-Otto Weber machine and the cooling time was around 13-15 minutes. In this way the PP sheets were prepared by compression molding. Now the composites were made for different ratio of PP and treated and untreated nut fibers (100:5,100:10 and 100:15 weight %). Each layer of PP was pre-impregnated with nut fibers and placed one over another (nut fibers out between two PP sheets by a strainer) as a sandwich-making system. The sandwich was then placed between two molds. Then the sandwich was subjected to heat and pressure in a single stoke. This was accomplished by placed the molds between two steel plates of 350 KN Weber-press. Then the two plates were heated at temperature which was set at 160º C around 30 minutes under 90 KN pressure. After reaching the set temperature, the holding time was taken about 10 minutes. Then the pressure was increased up to 100 KN and stopped the heating system and the system was allowed to cool. Cooling was done by tap water through the outer area of the heating plates of the Paul-Otto Weber machine and the cooling time was around 11-15 minutes. Thus the composites (wt. % of fiber) of betel nut fibers reinforced Polypropylene (PP) matrix were prepared by compression molding at 160º C and 90 KN pressure. In order to know, the physical properties of treated and untreated fiber reinforced polypropylene, composites made by the compressive molding process.

3 RESULT AND DISCUSSION

3.1 Bulk Density

The effect of bulk density of untreated and treated nut fiber reinforced polypropylene composites are shown in figure 2.

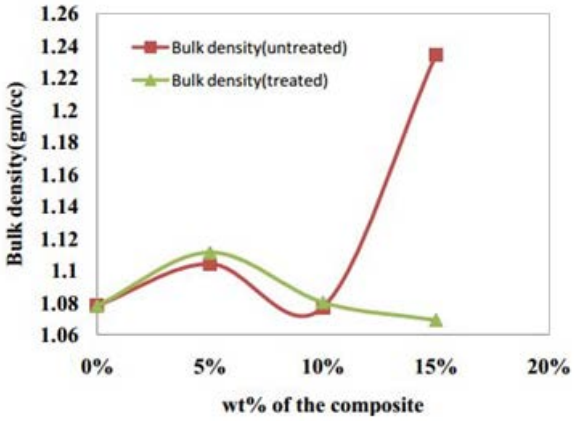

Fig. 2. Comparison of bulk density between untreated nut fiber-PP and treated nut fiber-PP composites with different wt. % of fiber.

A number of wt. % percent of untreated fiber (0%, 5%, 10%, and 15%) and treated fiber (0%, 5%, 10%, and 15%) have been taken for fabrication. Bulk density of the composites decreases due to increases the wt. % of the treated fiber. This follows the mixture rule. [12]. On the other hand, the density of untreated -PP composites increases with increasing fiber addition.

3.2 Water Absorption

The effect of soaking time on water absorption of PP and PP-untreated nut fiber composites prepared with different wt. % of untreated fiber is shown in fig. 3. It reveals that the water absorption depend on fiber addition and immersion of time.

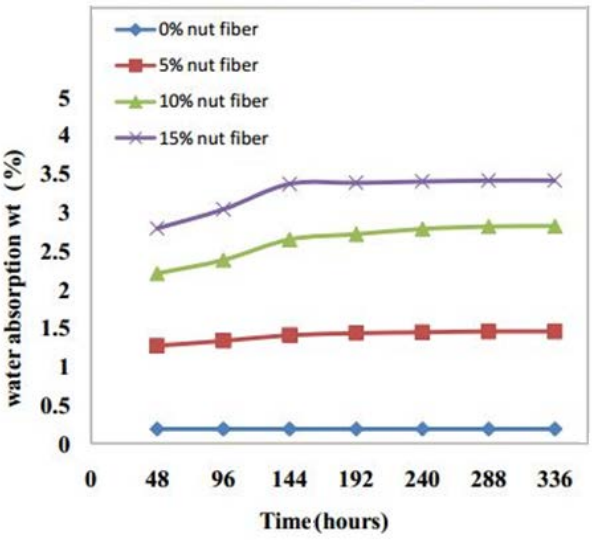

Fig. 3. Effect of soaking time on water absorption of PP-untreated nut fiber composites for different % of fiber.

It can be seen that the percentage of water absorption for all percent of fiber content increases with time, as it is a diffusion phenomenon. While the PP shows very little absorption with time. This is because of hydrophilic nature of betel nut fiber and hydrophobic nature of PP. For this reason, PP shows almost no water absorption with time but due to hydrophilic nature of nut is higher water intake in the composites.

The water absorption of these composites was measured by soaking the composites in water contained in a static bath for different period of time. The cellulosic, the lignin and also void spaces that present in the composites might be responsible for the increase of water absorption with soaking time.

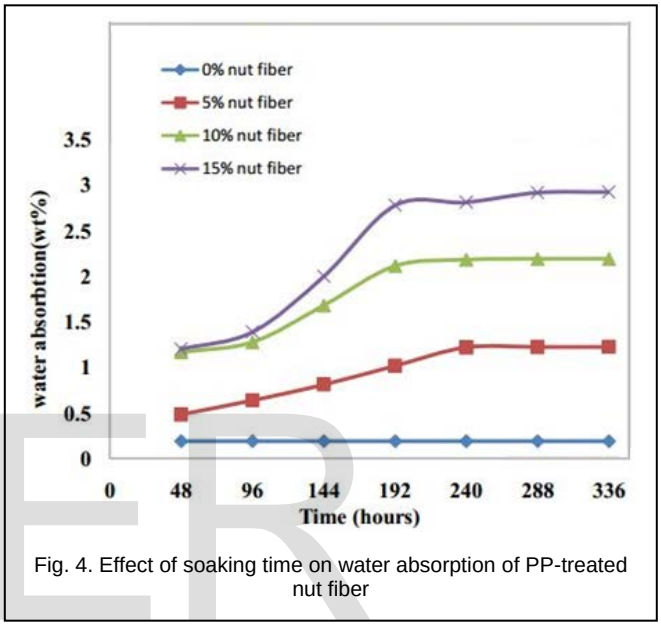

Fig. 4. Effect of soaking time on water absorption of PP-treated nut fiber

Fig. 4 shows the effect of time on water absorption of treated nut fiber-PP composites. It shows rapid water absorption with increasing treated fiber addition and soaking time. The figure shows that % of water intake increases speedily initially with increases time after that it remain constant.

4 CONCLUSION

The following conclusions may be drawn from the present study.

- Betel nut fiber reinforced PP based composites were fabricated by hot press molding machine.
- Varying the amount of matrix and fiber is the most important parameter of this fabricated process. A number of wt. % of fiber (0%, 5%, 10%, and 15%) had been taken for fabrication.
- The bulk density of PP without addition of fiber was found 1.078 gm/cc. After addition of untreated fiber bulk density of composites increased. But bulk density of treated nut fiber –pp composites decreased very slowly.
- For all the composites water absorption increases with increase of fiber addition and soaking time. But the same percentage of fiber, water absorption of

treated fiber based composites increased much more than that of untreated fiber composites with time.

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