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ALKALINE TREATMENT ON KENAF FIBER TO BE INCORPORATED IN UNSATURATED POLYESTER

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ABSTRACT

The improvement of mechanical characteristics including of tensile strength, tensile modulus, flexural strength and flexural modulus of kenaf fiber incorporated in unsaturated polyester by alkaline treatment. Different concentration of 2%, 4%, 6% and 8% NaOH was used on kenaf fiber mat and the best concentration was chosen to check on the tensile tensile strength, tensile modulus, flexural strength and flexural modulus. The scanning electron microscope (SEM) image was used to observe the changes in the view of kenaf fiber. SEM image of treated and untreated kenaf showed the difference where the surface of kenaf seems to be rough. The modification of fiber by sodium hydroxide was effectively softening the fiber surface. Results show the tensile tensile strength, tensile modulus, flexural strength and flexural modulus was increasing with the increasing of NaOH concentration. Results from this study showed that the alkaline treatment has improved the mechanical characteristics of kenaf fiber incorporated in saturated polyester.

Keywords: mechanical characteristics, kenaf, biocomposite.

INTRODUCTION

The introduction of natural fiber composites is becoming interesting, especially by manufacturers in the automotive application. Natural fibers like kenaf can offer great advantages as compared to the synthetic fibers. Kenaf (Hibiscus cannabinus L) can offer renewability, biodegradability, low cost, low density and acceptable specific mechanical properties. In fact, it can reduce the environmental problems due to dependency on the petroleum based product which produce toxic chemicals and exhibits non-degradable characteristics. This leads to the increasing usage of kenaf as a reinforcement in the biocomposites [1] or as a hybrid material [2].

Polyester resins are widely used as a matrix in polymer composites, but polymerization of these resins will result in brittleness due to high cross linking level. Polyester has comparable mechanical properties to a number of conventional plastic which it made it as a reasonable substitute. However, polyester is a material with inherent brittleness and rigid behavior. The idea of producing polyester bio-composite materials is to strike a balance within the framework of strength and stiffness. The most frequently used reinforcement in this system is provided by glass fibers. More recently, the possibility of using cellulosic fibers as reinforcement in composites has brought forth several studies. In order to maintain the degradable properties, one promising candidate of natural fiber which is kenaf fiber may be incorporated as reinforcement fiber into a polyester resin.

The major problem of natural fiber composite originates from the hydrophilic nature of the fiber and hydrophobic nature of the matrix. The inherent incompatibility between these two phase results weakening the bonding at the interface. Chemical treatment on reinforcing fiber can reduce its hydrophilic tendency and thus improve compatibility with the matrix. Several research activities have been conducted to improve fiber adhesion properties with the matrix through various types of chemical treatment [3]. Some researchers have treated hemp, jute, sisal and kapok fiber with various concentrations of NaOH and found out that alkalizing gave a better flexural modulus, flexural strength, impact strength and strength modulus for polymeric composite [4].

In this present study, the effect of the alkaline treatment on kenaf fiber composite was investigated. Lastly, the toy car model will be developed using the best characteristics of kenaf fiber reinforced polyester composite.

METHODOLOGY

Materials

Kenaf fiber used in this work was supplied by Innovative Pultrusion Sdn. Bhd in Negeri Sembilan, Malaysia. Kenaf fiber was cut into a square shaped of 12cm x 12cm to undergo the treatment that was selected to be incorporated with unsaturated polyester (UP) or resin and also analytical grade NaOH.

Alkaline treatment

Samples of kenaf fiber were immersed in NaOH solution with different concentrations which are 2% wt, 4% wt, 6% wt and 8% wt for 3 hours at room temperature. Then, it was washed six times with distilled water to remove excess NaOH. Kenaf fiber was then oven dried at 80 °C for 24 hours.

Scanning electron microscope

The surface morphology of untreated, treated fibers was investigated using a scanning electron microscope (SEM) model SUPRA 35VP. The fiber was cut to a height of 10mm, coated with gold and rubbed upon a 25mm diameter disc as before analysis begin.

Preparation of Kenaf fiber/polyester composite

After the specimens from SEM are scanned, the selected specimen with the best structure is then incorporated with polyester. This production requires compression molding machine that can apply 1400 psi of pressure to make the composite to become in square-shaped. The measurements of the sample were cut to become 120mm x 120mm and the thickness of the sample is 4mm. The ratios of polyester and kenaf fiber chosen are 80/20 respectively.

Tensile test

The thickness, width and gauge length of a dumbbell shape sample was measured. Then, it was placed in the grips for further testing. Tensile test was carried out using Universal Testing Machine (UTM) (Instron 5567). The testing was done according to the ASTM D 638 standard at a cross-head speed of 50 mm/min.

Flexural test

A simple square-shaped specimen was used for the flexural test. The thickness and width of the specimen were measured and recorded. This test was conducted using UTM (Instron 5567). The speed of cross-head was set at 1.5 mm/min. The load was applied to the center of the specimen producing three points bending at a specific rate.

Impact test

Standard notch according to ASTM D 256 was done on the specimens (rectangular bar) before the impact test was conducted. The width and thickness of the specimen were measured via Vernier caliper and the readings were recorded. Some calculation was done to obtain hardness measurements. 2.4 mm depth of the notch was made by using CEAST/Torino Italy Type 6530. Then the specimens were clamped in the vice precisely and rigid position on the Izod impact tester. The weight of the hammer used is 7.5 J.

Toy car model

After all the tests completed, the best sample was chosen to use as the toy car model composite. Toy car mold was waxed and resin was poured into the mold. Then, kenaf fiber was placed on the mold and resin was poured again on the mold to double the layer of the resin. The mold was then left at room temperatures to dry up for 4 hours.

RESULTS AND DISCUSSION

Surface morphology study using scanning electron microscope

SEM provides an excellent technique for the examination of surface of fiber composites. In this study, morphological changes that occurred after treatment were treated. All micrograph of untreated and treated kenaf fiber are provided in Figure-1. Figure-1 (a) shows the SEM micrograph of an untreated kenaf fiber. The surface of kenaf seems to be rough. The modification of fiber by NaOH was effectively softening the fiber surface. Figure-1 (b) shows the SEM micrograph of the surface of kenaf that undergoes 2% of NaOH treatment. From the micrograph, it was found that the surface of kenaf is more soften than untreated fiber and NaOH carried out the impurities in the fiber out to be removed. Figure-1 (c) shows the SEM micrograph of the surface of kenaf that undergoes 4% of NaOH treatment. It was observed that the surface of kenaf is cleaner than the treatment of kenaf fiber at 2% NaOH. Figure-1 (d) shows the SEM micrograph of the surface of kenaf fiber that undergoes 6% of NaOH treatment. As compared to the previous treatment, this treatment proves that the increase of NaOH concentration softens and cleans the surface of kenaf fiber. Figure-1 (e) shows the SEM micrograph of the surface of kenaf fiber that undergoes 8% of NaOH treatment. It was observed that the surface is most clean. However, it is a bit damaged due to high concentration of NaOH [5].

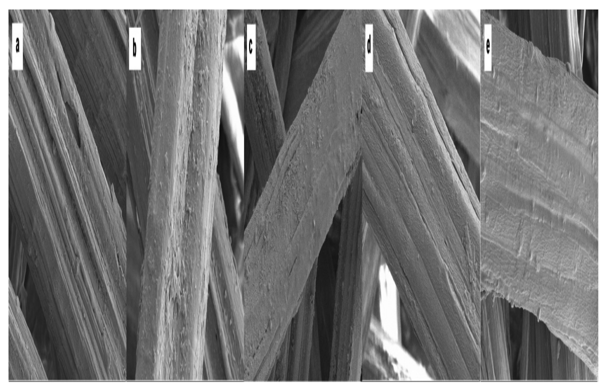

Figure-1.SEM micrograph of kenaf fiber (a) untreated fiber, (b) 2% NaOH, (c) 4%NaOH, (d) 6% NaOH and (e) 8% NaOH.

Tensile strength and tensile modulus

Figure-2 shows the measured the tensile strength of untreated and treated kenaf fiber bio-composites. 8% NaOH treatment shows the highest reading of tensile strength (84.2 MPa), while the untreated kenaf fiber composites have the lowest tensile strength. The tensile strength increased with the increasing NaOH concentration on the fibers. But if the concentration of fiber is too high, it might damage the fibers. It is believed that the treated kenaf will ease the fiber penetrated into the biocomposite matrix.

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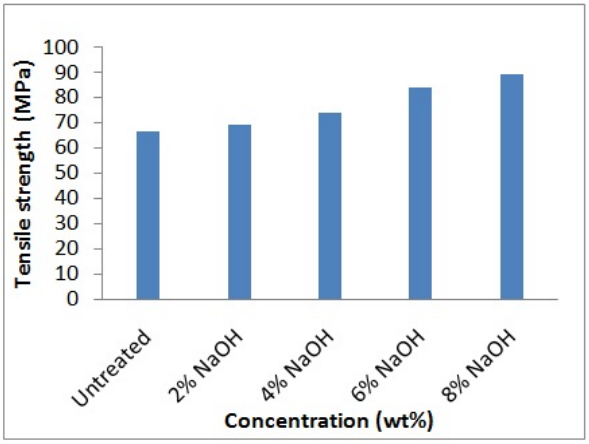

Figure-2. Tensile strength of of untreated and treated kenaf fiber composites.

Figure-3 shows the tensile modulus of untreated and alkalized kenaf fiber composites. From the graph, it is clearly observed that the tensile modulus increased when NaOH concentration on alkaline treatment increased. Treatment with 8% NaOH show the highest reading of modulus (3.2 GPa) as compared to untreated kenaf fiber composite (0.5 GPa). The alkalization treatment of fiber helps in improving the chemical bonding between the polyester and fiber resulting in superior mechanical properties. Usually, the tensile strength of the composites without chemical treatment are lower due to the inability of the filler to support stress transferred from the blend matrix [6].

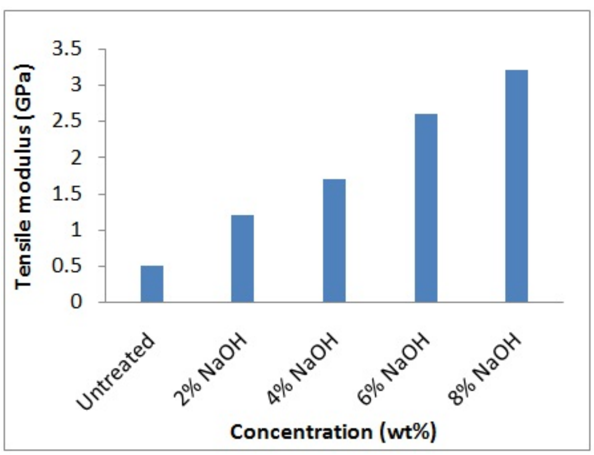

Figure-3. Tensile modulus of untreated and treated kenaf fiber composites.

Flexural strength and flexural modulus

As shown in Figure-4, the lowest flexural strength measured was untreated kenaf fiber (45.2 MPa) while the highest reading was the treatment with 8% NaOH concentration (90.2 MPa). It was observed that the flexural strength increased with the increase of NaOH concentration.

Figure-5 shows the flexural modulus of untreated and alkalized treatment of kenaf fiber composites. From the results showed the flexural modulus increase as the concentration of NaOH increase. As the concentration of NaOH increases, the bonding between kenaf fiber and polyester become strong as the surface of kenaf fiber was clean from impurities and soft. The fibers that have been treated have lowerlignin content, distension of crystalline cellulose orderand partial removal of wax and oil cover materials [7].

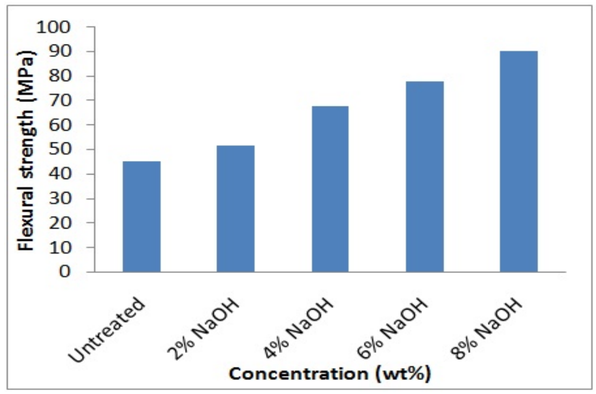

Figure-4. Flexural strength of alkalized treatment and untreated kenaf fiber composites.

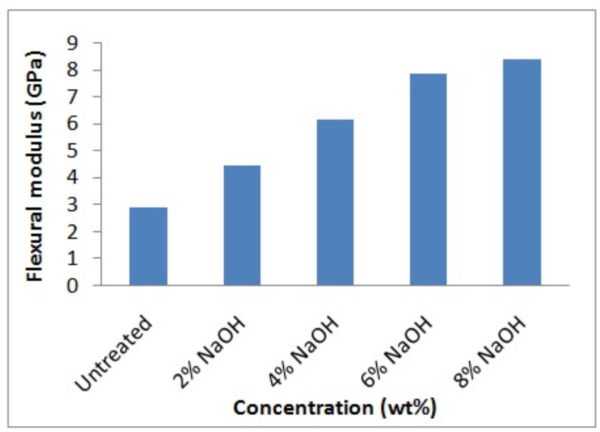

Figure-5. Flexural modulus of untreated and treated kenaf fiber composites.

Impact strength

Figure-6 visualized the Izod impact strength of the composites. The composite test displayed low strength for the untreated (0.06 J/mm^2), the treatment 2% NaOH (0.08 J/mm^2) and treatment 4% (0.09 J/mm^2). Treatment 6% shows the highest impact strength with (0.11 J/mm^2), but the impact strength of 8% NaOH concentration treatment decrease (0.1 J/mm^2). From this test, it was proven that even though the flexural and tensile strength of 6% NaOH concentration was low, it has the highest impact strength compared to 8% treatment. Higher concentration of NaOH might damage the fibersurface

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causing the bonding of kenaf fiber composite become weaker.

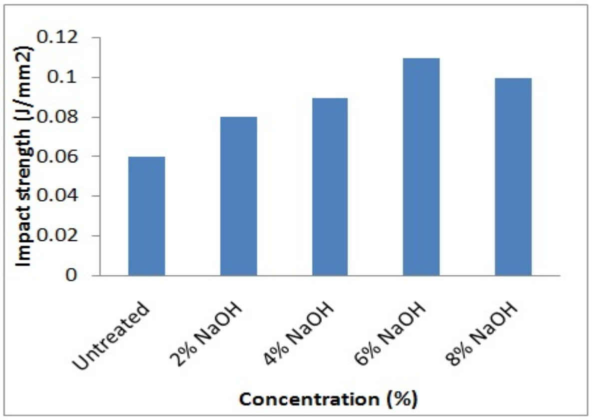

Figure-6. Impact strength of alkalized treatment and untreated kenaf fiber composites.

Modification of fibers were proved by several authors can improve the mechanical properties of composites [8].

CONCLUSIONS

The incorporation of treated kenaf fiber on polyester has a profound effect on the mechanical characteristics of biocomposite. The kenaf fiber had been treated at different concentration of NaOH resulted improvement of tensile strength, tensile modulus, flexural strength and flexural modulus. The changes of the morphological were investigated by using SEM. The solution of NaOH has been found that was effective ways to remove the impurities of the fiber surface. However, if the NaOH concentrations are too high such as 8 wt%, it will damage the fiber surface. The mechanical properties of kenaf fiber reinforced with polyester resin made by molding method were investigated. The kenaf-polyester manufactured by molding process provides an opportunity of replacing existing material with higher strength, low cost alternative that is environmentally friendly.

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