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BIO-COMPOSITE KENAF FIBRES FOR PALLET PRODUCT

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ABSTRACT

Bio-composite is a material formed by resin as a matrix and a reinforcement of natural fiber. The objectives of this research are to determine the impact of chemical treatment on mechanical properties and water absorption of bio-composite kenaf fiber. The long bast kenaf fibers were treated by chemical method using sodium hydroxide (NaOH) to improve fiber properties. The effects of the modification on fibers have been analyzed using scanning electron microscopy (SEM). Morphological analyses proved that sodium hydroxide have effective to remove impurities on the fiber surface. By using vacuum infusion process (VIP), the bio-composite kenaf fibers panel is produced. Vacuum infusion method offers benefits over hand lay-up method due to the better fiber to resin ratio and resulting in stronger. In this study, mechanical tests were performed to evaluate the effect of chemical treatment on the mechanical properties of bio-composite kenaf fiber. It has been found that the alkalization treatment has improved the mechanical properties of the composites. The mechanical properties of kenaf/polyester composites were found to increase with increase in concentration of NaOH. Otherwise, it decrease when immerse time is up from 12 to 24 hours. The tensile and flexural strength was achieved as high as 90.81 MPa and 93.35 MPa, respectively. In spite of its high tensile and flexural properties, kenaf polyester composites treated with 9 percent NaOH for 12 hours demonstrated relatively low impact strength. As better impact properties are demonstrated by high strain to failure value, it is believed that too high concentration of NaOH possibly lower the fiber strain to failure value. The ability of water absorption among the composite also have been analyzed in this study. The percentage of moisture uptake proven that fiber treatment have effected on the water absorption of the composites. Lastly, it has been summarize that chemical treatment on kenaf fibers as well as manufacturing process played important role to fabricate a good mechanical properties of composites.

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LIST OF ABBREVIATIONS

ABS	-	Acrylonitrile Butadiene Styrene
AC	-	Acidic Chloride
AO	-	Ammonium Oxelate
ASTM	-	American Society for Testing of Materials
CCC	-	Carbon/carbon Composite
CMC	-	Ceramic Matrix Composite
FI-TR	-	Fourier Transform Infra Red
FRP	-	Fiber Reinforced Polymer
GPa	-	Giga Pascal
hr	-	Hour
kGy	-	Kilogray
kJ	-	Kilo Joule
LDPE	-	Low-density Polyethylene
MAPP	-	Maleic Anhydride Grafted Polypropelene
MARDI	-	Malaysia Research and Development Institute
MEKP	-	Methyl Ethyl Ketone Peroxide
mm	-	Millimeter

MMC	-	Metal Matrix Composite
MPa	-	Mega Pascal
N	-	Newton
NaOH	-	Sodium Hydroxide
PET	-	Polyethylene Terephthalate
PHB	-	Polyhydroxybutyrate
PLLA	-	Poly-L-lactic Acid
PMC	-	Polymer Matrix Composite
PP	-	Polypropylene
RFI	-	Resin Film Infusion
RIP	-	Resin Infusion Process
RTM	-	Resin Transfer Molding
s	-	Second
SEM	-	Scanning Electron Microscopy
SH	-	Sodium Hydroxide
UTM	-	Universal Testing Machine
VIP	-	Vacuum Infusion Process
WAXS	-	Wide-angle X-ray Scattering

LIST OF SYMBOLS

b	-	Width of the sample
$dS/d\epsilon$	-	Slope of the stress versus strain curve
E_{abs}	-	Energy absorbed during impact
E_I	-	Initial Energy
E_k	-	Kinetic Energy
E_p	-	Potential Energy
E_r	-	Energy after rupture
E	-	Young's Modulus
E_b	-	Flexural Modulus
E_t	-	Young's Modulus in tension
g	-	Gravity
h	-	Height or thickness of the sample
L	-	Length of the sample
l_o	-	Initial gage length
m	-	Initial slope of the load versus deflection curve
P	-	Load
S	-	Stress
V	-	Velocity

W_a	-	Initial Work
W_b	-	Work after rapture
%	-	Percentage
Δl	-	Extension

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CHAPTER 1

INTRODUCTION

1.0 Background

Kenaf is a warm annual crop. It is a member of hibiscus family (Hibiscus cannnabinus L) and related to cotton and jute. Kenaf is originally native in Africa. For the last 200 years, India has produced and used kenaf. In the United States, kenaf was introduced as material for the war effort during World War II. Then in 1950s, the US researchers have found that kenaf was an excellent cellulose fiber source for pulping of paper products (Webber et al., 2002).

Kenaf plant is growing to more than 3 m tall within 4-5 month. The stems are 2.5-3.5 cm diameter and consisting of two parts, an outer fibrous bark and an inner woody core (Zhang, T., 2003). Raw kenaf fiber obtained from the outer fibrous bark is a bundle of lignocelluloses fibers. The core is the spongy tissue inner the bark of the plant. Figure 1.1-1.3 shows the kenaf plant and its intersection.

Figure 1.1 Pictures of kenaf field

Figure 1.2 Kenaf flower and leave

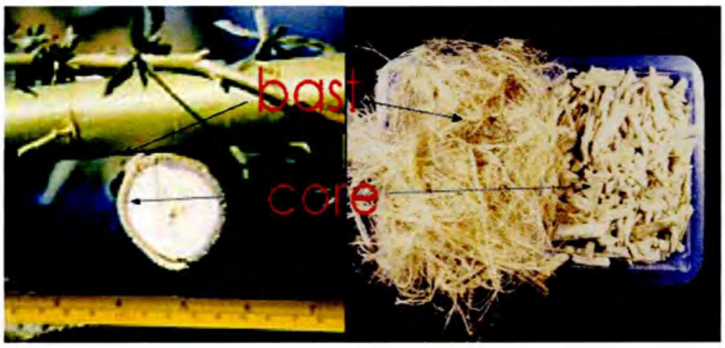

Figure 1.3 Kenaf bast and core

Kenaf has been used to produce twine, rope and sackcloth for thousands of years (Webber et. al., 2002). Because of its biodegradability and environmental protection, the usage of kenaf has increased recently. It has found more application. In some countries, kenaf is used as the substitute for wood to produce pulp and paper. Nowadays, there are various new applications for kenaf including automotive industry, packaging, building materials, absorbents and animal feeds (Zhang, T., 2003).

1.1 Statement of the Purpose

The purpose of the research is to investigate the effect of fiber treatment on the mechanical properties such as tensile, flexural and impact properties and water absorption of kenaf/polyester composite.

1.2 Hypotheses

i. Increasing either the concentration of NaOH or treatment time will weaken the kenaf fiber.

ii. Varying the manufacturing method will affect the mechanical properties of composite.

1.3 Objectives

i. To study the effect of alkalization treatment on the surface characteristic of kenaf fibers.

ii. To study and develop the composite between kenaf fibers and polyester resin using normal process.

iii. To determine and analyze the effect of fiber treatment on the mechanical properties and water absorption of kenaf/polyester composites.

1.4 Research Scopes Area

The following states the research scopes area;

i. Research on natural fibers based on literature survey and identify suitable matrix that can well adhere to selected fibers.

ii. Identify and propose the process of natural fibers treatment.

iii. Study on the manufacturing process that capable to produce high performance composite materials.

iv. Develop natural fiber reinforced composite by the selected method.

v. Obtain the mechanical properties and the percentage of water absorption from the composite produced.

1.5 Rational of Research

The rational of the research is as stated below;

i. Utilize natural resource of kenaf fibers.

ii. Offer cheaper and environmental friendly, an alternative to replace synthetic fiber and wood-based products in many applications.

1.6 Problem Statement

Composite materials offer many exceptional properties that are difficult or impossible to match with traditional materials such as steel, aluminum, and wood. Previously, composites made of glass and carbon fibers replaced many metal applications by supplying the benefits of low cost and high strength properties. Synthetic fiber composite is very well known for its strength and rigidity. For an example, the bicycle frame made from glass-carbon composites are offer high strength and lightweight. However, disadvantage of synthetic fibers is expensive to get the raw materials. Therefore, an amount of attention has been given to the fabrication and properties of bio-composites.

Figure 1.4 The bicycle frame is made of glass-carbon reinforced epoxy (Copyright © 1996-98 Torben Lenau).

A biocomposite can be defined as combination of biofibers and biopolymers. There is a problem of adhesive in using the hydrophilic nature of the biofibers with the hydrophobic polymer matrix (Sharifah et al., 2004). However, previous work has been done to improve the adhesion between biofiber and polymer matrix by using coupling agent and chemical modification.

Nowadays, natural fibers form an interesting option for the most widely applied fiber in the composite technology. There is a challenge to replace the synthetic fibers. Many studies on natural fiber have been done such as kenaf, bagasse, jute, ramie, hemp and oil palm. The advantages of natural fiber composites are renewable, environmental friendly, low cost, low density, flexibility of usage and biodegradability (Karnani et al., 1997 and Yousif et al.,