UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FABRICATION OF KENAF FIBER REINFORCED POLYESTER COMPOSITE BY USING VACUUM INFUSION TECHNIQUE

Thesis submitted in accordance with the requirements of the Universiti Teknikal Malaysia Melaka for the Degree of Bachelor of Engineering (Honours) Manufacturing (Engineering Material)

By

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This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Engineering Material). The members of the supervisory committee are as follow:

DECLARATION

I hereby, declared this thesis entitled "Fabrication of Kenaf/Polyester Composite Using Vacuum Infusion Technique," is the results of my own research except as cited in references.

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Author's Name : Siti Rohani bt Shafie

Date : 18 May 2009

ABSTRACT

The purpose of this research is to study and analyze mechanical properties and physical properties of kenaf fiber reinforced polyester composite. The problem that is facing by the researchers and manufacturers is to apply the advantages of natural fiber that will use for polymer composite which is has a good potential to substitute fibreglass and other synthetic fibers that are currently used. The techniques that are used to fabricate the composite in this study are vacuum infusion process and hand lay up process. Mechanical and physical properties of the composites that fabricate by both processes are comparing by using tensile testing, flexural testing, impact testing, and water absorption testing. Besides, the morphology of composites is observed by using scanning electron microscope. The composite composition that fabricated is pure polyester, 10 wt. % kenaf fiber, 20 wt. % kenaf fiber, and 25 wt. % kenaf fiber. The 100 wt. % polyester is fabricated by using hand lay up process, while others compositions are fabricated with hand lay up process and vacuum infusion process. Based on the result, it shows that at composition 10 wt. % kenaf fibers that fabricate by using vacuum infusion, the flexural strength and impact strength are the highest. While, the highest weights gain composition is 25 wt. % kenaf fibers. Its means that composite that fabricate by using vacuum infusion process is lightweight, high flexural strength, high impact strength, reduce using of resin, low water absorption, and reduce the air trap during the fabrication process. As a conclusion, the best method to fabricate the composite is by using vacuum infusion process based on the mechanical and physical testing analysis.

ABSTRAK

Tujuan kajian ini diadakan adalah untuk mengkaji dan menganalisa sifat-sifat mekanikal dan sifat-sifat fizikal mengenai komposit gentian kenaf dan peneguhan polyester. Masalah yang dihadapi oleh penyelidik dan industri pembuatan adalah untuk mengaplikasikan kelebihan yang terdapat pada gentian semulajadi kepada penggunaan komposit polimer yang mana mempunyai peluang yang baik untuk menggantikan gentian kaca dan gentian-gentian sintetik yang lain yang selalu digunakan. Teknik yang terlibat dalam membina komposit dalam kajian ini adalah teknik pemasukan vakum dan teknik manual yang menggunakan tangan. Sifat-sifat mekanikal dan fizikal komposit yang dibuat menggunakan kedua-dua proses ini dibandingkan melaui ujian kekuatan, ujian ketegangan dan kelenturan, ujian hentaman, dan ujian peyerapan air. Selain itu, morphologi komposit ini dilihat melalui mikroskop pengimbasan elektron. Komposisi komposit yang dibina adalah 100 wt. % polyester, 10 wt. % gentian kenaf, 20 wt. % gentian kenaf, dan 25 wt. % gentian kenaf. Untuk 100 wt. % polyester, teknik yang digunakan adalah teknik manual sahaja, manakala lain-lain komposisi menggunakan kedua-dua teknik. Berdasarkan keputusan kajian, komposit yang mempunyai komposisi 10 wt. % gentian kenaf yang menggunakan teknik pemasukan vakum menunjukkan ujian ketegangan dan kelenturan, dan ujian hentaman yang tinggi. Manakala untuk ujian penyerapan air, komposisi 25 wt. % gentian fiber yang menggunakan teknik manual adalah tertinggi. Ini menunjukkan bahawa komposit yang dibina menggunakan teknik pemasukan vakum adalah ringan, ketegangan dan kelenturan yang tinggi, hentaman yang tinggi, dan pengurangan udara yang terperangkap semasa proses berlaku. Sebagai kesimpulan, teknik pemasukan vakum adalah teknik yang terbaik.

DEDICATION

For my beloved father and mother,
Mr. Shafie bin Othman and Mdm. Siti Haminah bt. Mahmud, thanks you for giving full support for your youngest daughter.

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UTM	-	Universal Testing Machine
Max	-	maximum
Min	-	minimum
SEM	-	Scanning Electron Microscope
MEKP	-	Methyl Ethyl Ketone Peroxide
ASTM	-	American Standard Testing Material
MARDI	-	Malaysia Agriculture Research nad Development Institute
LTN	-	Lembaga Tembakau Negara
PET	-	Polyetylene terephalate
VIP	-	Vacuum Infusion Process
HLP	-	Hand Lay-up Process

LIST OF SYMBOLS

°C	-	degrees celcius
%	-	percentage
vs.	-	versus
R&D	-	Research and Development
mm	-	millimeter
MPa	-	Mega Pascal
GPa	-	Giga Pascal
J	-	Joule
N	-	Newton
wt. %	-	weight percent
sq²	-	square feet
Prof.	-	Professor
Dr.	-	Doctor
3-D	-	Three Dimension

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

In this project, this study will used vacuum infusion techniques to produce composite that is base on the raw material which is called fiber. The reinforcement of kenaf will be combined with matrix resin polyester. This technique will be used because of its capabilities to produce composite to a high of reinforcement ration. Kenaf reinforcement that will be used is mixture of core and bast fiber which is in random and particulate. Composites that are produced will be testing base on mechanical properties, physical properties, and it topography. Kenaf fiber is potentially used because of its outstanding reinforcing filler in thermosetting composites. Results indicate that kenaf fibers are a viable alternative to inorganic material-based reinforcing fibers as long as the right processing conditions and aid are used. This study will continues the previous study about properties of kenaf fiber reinforcement polyester composite. This study will be focused on the properties of kenaf fiber reinforced polyester composite by using vacuum infusion techniques at the several specimens that contain mixture of kenaf core and bast fiber. The kenaf fiber reinforced polyester composite is fabricated by using vacuum infusion method with the addition of composition of MEKP catalyst hardener for the composite cure. The several samples of kenaf core fiber are cut into several sizes based on the ASTM standard by using automatic handsaw. The process is continuing by sieving the kenaf fiber reinforced polyester composite to separate it into several samples that is needed. The testing involves for this study is tensile test, flexural test, impact test, hardness test and water absorption test. The result of the kenaf fiber reinforced composite testing will be discussed at the end of this study.

1.2 Statement of the Purpose

The purpose of this research is to study and analyzed the mechanical properties, physical properties and the morphology of kenaf fiber reinforced polyester composite by several specimens of this composite. The mechanical properties that are studied in this research are tensile, flexural, hardness and impact properties, while the physical property is water absorption test.

1.3 Hypotheses

The different techniques of fabrication kenaf reinforced polyester composite are used for this study are effect the mechanical and physical properties of the composite. Besides, the different composition of kenaf fiber and the polyester that is used for this study will affect the mechanical and physical properties of the composite, and also will be affecting the morphology structure.

1.4 Problem Statement

The usage of the natural fiber in the polymer composite as the replacement of synthetic fiber can reduce the material cost of the polymer composite product. Global environmental issues have led to a renewed interest in green materials, with focused on renewable raw materials can be biodegradable or recyclable at reasonable cost.

Nowadays, the problem that is facing by the researchers and manufactures is to apply the advantages of natural fiber that will use for polymer composite. There also a several factors such as mechanical properties and physical properties of the fiber that is under researching. Thus, kenaf fiber which is known as natural fiber has a good potential to substitute fibreglass and other synthetic fibers that are currently used.

Besides, the previous researchers on kenaf fiber found that there are a lot of good mechanical properties that are good specific strengths and modulus, economical viability, low density and low weight. Nevertheless, the researchers today not totally focused on the study of size and dimension that affected of the fiber used in the natural fiber reinforced polymer composite. But, in this project the student will study the effect of composition on mechanical properties that is can affected the properties of the composite that is produced. (Roger, M. R., et. al., 1996)

1.5 Objectives

The objectives are:

(a) To study the mechanical and physical properties of the composites.
(b) To study the advantages of using vacuum infusion process and hand lay-up process for the composite fabrication.
(c) To analyze the microstructures of the produced composite.

1.6 Scope of Study

The scope of this study is based on the objectives which are:

(a) To study the mechanical properties of the composite such as tensile strength, flexural strength, and Izod impact strength using the ASTM standard.

(b) To study the physical properties of the composite by using water absorption testing method.

(c) To analyze the fiber orientation and defects occurred in composite at different composition of composite by using Scanning Electron Microscope (SEM).

CHAPTER 2

LITERATURE REVIEW

Kenaf or the binomial name, Hibiscus cannabinus, is a plant from Malvaceae family. Hibiscus cannabinus is in the genus Hibiscus and is probably native to southern Asia, and most of kenaf plant can be found at ancient Africa. Kenaf is one of the allied fibers of jute and shows the similar characteristics. Other names include Bimli, Ambary, Ambari Hemp, Deccan Hemp, and Bimlipatum Jute. (Anonymous, 2009)

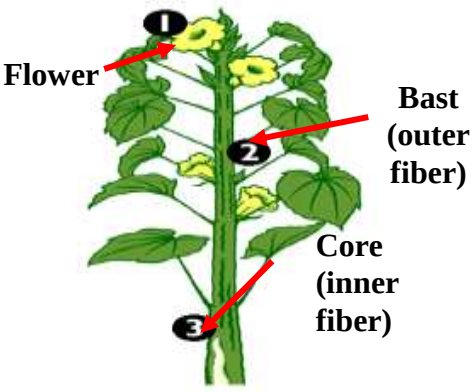

Figure 2.1: The basic component of kenaf plant which is flower, bast or outer fiber, and core or inner fiber. (Anonymous, 2009)

From Figure 2.1, the flowering can last 3 to 4 weeks, or more, per plant, each individual flower blooms for only one day. The stalk of the kenaf plant consists of two distinct fiber types. There are several colors of the kenaf flower which are white, yellow, or purple. The outer fiber which is called bast fiber comprises roughly 40 % of the stalk's dry weight. The refined bast fibers measure 2.6 mm and are similar to the best softwood fibers used to make paper. Then, there are inner fibers which are called core, and comprises 60 % of the stalk's dry weight. These refined fibers measure 0.6 mm and are comparable to hardwood tree fibers, which are used in a widening range of paper products. The traditional uses of kenaf fiber are in the manufacture of the rope, twine, coarse cloth, and the production papers. (Anonymous, 2009)

2.1 Recent Issues in Kenaf

Figure 2.2: The original kenaf plant that growth in Malaysia. (Anonymous, 2002)

Kenaf has been started to be planted at Malaysia by Malaysian Agricultural Research and Development Institute, which is lead by Mr. Mohd Daham who is the chairperson of the upstream National Kenaf Technical Committee. The downstream of this project is Universiti Putra Malaysia, which is lead by Assoc. Prof. Dr. Jalaluddin Harun. They are doing the research based on Research and Development (R&D) Projects and relevant expertise.

A total of RM 7 million R&D grant was allocated to conduct multidisciplinary R&D on Kenaf for year of 2000 to 2005 that is involving by multi agencies. Besides, RM10 million is for year 2006 to 2010 has been allocated to further conduct R&D for both Upstream & Downstream which is RM 5.0 million respectively. The Upstream function is to evaluate the feasibility of Kenaf cultivation through effective agronomic practices in Malaysian conditions. While the function of Downstream is to develop potential commercial products in Biocomposites, Pulp & Paper Products utilizing Kenaf as base raw material for wood-based sector. (Jalaludin H., et. al., 2007)

Furthermore, Tobacco Board of Malaysia has planted a lot of Kenaf trees in Kelantan and Terengganu, as a second important planted after tobacco. Kenaf is set to be the alternative crop for tobacco as the some 5,000 tobacco growers in the country are expected to be badly affected when The ASEAN Free Trade Area (AFTA) regulations are in place by 2010. Under the AFTA, there will be reduction in the price and import duty of tobacco. (Nur Adilah A., 2008)

Malaysia is expected to export 50,000 tonnes of Kenaf annually, valued at RM15 billion. This would make Kenaf the country major commodity by the year 2010, and the Republic of Korea is expected to be the first importing country for Malaysias Kenaf, at 50,000 tonnes a year. Kenaf-planting project, that is capable of producing 15,000 tonnes of Kenaf per hectare, provides the tobacco farmers an alternative source of income when the AFTA is enforced. Under the projects initial phase, some 1,000 hectares of land would be planted with Kenaf including 700 hectares in Kelantan and the processed Kenaf is exported to Germany and Korea. (Nur Adilah A., 2008)