

STUDY ON PREPARATION AND  
PROPERTIES OF HYBRID KENAF FIBER  
AND SAWDUST PARTICLEBOARD  
COMPOSITE

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COMPOSITE

NOR FASHILIN BT AZAHAR

Thesis submitted in fulfillment of the requirements  
for the award of the degree of  
Bachelor of Applied Science (Honor) Material Technology

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## **SUPERVISORS' DECLARATION**

I hereby declare that I have checked the thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Honor) Material Technology.

Signature

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## **STUDENT'S DECLARATION**

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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## **DEDICATION**

I dedicated this work to my respected supervisor, Dr. Nurjannah Binti Salim, my family, and friends. A special feeling of gratitude towards both of my parents, Azahar Bin Mat Noor and Rosaidah Binti Abdul Majid who always been supporting me through thick and thin.

I also dedicated this work to all of my friends that have helped me throughout this journey and very appreciate them a lot especially with friends under the same supervisor, Raodah Binti Hussin, and Nurizzati Binti Idris.

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## LIST OF SYMBOLS

~	-	approximately
%	-	percent
°C	-	degree celcius
MPa	-	mega pascal
g	-	grams
h	-	hour
<i>t</i>	-	time

## LIST OF ABBREVIATIONS

UF	-	urea formaldehyde
PF	-	phenol formaldehyde
KF	-	kenaf fiber
SD	-	sawdust
TGA	-	thermogravimetric analysis
SEM	-	scanning electron microscope

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## **ABSTRACT**

This thesis reports study of Hybrid kenaf fiber and Sawdust particleboard composite using urea formaldehyde and phenol formaldehyde and its physical and chemical properties. Hybrid particleboard are introduced as an alternative for traditional particleboard. The objectives of this research are to prepare hybrid kenaf fiber and sawdust particleboard composite, to determine the physical and mechanical properties of hybrid kenaf fiber and sawdust particleboard composite and to characterize hybrid kenaf fiber and sawdust particleboard composite by using scanning electron microscopy (SEM) and thermogravimetric analysis (TGA). Hybrid kenaf and sawdust particleboard are formed by mixing kenaf fiber and sawdust particle together with urea formaldehyde (UF) or phenol formaldehyde (PF). Before mixing with resin, both kenaf fiber and sawdust particleboard are needed to be grind to obtain powder form. After mixing with resin, the particleboard then placed into a mold and hot pressed. Then, the particleboard undergo conditioning for one week before being cut for physical and mechanical testing. Then, the kenaf fiber particleboard is characterized by using Thermogravimetric Analysis (TGA) and Scanning Electron Microscopy (SEM). Hybrid particleboard with phenol formaldehyde do not swell too much and hybrid particleboard with urea formaldehyde has higher tensile strength. From the SEM images, the UF resin and PF resin used are identified. After being tested, hybrid particleboard with phenol formaldehyde has better bond than hybrid particleboard with urea formaldehyde.

## ABSTRAK

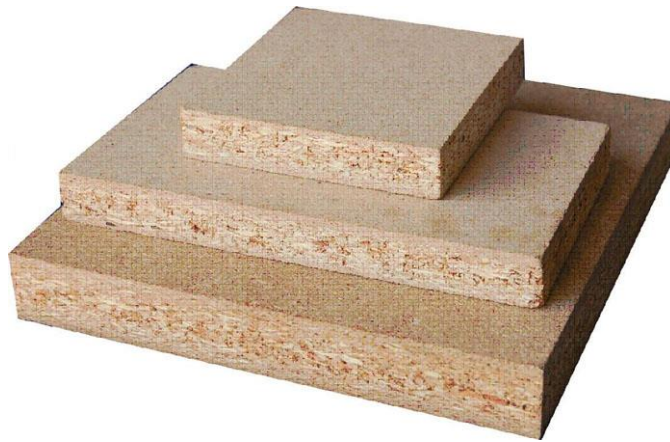
Tesis ini melaporkan kajian tentang hybrid serat kenaf dan habuk kayu partikel komposit menggunakan formaldehid urea dan fenol formaldehid dan sifat-sifat fizikal dan kimia. Hybrid partikel komposit diperkenalkan sebagai alternatif untuk partikel komposit tradisional. Objektif kajian ini adalah untuk menyediakan hybrid kenaf dan habuk kayu partikel komposit, untuk menentukan sifat fizikal dan mekanikal hybrid kenaf dan habuk kayu partikel komposit, dan untuk mencirikan hybrid kenaf dan habuk kayu partikel komposit dengan menggunakan Mengimbas Mikroskopi Elektron (SEM) dan Analisis Termogravimetri (TGA). Hybrid kenaf dan habuk kayu partikel komposit dibuat dengan mencampurkan serat kenaf dan habuk kayu bersama dengan urea formaldehid (UF) atau phenol formaldehid (PF). Sebelum dicampur dengan resin, kedua-dua serat kenaf dan habuk kayu perlu dikisar terlebih dahulu untuk menghasilkan serbuk. Setelah dicampur dengan resin, partikel komposit diletakkan di dalam acuan dan dipanaskan dengan tekanan. Sesudah itu, partikel komposit menjalani proses condition selama satu minggu sebelum dipotong untuk ujian fizikal dan mekanikal.. Kemudian, partikel gentian kenaf dicirikan dengan menggunakan Analisis Termogravimetri (TGA) dan Mengimbas Mikroskopi Elektron (SEM). Hybrid partikel dengan fenol formaldehid tidak membengkak terlalu banyak dan hybrid partikel dengan urea formaldehid mempunyai kekuatan tegangan yang lebih tinggi. Dari imej SEM, resin UF dan resin PF digunakan dikenal pasti. Setelah diuji, hybrid partikel dengan fenol formaldehid mempunyai ikatan yang lebih baik daripada hybrid partikel dengan urea formaldehid.



## CHAPTER 1

### INTRODUCTION

#### 1.1 INTRODUCTION



*Figure 1.1.1: Particleboard.*

Particleboard has been around for quite a while. A form of composite, particleboard was first produced by Max Himmelheber after World War II. The first board was made up of wood scraps, shavings, sawdust, and offcuts, all glued together using a special resin. Before they were glued together, they would be smashed and pounded to smaller pieces. Basically, particleboard is produced by mixing wood particles, sawmill shaving, flakes, or even sawdust together with resin and forming the mix into a sheet [1]. When particleboards first came onto the market, it was only available for the wealthy because the price was higher than some natural hardwoods. Over time, the manufacturing process becomes matured, the supply becomes steady and the material becomes cheaper. Now, particleboard becomes an alternative for

expensive plywood and natural hardwoods. It became much cheaper compared to plywood and natural hardwoods and is widely used in furniture.

The particleboard then evolved as the technology increased. A hybrid particleboard was introduced to fulfill the massive demands of particleboard. Hybridization can be defined as the act of mixing different species of plants to produce hybrids [1]. Hybrid particleboard is made up of two or more different materials. It is developed to encounter the problem of limited resources to manufacture particleboard according to the world's demand. Hybrid particleboard is much cheaper than the traditional particleboard because it consumed less amount of material during the manufacturing process.

Originated from Africa, kenaf is a close relative of Okra and Cotton. Kenaf is well known in most Asia countries such as Thailand, India and Malaysia because of its fibers [2]. Kenaf plant is a promising source of raw material fiber for pulp, paper and other fiber products. The non-wood plant became an alternative solution or source of fibrous material in this millennium due to increasing population and industrialization along with better education [3]. The automotive and aerospace industries have an interest in using more natural fiber composites, in order to reduce the weight of the object [3]. They gradually decrease the use of metal such as steel. Researcher predicted that in the near future polymer composites and plastic will comprise 15% of total automobile weight. Kenaf has also been used in paper making. Potential threats for the paper industry such as biofuel production and bio-refineries may reduce the availability of raw materials in the future, therefore cause interest in non-wood plants as sources of cellulose fiber to increase [4]. Kenaf bark is fibrous making it a suitable medium to use for paper making. Paper made from kenaf is said to have superior tensile strength and burst rating. It also requires less energy and chemical during manufacturing the process.

Sawdust is the by-product from the mechanical milling or processing of timber [5]. The production of sawdust is up to 24.5 million per years [5]. Lignin, cellulose, and hemicellulose is the main component of sawdust. Commonly, sawdust is treated as a waste and it is either burnt or land filled. Growing awareness of green

technology and eco-friendly material has made sawdust as the next potential material. Sawdust starts to be developed as an adsorbent, fuel and mineral-bonded composites.

Formaldehyde has been used in industries for various purpose. It has exceptional properties that cannot be replaced by any other product and it is necessary to use until there are other alternatives. Formaldehyde has also been mixed in embalming fluid. Embalming is the process for the disinfection and preservation of the remains. Urea-formaldehyde (UF) resin is the primary binder of interior grade wood composites boards [6]. UF has an excellent adhesion, water solubility, intrinsic cohesion and it is relatively low cost. Phenol-formaldehyde (PF) is an important type of adhesives employed in the production of wood based panel of superior water resistant. It is the main material involved in the production of circuit boards before epoxy resins and fiberglass cloth already replaced it. Comparing UF and PF resin, PF resin has a stronger interaction between their particles. Nowadays, researchers have been focused on reducing the emission or exposure of formaldehyde because formaldehyde is considered a priority pollutant by the United States Environmental Protection Agency.

## **1.2 PROBLEM STATEMENT**

The demand of particleboard has increased massively each year due to its strength and workability. This demand of particleboard influenced in demand of raw materials used to produce particleboard. Wood particles are the main material used to produce particleboard. The problem arises as the demand of particleboard increase because it also increase the demand of raw materials that was wood particles. It may increases deforestation and degradation of natural forest. Therefore researcher came up with the idea of replacing the traditional particleboard with hybrid particleboard. A hybrid particle board composite could encounter the problem of limited source of the raw materials. Hybrid particleboard should consist of two different materials and binding with adhesives. The hybrid particleboard mostly cheaper and more sustainable than the traditional particleboard composite.

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