PHYSICAL AND MECHANICAL PROPERTIES OF PARTICLEBOARD MADE FROM OIL HEAT-TREATED RUBBERWOOD PARTICLES

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By

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DEDICATIONS

This thesis is dedicated with deepest love and affection to:

MY BELOVED PARENTS

Mohd Atkhar Bin Sarman and Mariah Binti Sarbini

Who's giving me strength to reach for the stars and chase my dreams and taught me that even the largest task can be accomplished if it is done on step at a time,

MY SIBLINGS

Mohd Faiz Bin Mohd Atkhar and Nor Farizah Binti MohdAtkhar

MY SUPERVISOR AND CO-SUPERVISOR

Dr. Paiman Bawon and Dr. Lee Seng Hua

And

FRIENDS

Their love, prayer, concern and strength have inspired me to be the best as I can, this thesis is only a beginning of my journey.

May ALLAH bless all of you

ABSTRACT

Oil heat treatment on wood particles is one of the feasible methods in reducing the rate of water absorption into the wood particles and can improve the stability of wood particle dimensions. The objective of this study was to determine dimension stability and mechanical properties of the particleboard made of oil-treated rubberwood particles. The rubberwood particles were soaked in cooking palm oil and heated in the oven at 200 ° C for 2 hrs. Particleboard were then fabricated using 4 different ratios of untreated (U) and treated particles (T), namely 100U, 70U:30T, 50U:50T and 30U:70T with urea formaldehyde resin as binders. The particleboard produced were tested for physical and mechanical properties based on the Japanese Industrial standard. The results showed that the wood absorption and thickness swelling of the particleboard made from different ratios of oil heat treated particles were reduced. Meanwhile, the mechanical properties did not adversely affect when up to 50% oil heat treated particles were added.

ABSTRAK

Rawatan haba minyak pada kayu sepai adalah salah satu kaedah yang boleh dilaksanakan dalam mengurangkan kadar penyerapan air ke dalam kayu sepai dan dapat meningkatkan kestabilan dimensi kayu sepai. Objektif kajian ini adalah untuk menentukan kestabilan dimensi dan sifat-sifat mekanik dari papan sepai yang diperbuat daripada sepia kayu getah yang dirawat minyak. Sepai kayu getah direndam dalam minyak masak sawit dan dipanaskan di dalam ketuhar pada 200 °C selama 2 jam. Papan sepia kemudian dibentukkan dengan menggunakan 4 nisbah berbezayang tidak dirawat (U) dan kayu sepai yang dirawat (T), iaitu 100U, 70U: 30T, 50U: 50T dan 30U: 70T dengan resin urea formaldehid sebagai pengikat. Papan sepai yang dihasilkan telah diuji untuk sifat fizikal dan mekanikal berdasarkan piawaian Perindustrian Jepun (JIS A 5908: 2003 E). Keputusan menunjukkan bahawa penyerapan kayu dan pengembangan pengecutan dari papan sepai yang dibuat daripada nisbah yang berbeza dari zarah-zarah yang dirawat haba minyak telah dikurangkan. Sementara itu, sifat mekanikal tidak menjejaskan apabila 50% minyak zarah yang dirawat haba ditambah.

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APPROVAL SHEET

I certify that this research project entitle "Physical and Mechanical Properties of Particleboard Made from Oil Heat-Treated Rubberwood Particles" has been examined and approved as a partial fulfillment of the requirement for the degree of Bachelor of Wood Science and Technology at the Faculty of Forestry, Universiti Putra Malaysia.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	Analysis Of Variance
JIS	Japanese Industrial Standard
MOE	Modulus Of Elasticity
MOR	Modulus Of Rupture
IB	Internal Bonding
TS	Thickness Swelling
WA	Water Absorption
MC	Moisture Content
TEMP	Temperature
UF	Urea Formaldehyde
SPSS	Statistical Package for The Social Science

CHAPTER 1

INTRODUCTION

1.1 Background

In the era of globalization, rubberwood is very important to Malaysians as it is the major timber used in the furniture manufacturing industry. Eighty percent of the total furniture exported from Malaysia is made from rubberwood. Prevalent utilization of rubberwood in the furniture industry is due to its interesting features such as its medium density that ranged from 0.48 to 0.65g/cm^3 and having good strength. In addition, rubberwood has light and whitish colour that is very suitable for furnishing. Apart from furniture, rubberwood is also widely used in the particleboard manufacturing. Particleboard has been widely used to replace solid wood for furniture.

Particleboard is a type of composite panel made of wood. It is widely used as an interior panel for furniture and cabinet manufacturer in many countries including Malaysia. With the lack of timber resources, the timber industry strives to obtain sufficient amount of raw material for composite production. The use of rubberwood can also meet the demand for raw materials in the timber industry. Additionally, it is able to solve the shortage of raw material supplies and viable methods to maximize the potential utilization of rubber trees. There are 16 particleboard mills operating in 2011. (Juliana et al., 2012).The main raw materials for the manufacture of wood composites are from fell rubberwood, board waste from factories, mixed hardwood species and also empty fruit bunches.

However, particleboard is usually bonded with urea formaldehyde resin (UF) due to its low cost and high reactivity. UF resin is not water resistant and therefore UF-bonded particleboard has a significant drawback, which is of high dimensional instability that will affect the performance of particleboard visually and functionally. Therefore, heat treatment is needed in enhancing its dimensional stability. Several attempts have been made to enhance the stability of particleboards using pre and post heat treatment (Lee et al. 2015; Writers & Ayrilmis 2016). Dimensional stability and acceptable mechanical properties can be seen when particleboards were heat-treated compared to that of the untreated particleboard (Saari et al., 2014).

Heat treatment of wood has long been recognized as an effective method of improving dimensional stability and resistance to wood decay (Lee et al. 2015; Umar et al., 2016). Heat treatment method has been introduced in the early of 1990s, where high-temperature heating is required for several hours. This modification process also improves the resistance of wood against decay and can also dimensionally stabilize the wood. However, heat treatment has a weakness in terms of mechanical properties of wood. Heating at high temperatures will cause major polymers such as cellulose, hemicelluloses, and lignin degraded, which in turn led to poorer mechanical properties and strength.

In addition, different heating medium during the heat treatment process resulted in different results. The heating medium that is used in heat treatment including steam pressure, oil, gas (fumes, nitrogen) and vacuum (Surini et al., 2012; Allegretti et al., 2012). Some researchers used vegetable oils heated at high temperatures to treat wood as oil has a high boiling point that is suitable for heat treatment. Among the

vegetable oils that are commonly used in heat treatment include palm oil, linseed oil, rapeseed, coconut oil, soybean oil and sunflower oil. This oil heat treatment is non-toxic, easy to adopt and cheap. In addition, oil provides a good heat transfer medium and has a high level of the boiling point that is suitable for the heat treatment of wood. Oil heat treatment is able to enhance the properties of wood with a combination of chemical properties changes, high-temperature exposure and oil absorption by wood.

1.2 Problem Statement

Dimensional instability of particleboard in use is very undesirable as it affects the performance of particleboard, both functionally and visually. Therefore, some experiments have been conducted to enhance the stability of particleboard using pre and post-heat treatments (Lee et al., 2015; Kwon & Ayrilmis., 2016). However, those studies have shown that the post-heat-treatment adversely affected the particleboard strength as UF resin is not heat resistant. Therefore, the pre-heat-treatment is recommended as it will not interfere the resin system.

1.3 Justifications

Rubberwood is the main species used in the production of particleboard. Pre-treatment is necessary for the rubberwood particles to ensure that its performance is acceptable and able to be used for high-end multipurpose applications. As UF resin is not heat resistant and will be degraded when subjected to high temperature, post heat-treatment is not suitable for enhancing the dimensional stability of the UF-bonded particleboard. Instead, pre-heat-treatment should be applied to the rubberwood particles before it was formed into particleboard. Pre heat-treatment

could reduce the hygroscopicity of the rubberwood particles but do not impose heat-induced degradation to the UF resin. In addition, vegetable oils are well known as an effective heating medium in the heat treatment process. Application of vegetables could transfer the heat more evenly and readily to the wood. In addition, it also can form a protective layer which inhibits water uptake. Therefore, this study aims to investigate the feasibility of the using oil heat-treated rubberwood particles to produce highly dimensional stable particleboards.

1.4 Objective

The general objective of this study was to determine the effects of oil heat treatment on the rubberwood particles and its relation to the properties of particleboard. The specific objectives are:

I. To determine dimensional stability properties of particleboard made from oil heat-treated rubberwood.

II. To determine mechanical strength properties of particleboard made from oil heat-treated rubberwood.

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