THERMAL INSULATION PERTICLE BOARD MADE FROM SUGARCANE BAGASSE AND KENAF FIBERS REINFORCED WITH POLYETHYLENE

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SUPERVISOR VERIFICATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal- Fluids)."

Signature **:…..……..**

Name of Supervisor **:……..**

Date **:……**

DECLARATION

"I hereby declare this report is resulted from my own research except as cited in references"

Signature **:…….**

Author's Name **:……**

Date **:…….**

DEDICATION

To my beloved parents

ACKNOWLEDGEMENT

First of all, I would like to thank our God Almighty for the blessings and love that He gave to me throughout my time on completing this project and also to the people who have helped me. Amen.

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ABSTRACT

This study is about inventing a thermal insulation particle board. Sugarcane bagasse and kenaf fibers were chosen for this project. It is believed that natural fibers have a lot of advantages compared to the non-natural fibers. These materials will be formed into a composite particle board by using polyethylene as the binder. In this study, different composition of these three main materials will be produced. The first composition consists of 100% polyethylene. The second composition is 80% polyethylene, 10% kenaf fiber and 10% sugarcane baggase. The third composition is 60% polyethylene, 10% sugarcane baggase, 30% kenaf fiber while the fourth composition is 60% of polyethylene, 10% kenaf fiber and 30% of sugarcane bagasse. The mechanical properties for every different composition will be measured by using Rockwell for the hardness test. Instron will be used for the tensile and bending test, KD2 Pro to measure the thermal conductivity and pendulum impact test machine to measure the impact. Based on all mechanical tests that had being done, the composition with 60% polyethylene, 30% sugarcane and 10% of kenaf fibers has the best mechanical properties.

ABSTRAK

Kajian ini adalah mengenai penghasilan papan komposit yang dapat menghalang proses penukaran haba terjadi di antara dimensi yang berbeza. Hampas tebu dan gentian kenaf akan digunakan sebagai bahan utama untuk penghasilan komposit ini. Serat semulajadi memiliki lebih banyak kelebihan jika dibandingkan dengan serat yang bukan semulajadi.. Polietilena akan bertindak menjadi pengikat bagi dua bahan ini. Nilai komposisi yang berbeza untuk papan yang berbeza akan dikenakan dan dihasilkan. Terdapat empat komposisi yang berlainan yang telah dilakukan di dalam kajian ini. Komposisi yang pertama adalah 100% polietilena. Komposisi yang kedua adalah 80% polietilena, 10% gentian kenaf dan 10% hampas tebu. Komposisi yang kedua terdiri daripada 60% polietilena, 10% gentian kenaf dan 30% hampas tebu. Manakal komposisi yang keempat terdiri daripada 60% polietilena, 10% hampas tebu dan 30% gentian kenaf. Papan yang tercipta akan diuji dengan menggunakan Rockwell untuk ujian kekuatan, Instron untuk ujian ketegangan dan kelenturan manakala KD2 Pro akan digunakan untuk mencari kadar konduksi terma. Mesin pendulum ujian hentaman digunakan untuk menguji kekuatan hentaman. Setelah menjalankan kesemua ujian mekanikal tersebut keatas setiap papan yang berlainan komposisi, papan yang memiliki komposisi 60% polietilena , 30% hampas tebu dan 10% gentian kenaf merupakan papan yang memiliki ciri-ciri mekanikal yang paling baik.

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k	=	Thermal Conductivity, (W/mK)
D	=	Hardness Reading, D
PE	=	Polyethylene
K	=	Kenaf fibers
S	=	Sugarcane bagasse
ASTM	=	American Society for Testing and Materials

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

Thermal insulation is a process of reducing heat transfer between different objects or two different regions. Thermal insulation also can be known as heat flow resistor. (Dictionary of Construction, 2012). Wall insulation and roof insulation are two of the applications of thermal insulation that are always being used in the society nowadays. These two types of insulations are used to reduce the amount of heat from transferring into the inside part of a building or a house. Wall insulation and roof insulation are in the form of particle board which act as the wall and roof for certain building or houses.

How effective an insulation process is depends on the type of materials used and the process of the particle board production. These will cause the different in properties for different process or different materials used for every thermal insulation particle board. Three of the raw materials that are always being used for insulation purpose are synthetic polymer or synthetic fiber which is petroleum based, natural fibers and wool. The examples of synthetic polymers are polyurethane and polystyrene. While for natural fibers, it can be found in sugarcane, bamboo, flax, cotton or jute. Wool can be found in fiberglass, rock wool and sheep wool.

Sugarcane fibers can be obtained from sugarcane bagasse. Bagasse can be obtained as a by-product of sugar cane processing, which is composed of fiber, pith, non-soluble solids and water. Fibers represent about half of all the components

(Almazan et al., 1998). Kenaf is a type of bio-composite plant. Its scientific name is *Hibiscus Cannabinus L.* (Merriam-Webster, 2002). Kenaf is a type of plant that produces strong fibers.

1.2 OBJECTIVES

1. To design a particle board made from sugarcane bagasse and kenaf fibers reinforced with polyethylene with different composition.
2. To study the mechanical properties of the particle board made from sugarcane baggase and kenaf fibers reinforced with polyethylene.

1.3 SCOPES

This study is about process investigation of inventing a thermal insulation particle board. The process for this study can refer to gantt charts provided in Appendix A. This can be achieved through the selection of the materials used in the making of the particle board. The scope of this study is to produce an effective thermal insulation particle board which is made from sugarcane bagasse and kenaf fibers.

From this experiment, the different compositions of the materials were chosen to be formed into particle boards. Calculations were made for every composition to weight 220 gram. For a particle board preparation, approximately 220 gram of mixed polyethylene, sugarcane and kenaf fibers are needed.

A few tests had been done to obtain the mechanical properties of different composition of particle boards. The tests are tensile test, flexural test, thermal conductivity, impact test and hardness test.

1.3 PROBLEM STATEMENT

The temperature of a house can increase easily or rapidly nowadays especially during the hot weather. This is due to solar radiation. Most of the people choose to use air conditioner to cool down their house. However, not everyone can afford air conditioner. Besides, it is much harder for everyone to afford an eco-friendly air conditioner due to its higher price compare with the other ordinary air conditioner. This study was made to overcome this problem. The insulators can help in preventing heat from entering the house and also help to maintain the temperature of the house. Some of the method that had been done for the matter of this problem is aluminium foil as the radiant barrier.

Rockwool also had being used widely for heat insulation. It is also good for sound absorption. The other material that is used for insulation is gypsum board. Natural fibers are always used as a green building material. Insulation wall with petroleum is not very eco-friendly. It is expensive and non-biodegrable. This study is to create and eco-friendly thermal insulation particle board. This can be achieved by decreasing the use of petroleum based and replacing it with natural fibers. An eco-friendly type of particle board is also more practical to produce. Sugarcane is widely used around the world. It is easily to be found anywhere around the world. The quality or sugarcane can be improved by forming it into fiber board. The fiber board can be used as wall, partition, wall insulation or ceiling panel.

CHAPTER 2

LITERATURE REVIEW

2.1 NATURAL FIBERS

Natural fiber is a type of fibers that came from natural sources such as, plant, animals and mineral sources. Fiber is a type of hair like materials in a continuous form of filament which is a discrete elongate piece. Fibers are available from many of these materials, and they are also called plant fibers, natural fibers or vegetable fibers (Satyanarayana et al., 2007). Fibers can be found in many different type of source such as, pineapple, kenaf, sugarcane, bamboo, animal hair, feathers, sheep fur, goat and other.

Most of the fibers have to go through extraction method before involve in the manufacturing process. Extraction of fibers is a method of separating the fibers from the other non-fibers part of the sources. Different type of fibers will have their own extraction method which is depend on their chemical composition or properties. Some of the fibers just have to be dried to get the fibers while some plant has to go through chemical reaction to be extracted.

Natural fibers had being used rapidly so long in manufacturing materials. It can be used for many application and purpose such as producing composites or particle board. These materials can be used for further purpose such as in automotive industry, building construction for insulation purpose, human comfort uses like blanket or tissues, textile, building, plastics and many more. Fibers can be used to manufacture low cost material. Fiber is one of the materials that being proposed for

future reinforcing materials. It is easily to be found in most of the origins among developing countries (Aziz et al., 1981). Many technologies have been applied toward fibers in order to produce a good quality of fiber reinforced materials. Fibers are widely used in the society for the application of insulators, human comfort used, building construction and manufacturing materials. Fibers are widely used due to its advantages. Fibers are very easy to be found. Besides that, it is also low density but has quite high specific strength. Fibers are also believes non-relatively non-abrasive, easy for the surface modification. Plus, it is very widely available (Ribot et al., 2011). For many years, one of the application fibers had involved with is for the reinforcement purpose and act as fillers in manufacturing industries such as thermoplastic and thermosetting composites.

However, natural fibers have their own weaknesses such as lack of good interfacial adhesion, low melting point, and poor resistance towards moisture. These weaknesses cause use of natural fiber reinforced composites becoming less attention. By doing treatment on the natural fibers is believed can help to clean and chemically modify the surface, stop the moisture absorption process, and also increase the surface roughness (Kalia et al., 2009).

Based on Prakash (2009), there are two groups of natural fibers fillers; wood and non-wood natural fibers. The examples for non-wood natural fibers are straw fibers, bast, leaf, seeds, fruits and grass fibers. While for the wood fibers are soft or hard woods.

Figure 2.1 is the annual production agricultural waste obtained from the study of Satta et al. (2008). From this bar chart, bagasse has the highest amount of production, while durian peel has the least production of all. Thus, from this study, it is shown that baggase is the easiest waste material to be obtained. The amount of its production yearly is the highest compare to the other waste material. Oil palm leaves and rice hull are the second highest annual production waste materials.

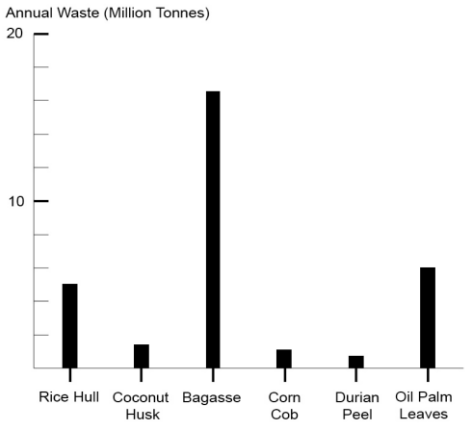

Figure 2.1: Annual production of agricultural waste
(Source: Satta et al., 2008).

Table 2.1 shows the average bagasse compositions obtained from the study of Verma et al. (2012). From the table, the composition for moisture is almost half of the whole item, 49%. The other 48.7% is occupied by fibers. Soluble solids have the lowest percentage inside the baggase composition. From this study, most of the baggase composition stands from moisture. One of the ways to get rid of moisture is by exposing them with heat. Soluble solids might be outside materials that get attached accidentally together with the baggase. From this study, it is proven that baggase is one of the most convenient waste materials ever. The composition is very simple and separation between different types of compositions can be made easily.

Table 2.1: Average bagasse compositions
(Source: Verma et al., 2012).

Items	**Percentage (%)**
1. Moisture	49.0
2. Soluble solids	2.3
3. Fiber	48.7

Figure 2.2 shows the cross section of different fiber plant that had been found from Murali et al. (2007). According to this study, vakka plant has the largest diameter among tested plants. The smallest diameter goes to sisal plant. The size of the plant diameter determines the amount of fibers can be obtained from each plant.

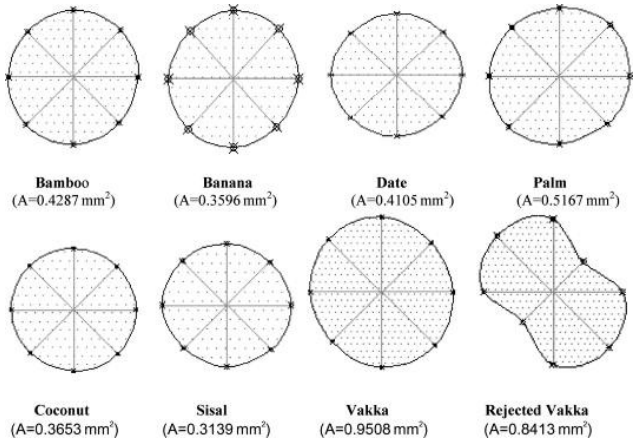

Figure 2.2: Cross section of different fiber

(Source: Murali et al., 2007).

2.1.1 Sugarcane Fibers

Sugarcane is widely used around the world for the production of ethanol and sugar. Sugarcane composed of fiber, pith, non-soluble solids and water (Almazan et al., 1998). Sugarcane bagasse is a residue produced in large quantities by sugar industries. Generally, 1 ton of sugarcane bagasse generates 280 kg of bagasse which also known as the fibrous by-product remaining after sugar extraction from sugarcane (Sun et al., 2004). Sugar cane is one of the photosynthetic materials that work efficiently among the commercial crops. It can fix almost 2 - 3 percent of radiant solar energy and transform it into green biomass. Sugarcane high photosynthetic capability also allows it to show a high coefficient of carbon dioxide fixation, comparable to the moderate climate zone woods. This contributes to the decrease of the greenhouse effect (Cardona et al., 2010).

A very large amount of sugarcane bagasse can be easily obtained especially at the sugar factory. In Brazil, during the 2010/2011 harvest, more than 625 million tons of sugarcane were crushed for juice extraction, which generated around 208

million tons of sugarcane bagasse (CONAB, 2011). Thus, this made sugarcane one of the most one of the most abundant low-cost lignocelullosic material (Cardona et al., 2010). Lignocellulose is a combination of lignin and cellulose that strengthens cells within sugarcane which is categorized as woody plant.

Sugarcane consists of three main parts, lignin, hemicelullose and cellulose. Preliminary processing is needed to separate these three parts. These processes will cause the breakage of cell wall structure by removing, simplifying or disintegrating the lignin. The type of process used depends on the material used and the proposed purpose of lignocellulosic fractions utilization. It is depend on how it is mechanically, physically, biologically or chemically affected. The development of pre-treatment processes has to be strong enough to separate the cell wall arrangement. The process also has to be medium enough to avoid change in it properties.

Acid and alkali treatment can be done to obtain the chemical composition of the sugarcane. Figure 2.3 shows the chemical composition of untreated bagasse samples and of samples submitted to acid 1% of sulphuric acid (H_2SO_4), and alkaline pre-treatments (NaOH 0.25% to 4%).

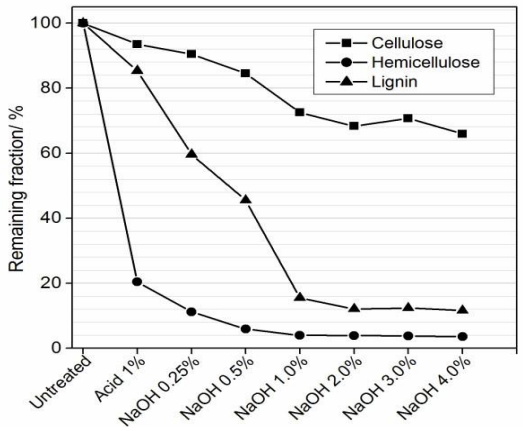

Figure 2.3: Remaining fractions of lignocellulosic components in bagasse samples after pre-treatment steps.

(Source: Rezende et al., 2011)

Tables 2.2 shows the results of bagasse chemical composition obtained in different time reaction of bagasse treatment with sulphuric acid. (Candido et al., 2012).

Table 2.2: Bagasse chemical composition

(Source: Candido et al., 2012)

Time reaction (min)	**Cellulose (%)**	**Insoluble lignin (%)**	**Soluble lignin (%)**	**Hemicellulose (%)**
0	47.44	23.43	7.31	21.20
5	50.17	23.47	6.38	18.38
10	51.98	24.58	6.55	15.96
20	53.88	26.02	5.72	13.93
30	53.96	26.18	5.59	12.98
40	53.78	25.90	6.87	10.57
50	55.06	29.57	5.71	9.18
60	53.21	28.37	6.07	11.37

Satyanarayana et al. (2007) states that international trends in the study of reveal that:

(i) Fibers have the potential to be used in automotive applications.

(ii) Fibers are one of the ideal competitors for the non-renewable.

(iii) Expensive petroleum-based synthetic fibers in composite materials which are particularly are used in the automotive industry and including building sectors.

(iv) The awareness of ecological concerns and particularly European countries are passing laws which will require, by 2015, the use of up to 95% recyclable materials in vehicles.

(v) It is possible to produce quality fibers, suitable for different applications, through better cultivation, including genetic engineering and treatment methods to get uniform properties.