THERMAL INSULATION PARTICLE BOARD MADE WITH SUGARCANE BAGASSE FIBER, KENAF CORE POWDER REINFORCED WITH POLYPROPYLENE

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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 **:……..**

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DECLARATION

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

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Date **:…….**

DEDICATION

To my loved ones.

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ABSTRACT

With theawareness of reducingthe environmental issue,the use ofrenewable material product is rapidly increased in many sectors by the manufacturers. This report present a study on mechanical properties of thermal insulation particle boards made from sugarcane bagasse fiber, kenaf core powder reinforced with polypropylene. There are five sets of composition of polypropylene, sugarcane fibers and kenaf core powder (PP/S/K), (%)are used to know the comparison of the results. The composition is measuredin percentage by weight, (%) which are100/0/0, 80/10/10, 70/ 15/15, 60/30/10 and 60/10/30. The hardness, flexural, impact and thermal conductivity tests have beencarried out to determine the mechanical properties and to classify the potential application of different composition of particle boards. From the study, it can be concluded that all the particle boards are good thermal insulation. The composition of 80/10/10 is chosen to be applied in automotive sector, 60/10/30 is chosen to be applied at ceiling and others can be applied as the inner layer of wall partition as wall insulation materials.

ABSTRAK

Kesedaran untuk mengurangkan isu alam sekitar menyebabkan penggunaan produk bahan boleh diperbaharui meningkat secara mendadak oleh pengeluar. Laporan ini membentangkan kajian mengenai sifat-sifat mekanikal papan zarah penebat haba yang diperbuat daripada serat hampas tebu serbuk teras kenaf yang diperkukuhkan dengan polipropilena. Terdapat lima set komposisi polipropilena, serat tebu dan serbuk teras skenaf (PP / S / K), (%) yang digunakan untuk dibuat perbandingan.Komposisi diukur mengikut peratusan, (%) berdasarkan berat iaitu 100/0/0, 80/10/10, 70/15/15, 60/30/10 dan 60/10/30. Ujian kekerasan, lenturan, daya hentaman dan kekonduksian haba telah dijalankan untuk menentukan sifat-sifat mekanikal dan bagi mengklasifikasikan aplikasi yang berpotensi daripada komposisi papan zarah yang berbeza. Dari kajian ini, dapat disimpulkan bahawa semua papan zarah adalah penebat haba yang baik. Komposisi 80/10/10 dipilih untuk digunakan dalam sektor automotif, 60/10/30 dipilih untuk digunakan di siling dan lain-lain papan zarah boleh digunakan sebagai lapisan dalam dinding sebagai bahan penebat.

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k	=	Thermal conductivity, (W/mK)
σ	=	Flexural Stress, MPa
D	=	Hardness Reading, D
UTeM	=	UniversitiTeknikal Malaysia, Melaka
FKM	=	Faculti of Mechanical Engineering
FKP	=	Faculty of Manufacturing Engineering
PP	=	Polypropylene
K	=	Kenaf Core
S	=	Sugarcane Fiber
WF	=	Wood flour
CO_2	=	Carbon Dioxide
% wt	=	Percentage by weight
RH	=	Relative Humidity, (%)
ASTM	=	American Society for Testing and materials.
TAPPI	=	Technical Association of the Pulp and Paper Industry
NaOH	=	Sodium Hydroxide
PLA	=	Polylactic acid
PP-g-MA	=	Glycidyl Methacrylate
MAH-g-PP	=	Maleic Anhydried- grafted PP

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

Thermal insulation is a design which helps to slow down the rate of heat transfer by limiting the heat conduction, convection and radiation process. Cengel (2011) stated that "the thermal conductivity is defined as the rate of heat transfer through a unit thickness of material per unit area per unit temperature difference." The function of thermal insulation is to maintain the temperature in space by delaying the heat transfer.

The use of renewable sources like natural fibers in making the thermal insulation board is increasing rapidly in many industries. Human now are tending to find ways to save the environment by inventing product that is high biodegradability, and low energy consumption.

From the literature review, it seems like thermal insulation particle board made from biodegradable material which is natural fiber are widely used in building and automotive industries. The board is said very suitable to be installed in roofing or ceiling also as the wall partition. According to Asdrubali, F. (2006), several natural materials like kenaf, flax, sisal, hemp, cork, sheep wool, and bamboo and coconut fibers would make a good sound proofing or noise absorbers. In automotive sector, the composite of natural materials are widely used in manufacturing of interior parts of car such as door panel, arm rest, dashboards, roof and so on.

1.2 PROBLEM STATEMENT

Insulation particle boards are widely used among human in many sectors. However, the existing insulation particle boards nowadays usually are fully made from petroleum based material. Petroleum based material is good in its useful life but when its life span has come to the end, it cannot be disposed because it is non-biodegradable. Hence, this will affect the environment in several negative ways. Besides brings the negative impacts towards environment, petroleum based also are also quite expensive. In bigger production, with the use of natural fibers, the quantity of petroleum based can be reduced in bulk.

1.3 OBJECTIVE

The aims of this project are

i. To fabricate thermal insulation particle boards made from hybrid composites of sugarcane bagasse fibers and kenaf core powder using polypropylene as the matrix or resin.
ii. To measure the mechanical properties of the hybrid composites particle boards.

1.4 SCOPE OF WORK

The scopes of this study are

i. To finalize the suitable composition ratio of polypropylene, sugarcane fiber and kenaf core powder to compare the relationship between thermoplastics and natural fibers.
ii. To conduct flexural, hardness, impact and thermal conductivity tests in order to determine the mechanical properties of the particle boards.
iii. Best board selection due to some suitable application.

CHAPTER 2

LITERATURE REVIEW

2.1 THERMAL INSULATION

Thermal insulation is a design which helps to slow down the rate of heat transfer by limiting the heat conduction, convection and radiation process. The function of thermal insulation is to maintain the temperature in the building by delaying the heat transfer. It also can conserves energy consumption by the human in a building. According to Manohar (2012), the energy consumption in the buildings can be reduced by using the thermal insulation. Thermal insulation also can help to reduce the use of air conditioning by applying it in walls and roofs.

2.1.1 Application of thermal insulation

Not only in the building, the thermal insulation system also suitable in automotive sector. Thermal insulation particle board can be installed as the roofing and also at the door panel armrest. This application can help to improve the thermal comfort in car and give the passengers to experience a quieter ride. The thermal insulation also acts as a sound proofing object. With the lighter weight of hybrid composite thermal insulation system installed in a car, it is believed that the fuel consumption of the car can be reduced. From Dos Santos's present study, (2009) it stated that the applications in the automotive industry could already be found in the 60s, when coconut fibers were used to manufacture car seats, and polypropylene (PP)

composites with wood flour, molded by compression, and applied as substrates for car interior.

2.2 COMPOSITE

2.2.1 Definition of Composite

From the findings in the present study, Verma (2012) stated that the composites are different from alloys which the individual components maintain its characteristics but absorbed into the other component in order to improve the properties. On the other hand, according to Davoodi (2010) a strong type of binder or resin, the size, length and the method of reinforcement will affect the mechanical properties of the product. Thus the right binder should be selected in the method to manufacture the composite material.

There are many studies have been done by the researchers on composite itself. Usually, most of the studies are done to find the properties mechanically or physical properties of the composites material. They are also tending to find the potential applications of the product. The sample that usually used by these researches is in particle board or panel form. Ghazali (2008) fabricated the particle board for testing. The particle boards of composites of bagasse, Portland cement and water are done at several different composition of polymer emulsion. The percentages of polymer emulsion are 3, 6, 9,12,15,18 and 21 % by weight. Initially, the mixing process of water and blended fiber- cement is done by using Winkworth mixer machine at the ratio of 0.25 (water/cement). Next, the water is added little by little to fiber- cement mixture for 5 minutes. Polymer emulsion is then added for 10 minutes. As the mixture is well- mixed, the process proceeded by placing the homogenous mixture into 10 mm diameter and 3.5 mm thick of mould. The mould is loaded at the temperature of 130 ˚C with pressure of 50 tons for 30 minutes. After that, the specimens are left to be cooled at room temperature and tested.

2.2.2 Hybrid Composite

Hybrid composites materials are the combination of two or more types of different fibers in the same binder or resin. From hybrid composite material, a new properties or characteristics that are not in a single type of reinforcement can be obtained through this. Basically, the hybrid composites material is one of the ways for one material to reinforce with another material in order to enhance the mechanical and physical properties of their combination. The study in hybrid composite using all from natural fibers as filler is less studied by the researchers. Usually in hybrid composites, they used one natural fiber and one non – natural fiber such as glass fiber to be reinforced with a binder.

Hybrid composites using natural fibers as filler have been done such as from Ismaiel Ghasemi (2008). The study used kenaf fibers (KF) and wood flour (WF) as the filler to be reinforced with polypropylene (PP) to study the rheological behavior of the hybrid composites. Table 2.1 shows the composition of samples of PP, kenaf fiber and wood flour content that have been weighed and bagged corresponds to the fiber content. The concentration of glycidyl methacrylate, (PP-g-MA) is constant for all samples which are at 2 phc (per hundred compounds). The composition is prepared by blending it first with Haake internal mixer (SYS 9000 USA) at the speed of 60 rpm and temperature of 180 ˚C for 8 minutes. Then the compounded material undergoes grinding process to get the granule form of the composition fibers using a pilot scale grinder (WIESER, WGLS 200/200 model). After the granule are dried at 105 ˚C for about 4 hours, the specimens are fabricated in compression moulding machine (Minipress Toyoseiki, Japan) at 190 ˚C with the pressure of 20 MPa. The tested samples are then placed under controlled conditions which at 23 ˚C of temperature and 50 % of relative humidity for at least 40 hours before testing.

Table 2.1**:** Composition of the studied formulations (wt %).

(Source: Ismaeil, 2008)

Code	Polypropylene content (% by wt)	Kenaf fiber content (% by wt)	Wood flour content (% by wt)	PP-g-MA (phc)
PP	100	0	0	2
KF40	60	40	0	2
KF30	60	30	10	2
KF20	60	20	20	2
KF10	60	10	30	2
WF40	60	0	40	2

Another hybrid composite study is done by Zhang et al. (2010), using polypropylene (PP), polylactic acid (PLA) blend and bamboo fiber. The preparation of poly blend composite had begun with the process of drying of the materials in a vacuum oven at 80 ˚C for 1 day (24 hours). After drying, the materials are melted by mixing it with hake Rheocord 90 internal batch mixer. The rotor speed used is at 80 rpm at the temperature of 190 ˚C. PP is first to be put in the mixer followed by PLA and bamboo fiber after 5 minutes. After another 3 minutes, Maleic Anhydried-grafted PP, (MAH-g_PP) is added and the mixing process is stopped 2 minutes later. The mixture is then being compressed between two metal plates and left in surrounding temperature for cooling purposes.

2.3 BINDER

Binder is a material or substance used as reinforced material which holds the filler in between them. In common words, binder acts as glue which provide adhesion or coating to the composite materials. The different names of binder called as resin or matrix. There are two types of synthetic binder which are thermoset and thermoplastic. Thermoplastic is a polymer that can be reshaped when it has been heated. On the other hand, thermoset is an irreversible polymer which it will be a total waste if the molded shape does not meet the desired shape after heated. During

the polymerization process, the bonding is chemically bonded by the covalent bond and it cannot be softening or changed. The examples of thermoplastic materials are polypropylene, polystyrene, polyethylene and so on. While the examples of thermoset are polyurethane, epoxy, urea formaldehyde and others. Below are the materials of thermoset and thermoplastic that are found by reading.

2.3.1 Polypropylene

Polypropylene (PP) is one of the thermoplastic binders which have been used a lot in making useful products. The properties of original polypropylene are stated by Dikobe D. G et al. (2009). The density, melting point and tensile strength are is 0.90 g/cm^3, 165 ˚C and 30 MPa respectively. The flow melt index of PP is 12 g/10 min (230 ˚C, 2.16 kg).

A hybrid composite from wood flour and nano clay are made by using polypropylene as the binder (Ismaiel, 2009). At certain composition, the materials are mixed with a Haake internal mixer (sys 90, USA) came with cam blade at the temperature of 180 ºC and speed of 60 rpm. Initially, after PP is melting in the mixer, the coupling agent and nano filler are added and 5 minutes later, the wood flour also had been added and the whole process took for 13 minutes. The clump materials are then grinded to produce in granule form by using pilot scale grinder (WIESER, WGLS 200/200 model) then are dried at 105 ºC for 4 hours.

2.3.5 Phenol Formaldehyde

The productions of particle boards or panels are done by combining bagasse and oil palm leaves with phenol formaldehyde resin (Panyakaew et al., 2008). When the renewable materials are combined with phenol formaldehyde, the water absorption and moisture content will be decreased. The phenolic binder can reject the moisture and give strength and rigidity in both materials when it is heated up to 140 ˚C in less than 30 seconds during a hot pressing process in the fabrication of board.

2.3.6 Epoxy

Epoxy is a kind of thermoset resin. Epoxy is high in strength and has special properties among the other thermoset resins (Davoodi, 2010). Epoxy is used as resin to make a bumper beam for car. It is suitable to use in automotive parts because it does not easy to deform and warping during the fabrication process. Other than that, the adhesion process between the distinct reinforcement materials can be improved due to its low viscosity and good flowing properties. By using epoxy also can help manufacturer to achieve the high rigidity if the curing agent is selected carefully and the temperature could patrol the degree of cross linking.

2.4 NATURAL FIBER

According to Dos Santos (2009) the natural fibers are the renewable sources that can be disposed at the end of its useful life. This characteristic is called as biodegradable and it is an important characteristic that should have in a component. Verma (2012), also states that the use of natural fibers in reinforcement material is increasing gradually because they are lower in cost and density, has its own specific properties, ease of extraction, reduce energy consumption, Carbon Dioxide (CO_2) neutrality, can be disposed and reused. Based on the survey from Asdrubali (2006) study, he stated that many natural fibers such as kenaf, flax, sisal, hemp, cork, sheep wool, bamboo and coconut have a good sound absorption performance. Hence, they can be applied in room acoustics as noise barriers. With the wide range of functionality, in automotive industry, the application of these bio- based composites can improve the mechanical strength and acoustic performance besides reducing the weight, used of energy, fuel, time and cost (Ashori, A., 2007). Moreover, it can promote a better safety for passenger and lasting performance and increase the biodegradability for interior components. Satyanarayana (2009) study shows the potential uses of natural fibers in Table 2.2.