UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF WATER RESISTANT PARTICLEBOARDS FROM RICE HUSK

This report is submitted in accordance with the requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Air conditioning & Refrigerant system) with Honours.

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DECLARATION

I hereby, declared this report entitled “Development of Water Resistant Particleboards from Rice” is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UniversitiTeknikal Malaysia Melaka (UTeM) as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Refrigeration & Air-Conditioning Systems) (Hons.). The member of the supervisory is as follow:

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ABSTRACT

Current technology is moving toward eco-friendly due to the environmental and health hazards. This paper focused on the development of water resistant particleboards from rice husk. Rice husk is a material used for the substitutes for wood and wood-based particleboard. The experimental work investigates the production of particleboards using the different compositions of rice husk, corn starch and wood glue (RH/CS/WG), (%) are used to know the comparison of results. The compositions are measured in percentage by weight, % which are 50/50/0 (Board A), 50/30/20 (Board B), 50/20/30 (Board C) and 50/10/40 (Board D). The mixture mixed manually and poured into a mould with a dimension of 100 mm × 100 mm × 30 mm. The particleboard was compacted using the hydraulic press with 125 ◦C, 30 minutes pressing and 3 ton. The water absorption, thickness and strength tests of all four particleboards have been carried out to determine the physical and mechanical properties. From the study, it can conclude that all particleboards show the percentage of water absorption increases with increasing the time of immersion and also good strength. The Particleboard D (50RH, 10CS, 40WG) is chosen as the best particleboard compared to others. The test results indicate that the particleboards can be used for indoor application. Thus, it shows the rice husk, corn starch and wood glue combination gives as an alternative way to replace the wood.

ABSTRAK

Teknologi zaman sekarang menuju ke arah mesra alam disebabkan oleh masalah pencemaran yang dihadapi oleh alam sekitar dan kesannya terhadap kesihatan manusia. Kertas kerja ini memberi tumpuan kepada pembangunan inovasi yang dilakukan pada papan partikel yang diperbuat daripada sekam padi untuk menguji ketahanan ataupun rintangan papan partikel tersebut dengan air. Sekam padi adalah bahan yang digunakan untuk penggantikan kayu dalam perbuatan papan partikel. Penyiasatan dalam eksperimen dijalankan mengunakan pelbagai komposis sekam padi, kanji jagung dan gam kayu, (SK/KJ/GK), (%) dalam proses kajian pengeluaran papan partikel. Komposis papan partikel diukur mengikut peratusan berat, % iaitu 50/50/0 (Papan A), 50/30/20 (Papan B), 50/20/30 (Papan C) dan 50/10/40 (Papan D). Campuran tersebut dicampur secara manual dan dituangkan ke dalam acuan dengan dimensi 100 mm × 100 mm × 30 mm. Papan partikel yang dipadatkan 3 ton, bersuhu 125◦C untuk 30 minit. Semua papan tersebut diuji untuk mengkaji ciri-ciri fizikal dan mekanikal iaitu penyerapan air, ketebalan dan juga tahap kekuatan. Kesimpulan, semua papan partikel menunjukkan peratusan penyerapan meningkat bersama peningkatan masa rendaman dan juga menunjukkan kekuatan yang baik oleh papan partikel. Papan D (50SK, 10KJ, 40GK) telah dipilih sebagai yang terbaik berbanding dengan yang lain. Nilai kajian ini menunjukkan bahawa papan partikel ini boleh digunakan untuk aplikasi dalaman. Maka gabungan sekam padi, kanji jagung dan gam kayu dijadikan alternatif bagi papan partikel kayu.

DEDICATION

I dedicate my disquisition work to all my family whose words of encouragement support me and even listens to my problems along my project period. I also dedicate this disquisition to my many friends and classmates who have always monitor and give idea throughout the process and also helping to complete this research on time without feel any disturbances.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Particleboard is a common product of wood industry in the world as its rise the usage of the wood (Melo et al., 2014). Wood is one of the earth's versatile and essential materials in early human which plays an important role in their daily lives. Even other materials also show the importance as a raw material in the industry. Since the existence of wood in the earth have been for a very long time and the value of the forest have grown extremely large amount. This is due to the human population and their economic growth. Today, wood is used for many purposes such as tools, paper, buildings, bridges, sports equipment, furniture, artworks and other products (Rafat & Azer, 2015). In the recent years, the wood supply in Peninsular Malaysia had been decreasing rapidly due to the raw materials supply was in a very large quantity. This means that the particleboard production from the wood is reducing, as manufacturers are forced to search for new alternative fast-growing species as a replacement of the wood to produce the particleboards (Tan et al., 2010).

In the view of Malaysia's agricultural wastes, the residues of cereal straw, sugarcane bagasse, Kenaf, coconut husk, rice husk, bamboo, oil palm leaves and others can be used as raw material for the particleboard manufacturing. Using agricultural by-products will generate economic development for farming in the rural areas. By the way, the agricultural wastes have high degree of fibrous content. Therefore, can use as main ingredient for composite materials which are suitable for manufacturing particleboards (Jindal, Singh, & Bansal, 2015). Based on Ndazi, rice husk is one of the agricultural residues easily available in very large amounts around the world. Even, it can also be considered as a good raw material for manufacturing the particleboards (Ndazi et al., 2006). This is because the presence of silica in rice

husk makes an ideal addition to particleboards which make them stronger and flexible. Within these, rice husk gives out the most highest potential for utilization as not only the rice is consumed cereals in the world wide (Melo et al., 2014).

The rice production is one of the most important economic activities on the Earth. The rice husks are the protective coatings for the rice seeds during the growing season until it being harvested (Pandey et al., 2010). The protections of the seed grains are formed by a hard material including the silica and lignin and even its unique physical chemical properties. In fact, rice husk is the by-product in rice milling operation with an approximately 20 % of the total weight of the paddy grain which being processed (Patel, 2005).

As in earlier times, only a little portion of the rice husk is being used in a meaningful way to the environment. But the remaining parts is burnt into ashes or dumped as a solid waste or used in animal feed products (Jhonson & Yunus, 2009). Therefore, the usage of rice husk will eliminate the waste disposal problem that experiences by the rice milling factories. However, by provide an alternative use that will improve the economic based among the committee of developing nations and even protect the environment from being hazardous (Noor Syuhadah & Rohasliney, 2012).

1.2 Problem Statement

Rice is a staple diet of many people all over the world. More than 600 million metric tonnes of rice are produced annually in Asia and the Far East (Jhonson & Yunus, 2009). According to the statistics of the Malaysia Ministry of Agriculture, around 408000 metric tonnes of rice husk are produced in Malaysia every year (Noor Syuhadah & Rohasliney, 2012). The current technology is moving towards eco-friendly to overcome the problem facing by the environment. Rice husk is considered as major agricultural waste due to the lack of awareness among the farmers. The most common practices followed by all the farmers are the burning and dumping of rice husk (Inhas, Umari, & Ash, 2016). Therefore, it causes the releases of gases like

sulphur dioxide, carbon dioxide, organic carbon, and others in the environment. These gases not only degrade the atmospheric air quality and climate but also influence the human health. The effect due to the large volume of CO_2 take over the oxygen in the air, result in lower oxygen concentration for breathing (Noor Syuhadah & Rohasliney, 2012).

This environmental problems lead to research more new products and a good utilization of the raw material available in nature. The nature resources have been increasing day by day without using it efficiently. Thus several researchers have been studying the properties of particleboards produced with the residues (Melo et al., 2014). The leftover of husk have not fully eliminated the problem facing by the milling industries. However, the true nature and properties of rice husks had been discovered, where more efforts made through the research and development. This helps the researchers to find out the infinite uses for these versatile husks to the environment. As rice husk is very cost-effective raw material to be used and also very easily obtain. Eventually, the large volume of rice husk waste could be reduced and converted to useful material for the consumer. Thus, in this research will be focus to the production of particleboard by using the natural adhesives (Abayomi, Temitope, Olawale, & Oyelayo, 2015).

1.3 Objectives

The main objectives of this research were to study the development of rice husk in the particleboards:

- To prepare the particleboards made from rice husk, corn starch and wood glue with different composition.
- To determine the level of water absorption in the particleboards by immersed into water.
- To examine the mechanical property of rice husk particleboards by Compression test.

1.4 Work Scope of the Study

In this research work is about the process of locally available rice husk which from the milling factory into a particleboard. These residues have own physical and mechanical properties which can be more economical particleboards with large quantities. The usage of rice husk from the rice mills will be more beneficial and diverse to the environment. The different compositions of the materials were chosen to be formed into the particleboards. The 4 different compositions of the particleboard were made with approximately 200 grams of mixed with rice husk; corn starch and wood glue are needed. Lastly, the production of particleboard from rice husk is being tested in term of physical and mechanical properties which contribute to the application of industries.

1.5 Significance of the Study

The significances of conducting to study the properties of rice husk on the particleboards. It is experimented by using different compositions and even monitoring the few parameters. Thus, the rice husk particleboards can be used effectively in the world. Besides that, it also reduces the cost of other materials as rice husk is easy to obtain and nearly all the country are the producer of rice. Lastly, the utilization of the rice husk can overcome the problem facing by the farmers during the processing of the rice.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A review of literature was performed to identify the studies which relevant to the topic of research. The author has found a good representative literature discussing the utilization of waste materials in the production of particleboards which substitute the demand for wood and wood-based board products. However, there was a study in detail about the materials and adhesives used in particleboards for the application of domestic or industries.

2.2 Particleboard

Based on the American Heritage Dictionary of the English Language (Fourth Edition, 2003), particleboard means a wood-based panel that is produced from wood particles such as wood chips, sawmill shavings, or even saw dust and adhesives via a hydraulic press or manual press process under high temperature and pressure. Wood was the first product which broken into small particles that are blended with appropriate amount of an adhesive (Prasittisopin, 2009). In 19^{th} century, the particleboard was produced from modern plywood when there is not enough of lumber to manufacture. Then introduce the natural wood during the World War II at factory in Bremen, Germany. The particleboard manufacturers used similar process

with slightly different type of resins (Building, Solutions, Characteristics, & History, n.d.).

As there are many types of particleboard differ in the size and geometry of particles, the amount of adhesive used and the density to which the boards are pressed shown in Figure 2.1. Generally, there are four types of particleboards such as random (no distinct layers), graduated (gradual transition between layers), three-layer (finer particles for faces and coarser for cores) and five or more layer particleboards (finer for faces, slender and flat for intermediate, coarse for core layers). The most commonly used to manufacture in the wood industry is three-layer particleboard as it is consists of a core layer and two face layers. This material provides bulk of particleboard and smooth surfaces for the laminating, painting, overlaying or veneering (Prasittisopin, 2009).

Figure 2.1: Particleboards different in size.

2.2.1 Application of Particleboard

The most common materials used in buildings construction is particleboard, where it gives numerous functions. Particleboard is commonly used for wall paneling, doors, windows, furniture, roofing panels, insulation, partitions and other applications. The wood-based products have undergone significant growth in the production due to its low manufacturing cost. With development in modern technology and some knowledge of the earth's serious environmental problems, more attention has been diverged to reduce the problems associated with the use of particleboards. Therefore, the increasing in

the agricultural wastes was a new alternative for particleboard production to replace the wood particles in the manufacture. Besides wood, they can use the residues from agricultural wastes such as bamboo, cereal straw, oil palm leaves, sugarcane bagasse, kenaf, coconut husk, rice husk, and others (Anderson, Yung, & Tanaka, 2005).

2.3 Composite

According to Verma (2012), the composites are different from alloy which the individual components maintain its characteristics but absorbed into other materials in order to improve the properties of their combination (Verma, Gope, Maheshwari, & Sharma, 2012). Even Davoodi (2010) have stated that a strong type of binder or resin, size, length and the method of production will affects the mechanical and physical properties of the product. Thus the right binder should be selected to manufacture the composite materials. There are many studies have been done by the researchers on the composite to find its mechanical and physical properties. The study shows that the using of natural composite as a product is very less.

Researchers have begun to focus attention to manufacture composite materials on natural fiber with natural or synthetic resins. The study from Ismaiel Ghasemi (2007) used kenaf fiber (KF) and wood flour (WF) with polypropylene (PP) to study the physics behavior of the composites. Table 2.1 shows the composition of samples of kenaf fiber, wood flour and PP content that have been weighed. 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 Hakke internal mixer at the speed of 60 rpm and temperature of 180◦C for 8 minutes. Then it undergoes the grinding process to get the granule form of the composition using the pilot scale grinder. After that, it was dried at 105◦C for about 4 hours, the specimens are fabricated in compression moulding machine at 190◦C with 20MPa. The tested samples are place under controlled conditions at 23◦C of

temperature and humidity relative at 50% for at least 40 hours before testing (Mirbagheri, Tajvidi, & Ghasemi, 2007).

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

Code	Polypropylene, %	Kenaf fiber, %	Wood flour, %
PP	100	0	0
KF 40	60	40	0
KF 30	60	30	10
KF 20	60	20	20
KF 10	60	10	30
WF 40	60	0	40

Another study is done by Suleiman (2013), using rice husk particles and gum Arabic to identify the surface morphology of the composite samples. The preparation of rice husk had begun with sieving at range of 25-35 mm. Then the rice husk was constant throughout the process. The total weight utilized was 150 g and ratio of 150:15 and 150:35 respectively. The mixture was poured into a wooden mould with size of 25mm × 15 mm. Then, pressed the mixture using a heavier medium in four uniform compacts for 30 minutes. The samples were left for 23 hours before de-moulded and cure for 18 days in the laboratory atmosphere. After that, the samples was washed, cleaned thoroughly, air-dried and coated with 100A thick platinum in JEOL sputter ion coater and observed scanning electron microscope, SEM at 20kV. Figure 2.2 clearly show when the agro-waste particle added to the binder morphological change in structure particleboard composites (Suleiman et al., 2013).

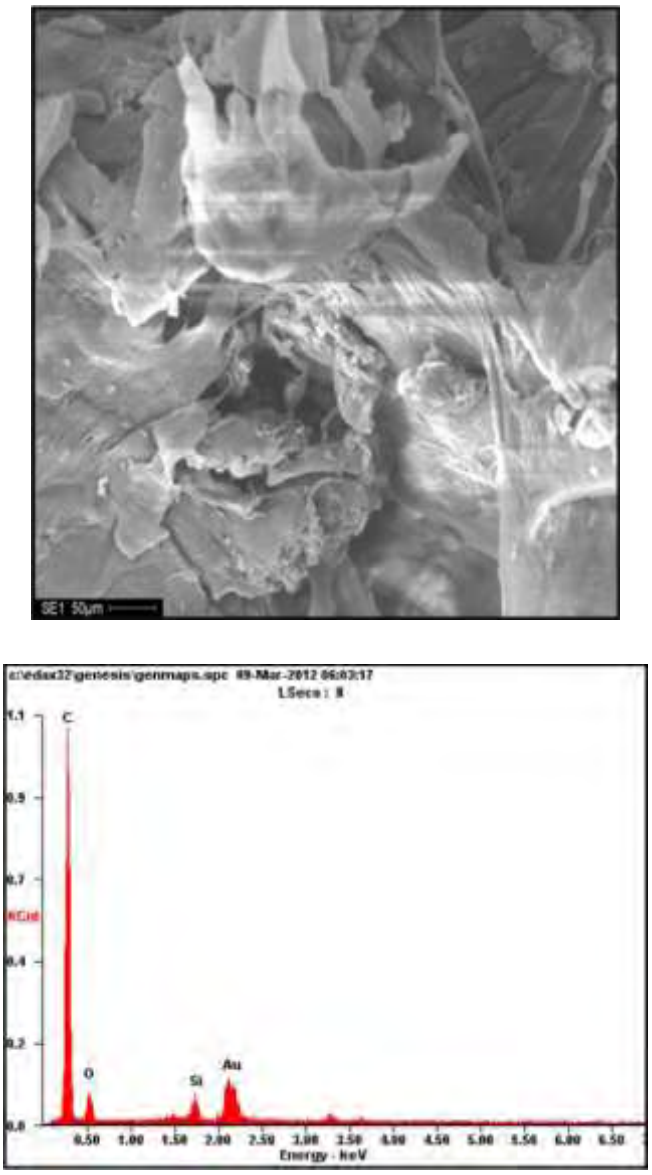

Figure 2.2: SEM microstructure of the particleboard with gum Arabic.

2.4 Materials for the Particleboard

Natural fiber is a type of fibers that came from natural sources such as plant, animals and mineral sources. Fibers are easily available and also called as plant fibers, natural fibers or vegetable fibers (Satyanarayana et al., 2007). Fibers can be found in many different type of source such as rice husk, coconuts, pineapple, kenaf, sugarcane, bamboo, animal hair, feathers, sheep fur, goat and others. It had been used rapidly in manufacturing materials. It can also be used in many applications even in

producing of particleboard. This is because the fibers in agricultural are low cost material for the manufacture of particleboard. Therefore, fibers are being proposed for future reinforcing materials. It is easily found among developing countries (Aziz et al., 1981).

Many technologies have utilized the fibers to produce a good quality of fiber reinforced materials. Fibers are widely used in the society for the application of insulators, particleboards, building construction, manufacturing materials and human comfort used. The fibers are widely used due to its advantages and even very easy to be found. Other than that, it is low density but has high specific strength even also non-abrasive which easy for the surface modification (Ribot et al., 2011). 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 the usage of natural fiber composites becoming less attention in the industries. By several treatments on the natural fibers are believed can help to modify the surface chemically, less 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 of non-wood natural fibers are oil palm leaves, sugarcane bagasse, kenaf, coconut husk, rice husk, fruits and grass fibers while for the wood fibers such as soft or hard woods. All these residues have the potential for the particleboard production (Takao Ota & Tomoya Okamoto, 2015).

Figure 2.3 is the annual production agricultural waste obtained from the study of researchers (Panyakaew & Fotios, 2008). The bar chart shows the bagasse has the highest amount of production among others. In this study have shown that bagasse is the easiest waste material to be obtained. This is because the amount of its production yearly is the highest compare to the other waste materials. The durian peel shows the least amount of the production. Besides that, oil palm leaves and rice hull is the second highest in annual production waste materials.

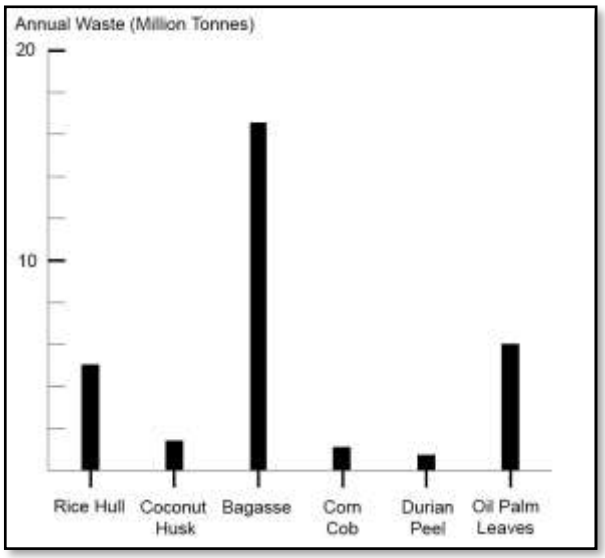

Figure 2.3: Annual production of agricultural waste.

2.4.1 Oil Palm Leaves

Malaysia is amongst the world's top producers of palm oil with the current planted area. In huge production, the oil palm consists of 10% of total biomass while the remaining parts are being burn. The demand for particleboards grows very large every year contributed by low availability of wood in the market. Therefore, the production of particleboards from the agricultural waste helps to reduce and utilize the excessive waste into a useable product rather than being burn. Since oil palm leaves consists of large amounts of lignin-cellulose components and high fiber. Therefore, it used to manufacture mattresses, composite panels, baskets, mats, roofing, and particleboards. Even some researchers have research as alternative raw material which shown the satisfaction to the industries demand in the particleboard production as well as reduce the dependent on wood. The end products from the oil palm frond are school and office desks, chairs, table tops, and cabinets (Yusoff, Kasim, Lias, Hussin, & Jasmi, 2014).

Figure 2.4: Oil palm dry leaves.

2.4.2 Sugarcane Bagasse

The use of agricultural residues for particleboard manufacturing is a goal for both environmental and economic. Besides that, the agricultural residue increases their value-add and also help meet the growing demand of raw materials in industry. According to the economy status, it is possible the by-product from agricultural waste become the primary products which take place of the wood-based products. Based on the studies sugarcane is commonly found in equatorial countries such as India, Malaysia, Pakistan, and Indonesia. Sugarcane can generates 10 tons of waste, a portion of waste is use as energy production in industries but another part is burned onsite to clear the field for the next crop. Sugarcane is one of the photosynthetic materials that work efficiently among the commercial crops. This capability shows a high coefficient of carbon dioxide fixation as compared to moderate climate zone woods. Thus, this contributes to decreases the greenhouse effects. Therefore, some efforts made to use the waste of sugarcane bagasse in the production of particleboard (Cardona et al., 2010).

As agricultural fibers in building show high-value application compared to the usage of fuel. This is because bagasse fibers have similar characteristics to hardwood fiber in the board products (Grace, 2005). Few researchers who have evaluate the usage of sugarcane bagasse in the production of particleboards and also the quality from other materials. Moreover, the particleboards from sugarcane bagasse allow the industry to expand, helps to reduce the use of timber and cost of boards (Lima, Farinassi, Marin, & Pereira, 2016).