Formation Of Composite Board By Using HDPE And Sawdust/Rice Husk With Addition Of Maleic Anhydride As Coupling Agent

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In this study, composites were prepared by using two main ingredients; that are high density polyethylene (HDPE) as the matrix and mixture of rice husk and sawdust as the filler. The composites were divided into two types; composites which contain coupling agent, and the composites that did not containing coupling agent. The coupling agent used in this study is maleic anhydride (MA). The aim of this study was basically to prepare the two types of composites and to know the effect of addition of coupling agent and effect of different ratio of matrix and filler toward mechanical properties of produced composites. For this study, composites were prepared at 170°C with different ratio of matrix and filler [1]. The composites was tested with several tests; mechanical properties of the prepared composites. The bending strength of the composite was increasing with addition of coupling agent MA and also increased as the percentage of filler increased. As for the tensile strength, the addition of coupling agent lowers the tensile strength. However, there are slight inconsistencies at 40% filler. This inconsistency may due to the presence of air bubble in the composites.

Key words: composite, HDPE, MA, rice husk and sawdust

INTRODUCTION

Composite board or also known as wood-plastics composite are a product which is widely used since last 40 years [2]. Due to its wide usage, it is constantly changing in term of usage and application. It can be said that composite board has been used as a replacement for regular wood or board. They are used in wide variation; whether structural or non-structural application. It can be used indoor as well as outdoor; for example it can be used as construction materials, garden and yard components, it even be used inside the automotive (engine and interior), household item and consumers good. However, the most popular usage of composite are the construction industry and automotive application [2].

Composite board usually made up of filler which come from wood fiber or organic material and matrix which also known as thermoset or thermoplastic [3]. Thermoset is basically a type of plastic which once cured, cannot be melted by heating such as epoxies and phenolic. While thermoplastic is basically a type of plastic that can be repeatedly melted. For the matrix, thermoplastics are more preferable due to its ability to be melted multiple times allowing it to be shaped and recycled. The composite having characteristics such as low density, low manufacturing cost and it is renewable and recyclable [1].

Composite board can be derived from used item. For example, the organic material can be come from used wood particle or any plant waste, such as the sawdust, rice husk and many more. The matrix is not necessarily comes from virgin thermoplastics. Used or recycled thermoplastics can also be used as the matrix. These properties allow the composite to become more popular. During these days, waste from organic materials can be easily found. Sawdust is usually left behind at the saw mill. The rice husk and rice stalk from the rice field usually being burned and causing air pollutions. With formation of composites with these used materials, waste from those industries can be minimized, and pollution can be reduced.

Despite its big popularity, the board is usually not strong enough compared to regular board, due to its low adhesion between the matrix and the filler. Most of the matrix, especially thermoplastics, is non-polar (hydrophobic) substances, which are not compatible with polar (hydrophilic) wood fibers and, therefore, resulting the poor adhesion between polymer and wood fiber. In order to improve the adhesion between the wood fibers and polymer, addition of coupling agent is needed [4]. Coupling agent is basically a chemical that is added to the mixture in small quantities, so it allow bonding to occur between its surface with the other surface such as the polymer and the wood fibers. The coupling agent will encourage the spreading of particle which will increase the adhesion between the polymer and wood fibers. So, the addition of coupling agent will increase the strength of the composites which will allow the composite to be used even more frequently in many applications.

METHODOLOGY

Equipments and Materials

The equipment that has been used for this study included stirred reactor consisting of a beaker (Pyrex), motor with stirrer (Fisher Scientific, max. speed 250 rpm), oil bath (silicone oil), hot press, grinder and 80-200 mesh size sieve with shaker, oven, digital scale, and thermometer (0-300°C). The materials used in this study are rice husk and sawdust as the filler, high density polyethylene as matrix, xylene as solvent and maleic anhydride as the coupling agent. Rice husk was obtained from BERNAS Sekinchan and sawdust was obtained from Faculty of Civil Engineering, UiTM Shah Alam.

Formation of Composites

Preparation of Matrix and Filler

In order to eliminate the extractive substance that may still be contained inside the rice husk, it was soaked with hot water at temperature of 100°C for about 2 hours. During soaking, the rice husk was stirred at the medium speed. After that, the rice husk was dried up in the oven for 24 hours. Later, the rice husk was grinded and sieved with 80-200 mesh size sieves [1]. Then, the rice husk was dried again by using oven at temperature of 80°C for 24 hours in order to remove the excess moisture content to be less than 8% by weight [5]. After dried for 24 hours, the rice husk will be stored

in the desiccator to prevent any moisture to come contact into the rice husk.
For the sawdust, the sawdust was initially grinded and sieved with 80-200 mesh size sieves. Then, the sawdust was dried in the oven at temperature of 80°C for 24 hours in order to remove moisture content in the sawdust [6]. The dried sawdust was stored in the desiccator to avoid moisture absorption.

Formation of Composites
Formation of composites was performed by using hot press. Initially, 35 g of virgin HDPE was placed inside the beaker, and 100 mL of xylene will be added into the beaker slowly. The oil bath was turned on at set at the temperature of 145°C. After the matrix was fully melted, 15 g of filler that was made up of dried sawdust and dried rice husk at ratio of 1:1, was added to the flask and stirred using stirrer until fully homogenize for about 20 minutes. MA was added to the mixture as much as 4% by weight. The ratio of matrix and filler will also be varied at 70:30, 60:40, 50:50 and 40:60. After the mixture is fully homogenized, the mixture was removed from the flask and allowed to cool down at room temperature until all the solvent evaporated. For further compression, it was compressed by using hot press at temperature of 170°C for 30 minutes. The composites then cooled naturally and tested. Another composite with the same variation of ratio of matrix and filler was prepared without MA for comparison.

Testing and Analysis
Mechanical properties which consist of tensile strength and bending strength were tested using Universal Testing Machine Model SHIMADZU in Concrete Lab, Faculty of Civil Engineering, UiTM Shah Alam.

RESULT AND DISCUSSION

Mechanical Properties of Composites
Maleic Anhydride is a bridge which connecting the polar wood fiber with the nonpolar polymer which are not compatible with polar (hydrophilic) wood fibers and, therefore, resulting the better adhesion between polymer and wood fiber.

In order to understand the effect of addition of MA on properties of produced composites, two types of mechanical properties (bending strength and tensile strength) were tested and analysed on all prepared samples. Theoretically, mechanical properties of composites are associated with ability of composite to resist external forces that acting on the composite. The results of bending strength and tensile strength value from this study were later compared to the standard of SNI 03-2105-1996. According to SNI 03-2105-1996, the bending strength and the tensile strength of minimum standards that allowed are 9.81 MPa and 0.15 MPa, respectively.

Figure 1 shows results of tensile strength for all composites with and without addition of MA with different ratio of matrix of HDPE and filler of rice husk and sawdust.

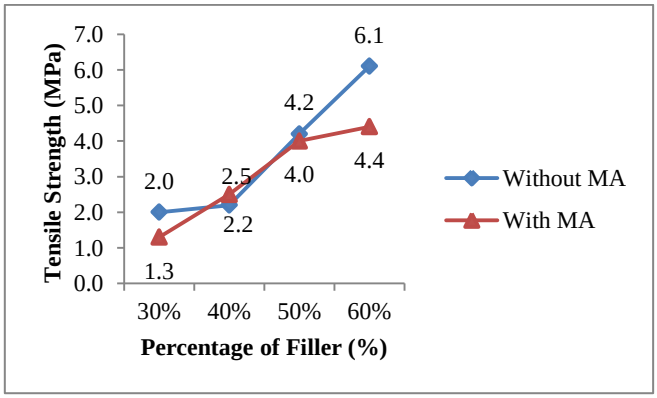

Figure 1. The effect of percentage of coupling agent (CA) toward tensile strength value on prepared composites

According to Figure 4.5, the presence of MA content in the mixture resulted in decreasing of tensile strength of the prepared composites. Meanwhile the increment of the filler gradually increases the tensile strength of the prepared composites. The highest tensile strength was when the filler was at 60% without the addition of MA and the value was 6.1 MPa. From the results, it was found that tensile strength of composites by using HDPE does meet the standard of SNI 03-2105-1996.

However, there was slight inconsistency that present in the result. At 40% filler, the tensile strength is higher with addition of MA. It differs from the other trends; where addition of MA reduces the tensile strength. This inconsistency may occur due to the presence of air bubble inside the prepared composite. Slight inconsistency in the thickness of the composite may also affect the results. This inconsistency of thickness may due to the method of hot press; where it does not really control the thickness compared to the injection molding method.

Figure 2 results of bending strength for all composites with and without addition of MA with different ratio of matrix of HDPE and filler of rice husk and sawdust.

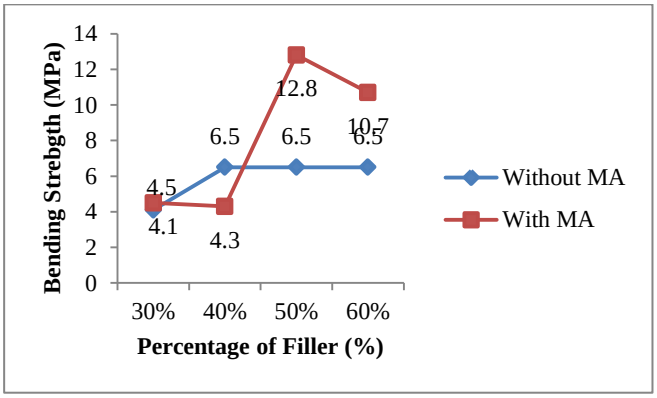

Figure 2. The effect of percentage of coupling agent (CA) toward bending strength value on prepared composites

According to Figure 4.10 the presence of MA content in the mixture resulted in increasing of bending strength of the prepared composites and the increment of the filler also increases the bending strength of the prepared composites. The highest tensile strength was when the filler was at 50% without the addition of MA and the value was 12.8 MPa. From the results, it was found that tensile strength of composites by using HDPE does meet the standard of SNI 03-2105-1996.

However, there was slight inconsistency that present in the result. At 40% filler, the tensile strength is lower with addition of MA. It differs from the other trends; where addition of MA increases the tensile strength. This inconsistency may occur due to the presence of air bubble inside the prepared composite. Slight inconsistency in the thickness of the composite may also affect the results. This inconsistency of thickness may due to the method of hot press; where it does not really control the thickness compared to the injection molding method.

CONCLUSION

The bending strength of the composite was increasing with addition of coupling agent MA and also increased as the percentage of filler increased. As for the tensile strength, the addition of coupling agent lowers the tensile strength. However,

there are slight inconsistencies at 40% filler. This inconsistency may due to the presence of air bubble in the composites.

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REFERENCE

1. MULANA, F. *The effect of MA/MAPE combination as coupling agent in formation of rice husk and recycled HDPE-based composites*. in *Proceedings of The Annual International Conference, Syiah Kuala University-Life Sciences & Engineering Chapter*. 2014.
2. Schwarzkopf, M.J. and M.D. Burnard, *Wood-Plastic Composites—Performance and Environmental Impacts*, in *Environmental Impacts of Traditional and Innovative Forest-based Bioproducts*. 2016, Springer. p. 19-43.
3. Clemons, C., *Wood-plastic composites in the United States: The interfacing of two industries.* Forest Products Journal, 2002. **52**(6): p. 10.
4. Lu, J.Z., Q. Wu, and H.S. McNabb, *Chemical coupling in wood fiber and polymer composites: a review of coupling agents and treatments.* Wood and Fiber Science, 2007. **32**(1): p. 88-104.
5. Schmidt, E., *Methods for preparation of composite materials*. 1993, Google Patents.
6. Shiroma, L. and A.L. Beraldo, *Wood-plastic composite.*