

Composite material making from empty fruit bunches of palm oil (EFB) and Ijuk (*Arengapinnata*) using plastic bottle waste as adhesives

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Abstract. Reviewed from the current technological required a new methods to capable offering a high profit value without overriding the quality. The development of composite technology is now beginning to shift from traditional composite materials based petroleum to natural fibers composite. In the present study, aim to made specimens using natural fibers in form of EFB as a composite reinforcement with Polyethylene Terephthalate (PET) derived from Plastic bottles waste as matrix with mixed composition parameters and time-tolerance in the mixing process to build a biocomposite material. The characterization of mechanical properties includes tensile test (ASTM D638-01) and bending test (ASTM D790-02) followed by thermal analysis using Thermogravimetric Analysis (TGA), and morphological analysis using scanning electron microscope (SEM). The analysis effect of EFB, Ijuk and PET mixtures on the composite matrix is very influential with mechanical properties characterization, including tensile test and bending strength. The results demonstrated that from the sample named : 50 : 25 : 25, hybrid composites showed improved properties such as tensile strength of 167 MPa while the 90:05:05 based composites exhibited tensile strength values of 30 MPa, respectively. In term the flexural test the best result of composition on the properties with 10 minutes duration time its load value 7,5 Mpa for 80:10:10.

1. Introduction

Indonesia is a major producer of palm oil. Indonesian oil palm plantations are found in Sumatra, West Java, Kalimantan, Sulawesi, Bangka Belitung and Papua. Indonesia has the number of oil palm plantations is about 13.5 million hectares [1]. The main product of fruit bunches palm is palm oil, after the processing, the remaining empty bunches of oil palm (EFB) as a by-product. Physically EFB has fibers that can be utilized for organic fertilizer, paper-making raw materials, briquettes, and also used as a filler medium such as filler cavity and car seat cushions. Therefore, awareness appears to

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examine further on the potential of EFB as a natural fiber material that can be processed into composite matrix material.

In addition to EFB, palm fiber is also widely available in Indonesia, which can be used as a composite matrix. The fibers are obtained from palm trees (*Arenga Pinnata*), which are traditionally often used as a base material for the construction of wooden structures planted in the soil to prevent termites. The usefulness is supported by the elastic nature of the elastic, hard, waterproof, and difficulty to digest by destructive organisms.

Currently, the bunch of empty Palm Oil Bunches (EFB), and Ijuk (*Arenga pinnata*) is easy to obtain. EFB tend not to be utilized and thrown away and there is still little information about the utilization of EFB, so it tends to become waste. Potential fibers almost 73% fiber is very potential to be utilized as research materials, especially low cost composite matrix materials. Therefore, due to the availability of abundant EFB and Ijuk and cost effectiveness, TKSS and Ijuk fibers can be excellent for composite matrix productio[2].

Plastic bottles are chemically polymeric materials widely used in human life. The waste of plastic bottles from the drink is wasted and underused, so it can pollute the environment. Plastic waste is generally difficult to decipher by bacteria and tends to stay inside and cause one of the degradation of environmental quality. Therefore, this study attempted to utilize plastic bottle waste combined with EFB fiber for the manufacture of composite matrix [3].

The development of the composites leads to a more natural composite as has been observed by some researchers. Ferdy Arif (2014) and Rihayat (2015), who has developed composite technology is now beginning to experience a shift from composite materials made synthetic fibers into composite materials fiber natural, in this research the specimens form is used natural fiber as a composite reinforcement to mixing polypropylene as a matrix with temperature and time-resistant parameters in the injection molding process and its not only easily to reused but also renewable too. This research has given a good effect with reducing the consumption of difficult chemicals in recycling that can disrupt the environment. Composites with natural fibers have other advantages when compared to synthetic composites. Natural composites are more environmentally friendly because they are able to degrade naturally and the price of natural fiber is cheaper than synthetic fibers. Have superior characteristics such as resistant to attack of destructive organisms, weather and moisture, thus relatively resistant to fire.

Therefore, the research aims to make a composite matrix by combining fiber, in this case empty palm bunches (EFB), palm fiber (*Arenga pinnata*), with polyethylene terephthalate (PET) derived from waste plastic bottles as matrix.

2. Materials and Methodes

2.1 Material

2.1.1 Fiber treatment In this study the materials used are PET (Polyethylene Terephtalat) as a matrix derived from plastic bottle waste around Lhokseumawe City North Aceh Indonesia, oil palm empty bunches (EFB) will be obtained from PTP II operating in Cot Girek North Aceh Indonesia, while Ijuk (Arengapinnata) is obtained from Sawang North Aceh Indonesia plantation, both fibers are used as filler. Sodium Hydroxide (NaOH) merck, and Aquadest. Furthermore, fibers and matrix is mixed by the Extruder and fabricated with Hot Press for pressing process. while for the analysis phase using UTM (universal Testing Machine) to analyze mechanical properties include tensile and flexural test according with (ASTM D638-01) and (ASTM D790-02) respectively. Thermal analysis using the Termogravimetric Analysis (TGA) while morphological analysis using a scanning electron microscopy (SEM).

In this research the first step procedure is EFB and Ijuk fiber in crusserh then soaked in 2% NaOH solution at room temperature for 30 minutes, then fiber is filtered and washed several times with aquades to reducing sodium hydroxide and alkalinity. Furthermore, the waste of plastic bottles made from PET (Polyethylene Terephtalat) material that has been collected and then cut into small pieces,

then PET, EFB and is mixed by Extruder between matrix and filler volume fraction 90:05:05, 80:10:10, 50:25:25 and fabricated with Hot Press machine while retention time variations is 5, 10, 15, 20 and 25 minutes at temperature 140°C.

2.1.2 Scanning electron microscopy Scanning electron microscope (SEM) LEO 1455 VPSEM equipped with EDX is used to identify the morphology of commercial samples. The surface of the composite specimen is examined directly by scanning an electron microscope. The EFB bench is mounted on an aluminum specimen stamp using a double-sided carbon adhesive tab. The sample is washed, cleaned properly, dried with air and coated with thick gold in JEOL ion sputter coil and SEM observed at 20 kV. To improve the conductivity of the sample, a thin layer of platinum vaporously evaporates forward before the photomicrograph is taken.

2.1.3 Tensile properties The tensile test is performed with according to a standard (ASTM D 638) used universal testing machine (UTM) with 10 kN load to determine tensile strength. Tensile test is performed to determine the tensile strength of the composite material.

Composite materials have better compression properties than their tensile properties. Tensile strength is influenced by the molecular bonds of the constituent material and Bending test specimens are made according to ASTM D790 standard with three point bend to investigations the ability of the material to a given load.

2.1.4 Thermogravimetric analysis (TGA) The study of thermal stability, determined by thermogravimetric analysis (TGA) was performed to understand the degradation characteristics of specimens using Thermogravimetric analyzer TGA Q500 (Perkin Elmer thermal analyzer). Thermal analysis of the material provides some basic information about the thermal stability of the material. All measurements were made under nitrogen flow (30 ml / min), keeping the heating rate constant 10°C/min and using alumina container with pinhole. Symmetric larvae analysis (TGA) was used to characterize the decomposition and thermal stability of the material under various conditions. In principle TGA analysis changes the thermal stability are examined in terms of percentage weight loss as a function of temperature. Samples with weight between 7 and 20 mg were placed on ceramic crucibles, while the tests were carried out in nitrogen atmosphere.

3. Result and Discussions

3.1 Mechanical properties

Mechanical properties are the most important for composite matrices. The mechanical properties of composite matrix, it can be seen by through tensile strength and flexibility (Bending). This aim was done to investigation materials composite reinforced natural fibers.

3.1.1 Tensile strength The tensile test is performed to determine the maximum tensile load to material test. Tensile strength is one of the most important properties that often is used to investigated the characteristics of a polymeric material. Therefore the tensile strength of a material is defined as the maximum load (Fmax) used to decide the specimen. The fracture samples test for tensile is shown in figure 1, while the average result of tensile test is present by figure 2. Its explained that highest tensile strength was produced at 167 Mpa for volume fraction 50:25:25 and hold time 20 minutes while graph nominal stress vs strain is presented by Figure 3.

Enhancement amount of fiber as fillers in the matrix composites has shown increasing the mechanical properties its depend on the holding time when the matrix is pressed and the optimal temperature, because many fiber breaks. Fiber break being by a strong bond between the matrix and filler. The composite bonding power affects the composite strength of the load while the hottest compress it will be effect which breaks of bonds on Polyethylene Terephthalat (PET) if the durability is too long.

The relationship between tensile strength with addition of EFB fibers and variation of rate time has given a different tensile strength, compared with a pure matrix, whereas in mixing of 90:05:05 at 5 minutes duration it shows the lowest tensile strength value. The bonding between the matrix and filler at the time of the breaking specimen and get some void can reduces the ability to receive the tensile load [5].



Figure 1. Fracture specimen.

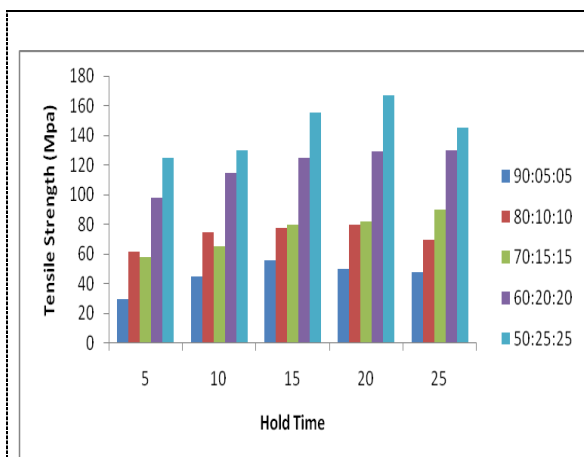


Figure. 2 Pull Test Grap.

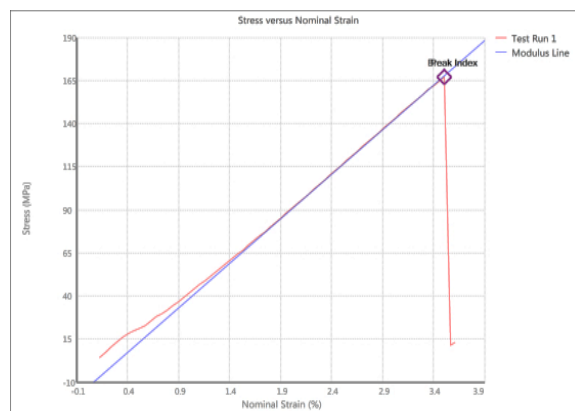


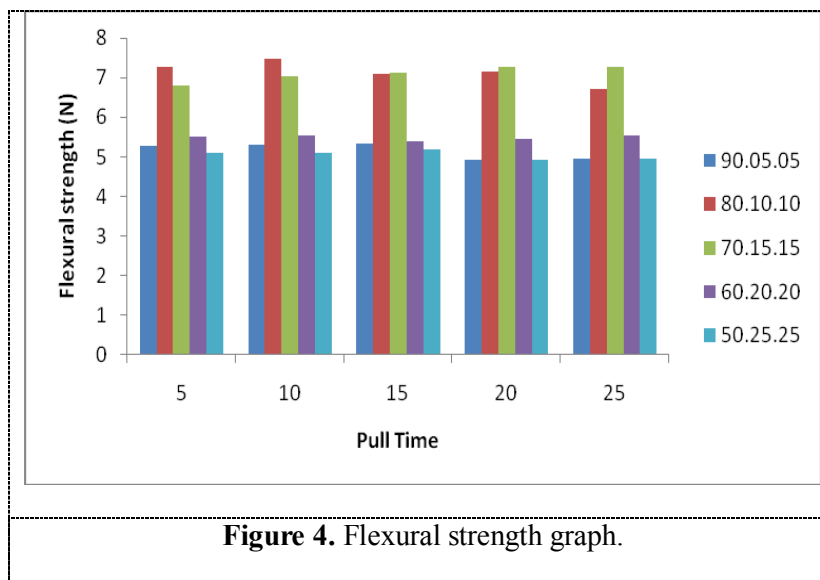
Figure. 3 Graph Nominal stress vs strain for sample 50:25:25 with hold time 20 minutes.

3.1.2 Flexural strength The bending test specimen is made according to ASTM D790 standard. It can be seen from the result of bending test analysis in Figure 4. After calculated using by the formula, its can be seen the results in the above table shows that the highest flexural strength value is got at the mixture of 80:10:10 with hold time 10 minutes and its load value 93,2 N during the flexural strength of 5,1 Mpa.

Figure. 4 shows the 50:25:25 composition variation with 20 minutes rate time indicating the lowest flexural strength value of 3.4 Mpa with the load value of 61.5 N. Then the bending strength shows an increase in the mixing composite of 70:15:15 while rate time 25 minute shows an increased flexural strength value of the mixing composite of 50:25:25 is 5 Mpa with a load value of 90.5 N. The best result of bending test was get from the average data during the test.

It was concluded that composites made from PET wastes had lower grades of flexibility compared to composites made of polyester (resins), indicating that polyesters were synthesized by means of petroleum-based acids and alcohol would be placed in high-temperature vacuum to create a process called "Condensation polymerization". Long chemical bands will be generated from condensed

polymers and when drawn up to five times longer than their original size so that polyester elasticity is higher than the PET value [6].



3.2 Thermogravimetric analysis (TGA)

Heat analysis of the material provides some basic information about the thermal stability of the material. All measurements were carried out under the flow of nitrogen (30 ml / min), maintaining a constant heating rate of 10 °C / min and using alumina containers. Thermogravimetric analysis (TGA) is used to characterize the decomposition and thermal stability of various material conditions. Particularly in the TGA analysis changes in thermal stability are examined in terms of percentage drop in sample weight as a function of temperature [7,8].

TGA is a technique used for the study of thermal stability/decomposition on a composite matrix. The thermal stability of the fibers is a very important parameter for the processing and use of materials. The composite preparation requires the mixing of fibers (filler) and matrix at high temperatures, so that the degradation effect on the cellulosic material properties can produce undesirable ones. A number of research reports have been investigated on the study of thermal stability of natural fiber composite fibers through TGA. The result of TGA in this research can be seen in figure 5.

In this study the results of the Thermogravimetric analysis (TGA) of composite matrix has been investigated and studied that the percentage of weight loss of samples with temperature increase are interrelated. The loss of mass as temperature increases, for the heating process to increase 10 °C / min, we can see in the graph the results of the analysis show the transition temperature ranging from 278.02 - 310.26 °C and Range for the final transition ranging from 600.86 – 601.58 °C, from room temperature to 600 °C.

From the graph above shows that the best temperature value in the heat-resistant composite matrix with mixing of 50: 25: 25 starting at the start temperature of 360.55 °C and the degradation start-up temperature starting from 446.63 - 492.20 °C and ending at temperature 521.18C so get the midpoint value 467.22 °C with get value weight loss -6.730 mg, here below can be seen in figure 6 graph of result of analysis of Thermogravimetri (TGA) mixing 50:25:25 below.

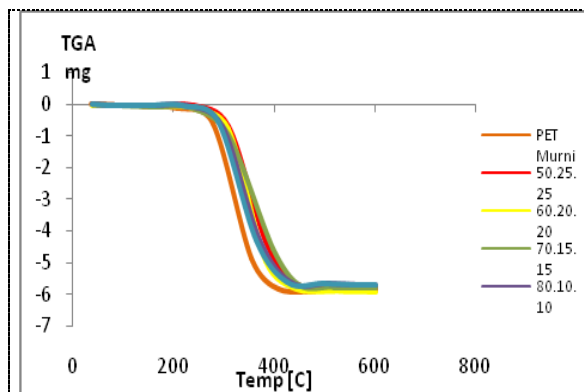


Figure.5 Graph The results of TGA analysis.

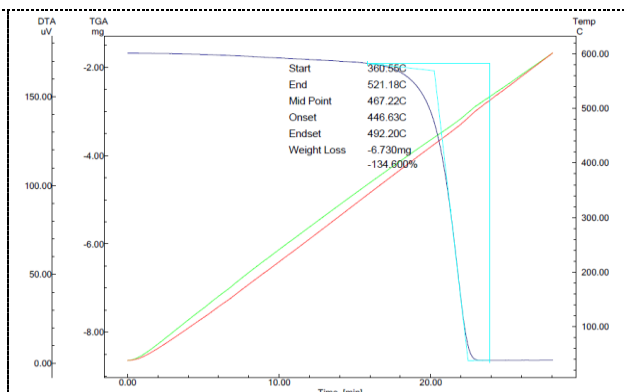


Figure.6 Graph The results of TGA mixing analysis 50:25:25 (20 minutes).

3.3 SEM (Scanning Electron microscope) Analysis

Structure morphology composites matrix was investigated by scanning electron microscopy LEO 1455 VPSEM. It is an excellent technique for examining morphology examination the surface morphology fiber. The best sample at the tensile test is used to investigate structure morphology can be seen in figure 7.

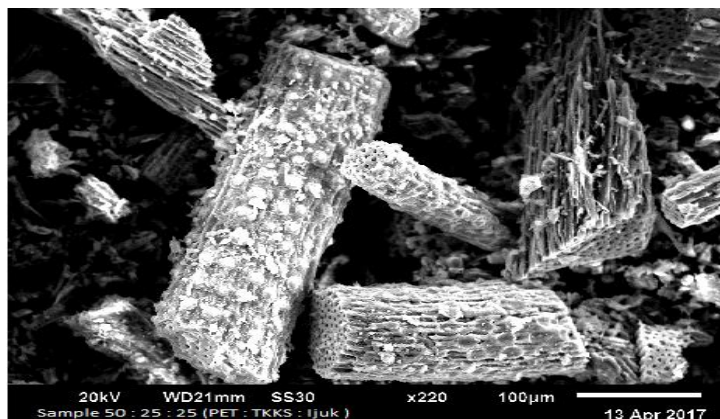


Figure. 7. Structure morphology for sample 50:25:25 wt% with hold time 20 minutes.

Figure 7 it's shown morphology composites for sample 50:25:25 wt% as the best sample at tensile test. It's observed that the fibers were broken and pulled out from the shell while the matrix doesn't flow into porous fiber. It can affect the mechanical properties composite not strongly because interfacial adhesion between fiber and matrix were broken.

4. Conclusion

The result of tensile test analysis according to ASTM D 638 has got the best result on mixing composition of 50:25:25 with 20 minutes holding time with tensile strength value 167 MPa. The result of Bending Strength test according to ASTM D 790 got the best result on 80:10:10 mixing composition with 10 minutes hold time of its load value 93,1509 N and flexural strength value 5,147 MPa. The results of the Thermogravimetric analysis (TGA) analysis showed a heat-resistant matrix is a mixing composition of 50:25:25 with a starting temperature of 360.55 °C and the starting degradation

temperature starting at 446.63 - 492.20 °C and ending at 521 , 18 °C so get the midpoint value 467,22 °C with get value weight loss -6,730.

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