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PINEAPPLE LEAF FIBER AND PINEAPPLE PEDUNCLE FIBER ANALYZING AND CHARACTERIZATION FOR YARN PRODUCTION

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ABSTRACT

Pineapple fiber which is rich in cellulose, relatively inexpensive, and abundantly available has the potential for polymer reinforcement. Pineapple leaf fibers (PALF) is the natural fiber that has good potential reinforcement in the yarn production. This research is done to investigate the mechanical properties of PALF in the form of single fiber and the twisted fiber. There are 3 type of sample which is 15 minutes, 30 minutes, and 45 minutes. There have 2 sample which is single fiber and twisted fiber. After undergo the treatment, fiber used to be measure the diameter using video analyzer that contain microscope to determine the diameter. After that, twisted fiber used to take the twist per inch (TPI) of every twisted fiber. Tensile test used to be run to get the load and time when test is run. This research presents a study of the mechanical properties of pineapple leaf fiber and pineapple peduncle fiber reinforced polypropylene composites. Composites were fabricated using leaf fiber and peduncle fiber with varying fiber volume fraction. Both fibers were mixed with polypropylene composites by various fiber volume fractions of 2, 4 and 6%. The composites panels were fabricated using injection molding machine. The tensile test was carried out in accordance to ISO 527-5A while hardness test accordance to ASTM D2240. The result showed that pineapple peduncle fiber with 2% fiber volume fraction give the highest tensile properties and pineapple leaf fiber with 6% give the highest hardness properties. From the overall results, pineapple peduncle fiber shown the higher tensile properties compared to pineapple leaf fiber, however pineapple leaf fiber shown higher hardness properties compared to pineapple peduncle fiber. It is found that by increasing the fiber volume fraction the tensile properties has decreased while hardness properties has increased. From the analysis done, there is a significant effect of fiber volume fraction on the tensile and hardness properties.

Keywords: pineapple leaf fiber, pineapple peduncle fiber, mechanical properties.

INTRODUCTION

Environmental awareness, new rules, and legislation are forcing industries to seek new materials that are environmental friendly. Over the past two decades, natural fibers have been receiving considerable attention as substitutes for synthetic fiber reinforcements. Natural fibers exhibit many advantageous properties as reinforcement for composites. It have its own characteristics that can give advantages to the composite with a low cost and more environmental friendly.

Bio-fibers are in most cases cheaper than synthetic fibers and cause less health problem and environmental hazard problems for people producing the composites as compared to glass fiber based composites. There are many type of natural fibers in the world. It may come from animal or plants. From the large classification of plant fibers, pineapple leaf fiber (PALF) and pineapple peduncle fiber (PAPF) is among of the popular bio-fiber today but still lacks deeper studies.

PALF and PAPF is come from the leaves and stem of the pineapple plant, Ananas comosus, from Bromeliaceae family. Pineapple is one of the tropical fruit in Malaysia and it has been use in many food industries. But it just focused for the fruits only, pineapple leaves and peduncles were just composted or burned by farmers and thus good potential fibers are wasted. From the most recent studies, pineapple leaf fiber has been choose as a reinforcement instead of other fiber. This presented paper looks for the opportunity to introduce pineapple peduncle fiber as a reinforcement in natural fiber composites.

The objectives of this paper is to compare the mechanical properties between pineapple leaf fiber and pineapple peduncle fiber reinforced polypropylene composites by investigate the test of hardness and tensile of the fibers.

Pineapple leaf fiber

In recent years, pineapple is always used as a food and used for treatment. Mostly people will throw away the leaf and does not used also. Some researcher have find the benefits in the pineapple leaf, it is call natural fiber that have some characteristic that can used for the human and benefits for other people. Yarn is one of the fiber that have similar characteristic with the pineapple leaf fiber. Yarn also used as a cotton and mostly people have make t-shirt from the yarn that they have made.

Pineapple leaf fiber (PALF), which was rich in cellulose, relatively inexpensive and abundantly available has the potential for polymer-reinforced composite. As can see that, the yarn production has already done in Filipina but it still cannot achieve the level like a cotton.

The methodology for this experiment is do the surface treatment on the fiber. The treatment which is Alkali treatment. So have to choose the Alkali treatment which content Sodium Hydroxide in this experiment.

For the expected result that have achieve is to get yarn production that almost similar characteristic or properties in cotton and also improve the properties in pineapple leaf fiber. It can also replace cotton that used

and find some similar characteristic with the pineapple leaf fiber that have used. PALF and PAPF is come from the leaves and stem of the pineapple plant, Ananas comosus, from Bromeliaceae family. Pineapple is one of the tropical fruit in Malaysia and it has been use in many food industries. But it just focused for the fruits only, pineapple leaves and peduncles were just composted or burned by farmers and thus good potential fibers are wasted. From the most recent studies, pineapple leaf fiber has been choose as a reinforcement instead of other fiber. This presented paper looks for the opportunity to introduce pineapple peduncle fiber as a reinforcement in natural fiber composites

Production process

There are important to know the method of production process and the quantity material involve because to make sure sample in good condition. It is important to know the process preparation for the sample. This is because the process involve will take time to complete it and the quality of sample depends in through preparation. All these specimen produced will undergo the test have been set. The test must be done carefully according the procedure that have given.

The specimen also was prepared according to the standard needed. There are also several type for the pineapple. They are Josephine, Sleeping Beauty, Betik, Sharlotte Sg, Moris Mexico, Tong San, Hanna, Moris Ceylon and Gandul. In this research, Moris Ceylon was selected because its easy to get in this area and also have bigger size between the other type of the fiber that have selected.

Sodium hydroxide (NaOH) was also known as the caustic soda. Its look like solid and highly caustic metallic base and alkali salt which can available in pellets, granules, flakes. The concentration also prepared at different number of solution. Sodium hydroxide also saturated solution with water. Sodium hydroxide also soluble in water, ethanol and methanol.

This alkali was deliquescent and can absorb carbon dioxide and moisture in air.

Each engineering material have certain characteristic and mechanical properties that differentiate it from other materials. Characteristic and mechanical properties of materials is what will differentiate one material with another material. Strength and ability of a product generated depending on the characteristic and mechanical properties found in these materials. Typically, the mechanical test results will be used for the purpose of design engineering materials and in quality control. The mechanical test results will determine the materials tested can be used in the production of the product or not.

A test method is a method for the test in science or engineering, such as physical test, mechanical test, or statistical test. A test also can be considered a technical operation or procedure that consists the determination of one or more characteristic of the product according to the specified procedure.

The test can be the qualitative or quantitative. It also can be the personal observation or the output for the precision in measuring instrument. Usually the test result is dependent variable, the measured also based on particular conditions for the test or the level independent variable. In this testing methods, we will used tensile test, video analyzer and twist per inch (TPI) test. It also used the standard that we have decided in every each test

FIBER COMPOSITE

Introduction of fiber composite

In general, a composite is a material mixture created by a synthetic/natural assembly of two or more physically and chemically distinct components. The first component is a selected filler or reinforcing agent (discontinuous phase) while the other component is a compatible matrix binder (continuous phase). These two components are combined in order to achieve specific characteristics and properties. Different types of natural fibers, matrix and processing techniques are used for composite fabrication.

Classification of fibers

Fibers can be classified into two main group which are man-made and natural fibers. In general natural fibers can be subdivided based on their origin such as animals, plants, or minerals; while man-made fibers can be subdivided based on natural and synthetic polymers.

The first fibers used is natural fibers like cotton, wool, silk, flax, hemp and sisal. Both natural and man-made fibers is often used as a filler to make a good properties of the composite.

Resin system

The resins that are used in fibers reinforced composites are referred to as matrix or polymers. Synthetic resins or simply resin were one of the man-made polymers. Polymers can be classified to two types which are thermosetting and thermoplastic according to the repercussion of heat on their properties. Even though there are many different types of resin use in the composite industry, three main types thermosetting polymers that is polyester, vinyl ester and epoxy were the majority of structural parts are made.

Besides, some of common thermoplastic polymers found are polypropylene, polyethylene, polystyrene, polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE, commonly known as Teflon), polyamide (commonly known as nylon) and acrylonitrile butadiene styrene (ABS plastic)

Testing process

The step used to prepare the samples until mechanical testing process are tensile and hardness test. Components and material used:

i. Polyester
ii. Pineapple leaf
iii. Pineapple peduncle

iv. Grinder
v. Roller-mill
vi. Injection molding machine
vii. Universal Testing Machine (UTM)
viii. Shore Durometer Type-D

Preparation of pineapple leaf and peduncle fiber

Pineapple leaf and peduncle showed in Figure-1, were obtained from Parit Raja Darat, Johore. The pineapple leaf and peduncle fibers were extracted by pineapple leaf extract machine and sugarcane crusher respectively. The pineapple leaf and peduncle were washed by using pipe water to remove the dirt and were dried for two days. After that, the long fiber produced was grinded to change into short fiber form.

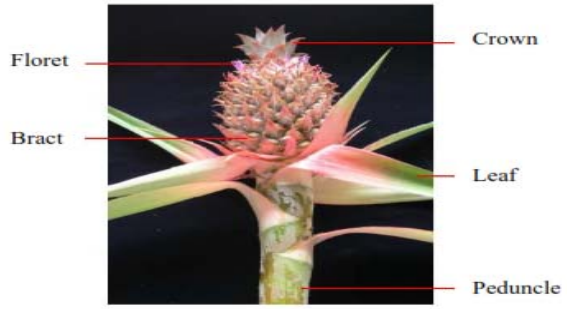

Figure-1. Pineapple plant structure.

Preparation of composites

All composite panels were prepared with various fiber volume fractions of 2, 4, and 6%. Polypropylene used as matrix. The mixture was mixed in roller-mill and then was grinded again into chip form. Finally, the chip form was inserted into the injection molding machine to produce the samples with specified dimension.

Mechanical testing

The tensile test was performed at the Polymer and Ceramic Laboratory in Universiti Tun Hussein Onn Malaysia (UTHM). Tensile test of the specimens was carried out at room temperature using universal testing machine type Autograph model. After that, using the same specimen the hardness test was carried out using shore durometer type-D. Three specimens were tested for each various fiber volume fraction, and the average value was obtained manually.

Tensile strength

Figure-2 shows a comparison of tensile strength between pineapple leaf and pineapple peduncle reinforced polyester composites. Both fiber showed the decreased trend in tensile strength when reached higher volume fraction. For overall result, fiber volume fraction at 2% gave the highest value of tensile strength. Pineapple peduncle showed a higher tensile strength when compared to the pineapple leaf reinforced polypropylene composite. The highest value of the tensile strength value is 23.59 MPa which are from the pineapple peduncle while for the pineapple leaf fiber the highest is 21.38 MPa.

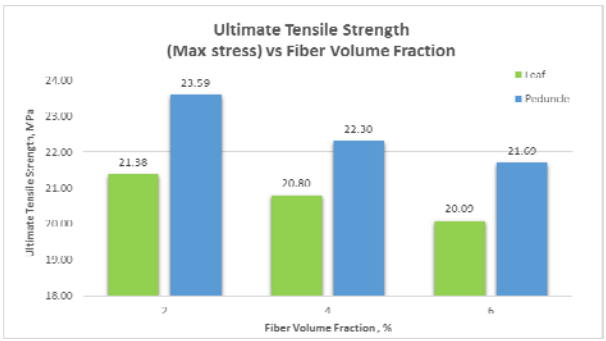

Figure-2. Comparison of tensile strength between pineapple leaf and pineapple peduncle reinforced polypropylene composites.

Hardness

Figure-3 shows a comparison of hardness between pineapple leaf and pineapple peduncle reinforced polypropylene composites. Both fiber showed the increased trend in hardness when reached higher volume fraction. For overall result, fiber volume fraction at 6% gave the highest value of hardness. Pineapple leaf showed a higher hardness value when compared to the pineapple peduncle reinforced polypropylene composite. The highest value of the hardness is 71.3 S_D which are from the pineapple leaf while for the pineapple peduncle fiber the highest is 70.3 S_D.

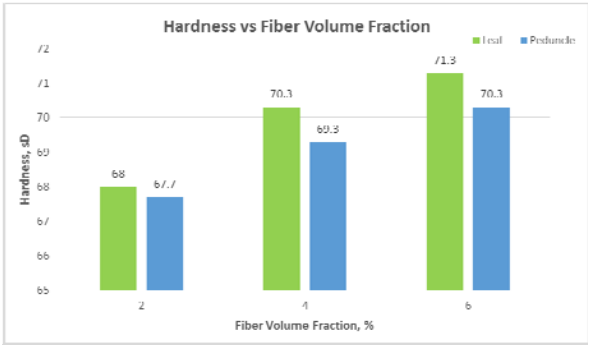

Figure-3. Comparison of hardness between pineapple leaf and pineapple peduncle reinforced polypropylene composites.

Single and twisted fiber treatment

Two type of non-treatment for the PALF which is single fiber and twisted fiber. Type for the treatment fiber contain single and twisted fiber and have different treatment of Sodium Hydroxide which is 15 minutes, 30 minutes, and 45minutes. There 3 type of test which is tensile test, Video Analyzer, and Twist per Inch (TPI).

Figure-4 indicates the typical load(N)-time(s) diagram of the pineapple leaf fiber for the non-treatment single fiber. The speed at crosshead was at the 50mm/min.

The maximum load for the Figure-4 is 0.9 N and the stress at maximum load is 285.46 MPa. The percentage for strain at maximum load is 1.59. The diameter for the single fiber at the figure is 63.370 µm.

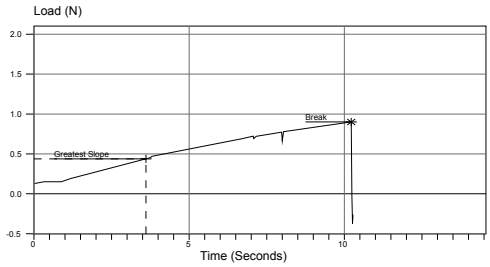

Figure-4 Fiber for non-treatment (Single Fiber) with diameter 63.37 µm

Figure-5 shows the fiber for non-treatment for the twist fiber at the diameter 340.60 µm for the pineapple leaf fiber (PALF). The stress for the maximum load is 86.303 MPa and the percentage strain at maximum load is 4.8889. The maximum load at break is at the 7.8633 N after the 15 sec.

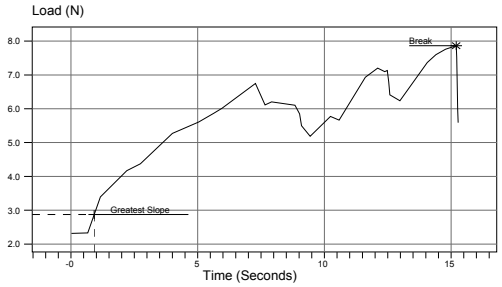

Figure-5. Fiber for non-treatment (Twist Fiber) with diameter 340.6 µm.

Figure-6 indicates the typical load(N)-time(s) diagram of the pineapple leaf fiber for the treatment single fiber. The speed at crosshead was at the 50mm/min. The maximum load for the figure 4 is 8.1088 N and the stress at maximum load is 137.22 MPa. The percentage for strain at maximum load is 2.4089. The diameter for the single fiber at the figure is 274.30 µm.

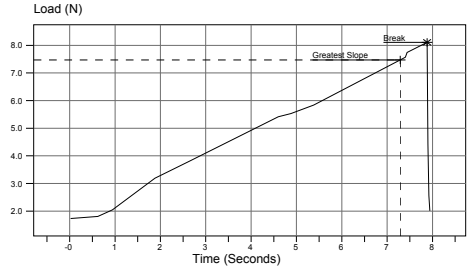

Figure-6 Fiber for treatment 15 minutes (Twist Fiber) with diameter 274.3 µm.

Figure-7 shows the fiber for non-treatment for the twist fiber at the diameter 305.70 µm for the pineapple leaf fiber (PALF). The stress for the maximum load is 88.881 MPa and the percentage strain at maximum load is 3.3423. The maximum load at break is at the 6.5237 N after the 10 sec.

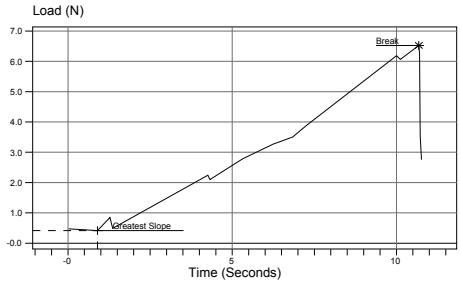

Figure-7. Fiber for treatment 30 minutes (Twist Fiber) with diameter 305.7 µm.

Figure-8 indicates the typical load(N)-time(s) diagram of the pineapple leaf fiber for the treatment single fiber. The speed at crosshead was at the 50mm/min. The maximum load for the figure is 8.5754 N and the stress at maximum load is 84.671 MPa. The percentage for strain at maximum load is 2.3723. The diameter for the single fiber at the figure is 259.10 µm.

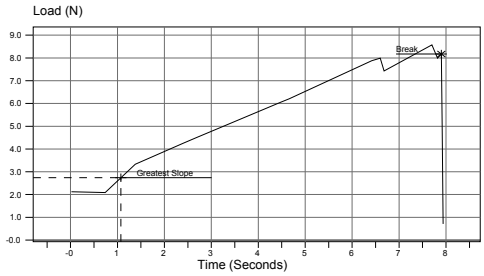

Figure-8. Fiber for treatment 45 minutes (Twist Fiber) with diameter 359.1 µm.

CONCLUSIONS

In this paper, the tensile strength and hardness of pineapple leaf fiber and pineapple peduncle fiber reinforced polypropylene composites was measured. Based on the results, it was found that the tensile strength showed decreased when increasing the fiber volume fractions.

The optimum of fiber volume fractions in polypropylene to obtain the highest tensile strength was found at 2% fiber volume fractions. Pineapple peduncle fiber reinforced polyester composites showed a higher tensile strength compared to pineapple leaf fiber reinforced composites. In the analysis of hardness, it was found that the hardness showed increased when increasing the fiber volume fractions.

The optimum of fiber volume fractions in polypropylene to obtain the highest hardness was found at

6% fiber volume fractions. Pineapple leaf fiber reinforced polyester composites showed a higher hardness compared to pineapple peduncle fiber reinforced composites. The results confirmed that more studies on mechanical test such as impact, bending and flexural test are needed to determine the beneficial and cost effective applications of the pineapple fiber in composites.

The result for this yarn shows that the treatment for the fiber with a good properties can be successfully developed using treated PALF as reinforcing agent for the Sodium Hydroxide (NaOH). Several conclusions were drawn regarding from the mechanical properties of the fiber to the effect of fiber loading namely tensile. Another test that already doing was video analyzer which is to determine the diameter of fiber for single and twisted. Another test which is Twist per Inch (TPI) by using the magnifier.

For the experiment that have made, we can see that treatment fiber have effect the tensile test for the experiment. Treatment also used sodium hydroxide which has the 15, 30, and 45 minutes of each fiber. Each of the treatment have different value for the tensile test, the highest tensile test for the fiber is 331.53 MPa and the lowest tensile strength is 84.67 MPa. Natural fiber also very sensitive because easy to broken than the synthetic fiber. In this new era, mostly used natural fiber than the synthetic fiber because of the cost and usage in everyday. The fiber also have similar in the tensile strength of the cotton yarn.

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