The Effect of Additional Zinc Oxide (ZnO) in Polymeric Foam Composites on Impact Strength

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***Abstract*—Zinc Oxide (ZnO) is a relatively soft material with an approximate hardness of 4.5 on the Mohs scale. Its elastic constant is smaller than that of the relevant semiconductor. The purpose of conducting this research was to determine the effect of zinc Oxide on the impact strength of polymeric foam composite materials, to determine the best composition of composite materials reinforced by Oil Palm Empty Bunches (EFB) and Zinc Oxide (ZnO) as reinforcing composite materials. Zinc Oxide Treatment (ZnO) 5%, 10%, 15%, and 20% with different sizes of each fiber of Oil Palm Empty Bunches (EFB) which are different, namely mesh 40, 60, 80, 100. The method used hand lay up which the direct pouring method. This method is done by attaching or touching the constituent materials in an open mold, slowly leveling it using a grading wheel or applying external pressure. The best composition of this research is mesh 100 with Zinc Oxide (ZnO) 15% with an Impact value of 2.65116 Joules.**

Keywords—polymeric foam composite, Oil Palm Empty Fruit Bunch (EFB), Zinc Oxide (ZnO), impact strength

I. INTRODUCTION

Developments in the field of materials engineering have led researchers to produce lighter and stronger materials known as composite materials [1]. Composite materials produce materials that have high strength so that they can be used to replace existing materials such as metal samples, due to limited non-renewable natural resources [2]. Besides that, the manufacture of this material is very economical and affordable [3].

Composite is a new type of material engineered, which consists of two or more materials that remain separate and different at a macroscopic level while forming a single component, resulting in a composite material that has different mechanical properties and characteristics from the material it forms [4]. Composites are heterogeneous on a macroscopic scale [5]. Each of these composite constituent materials has different properties and when combined in a certain composition, new properties are formed that are adjusted to the wishes [6].

The advantages of composites can be seen from the characteristics of the constituent materials and the characteristics of the composites themselves, including (a). Light, strong and stiff material, (b). The structure can change according to changes in the surrounding conditions, (c). Superior in required engineering material properties; high strength, hard, tough/supple, lightweight, and resistant to scratches and blows (impact) [7,8].

One of the advantages of composite materials is the ability of the material to adjust its strength according to usage needs. This is called the tailoring property and it is one of the special properties of composites compared to other conventional materials [9]. In addition, composites are resistant to high corrosion and also have high resistance to loads. Therefore, strong, stiff, and brittle materials are used for fiber materials, while for matrix materials, materials that are tough and soft are selected [10].

The matrix serves as a support, phase binder/amplifier. The fiber reinforcement is the reinforcing element to the matrix. Whereas a Composite is a combination or mixture of two or more separate materials to produce new materials with stronger properties than the matrix and reinforcing materials [4,8]. Fiber Oil Palm Empty Fruit Bunch (EFB) is a natural fiber made from oil palm empty fruit bunches which is a waste in the processing at a palm oil mill. In this study, the fiber of the Oil Palm Empty Bunches. In this study Fiber, Oil Palm Empty Fruit Bunch (EFB) is used as a reinforcing element that is produced [11].

Oil palm empty fruit bunches (EFB) are a material that is hard and strong and almost has morphological similarities with coconut coir [12]. SEM image (scanning electron microscopic) of fiber Oil Palm Empty Fruit Bunch (EFB) taken to indicate the presence of a void at the center surrounded by a porous tubular structure [13].

The impact test is a test that is carried out to test the toughness of a specimen when it is given a sudden load through an impact [14]. Toughness is a measure of the energy required to break or break a material which is measured from the area under the stress-strain curve. A material may have high tensile strength but it does not meet the requirements for shock loading conditions [15,16]. An alloy has a fracture toughness parameter which is defined as a combination of critical stress and cracks length [17].

The basis of this test is the absorption of potential energy from a load pendulum that swings from a certain height and hits a deformed object [18]. Charpy impact testing standard based on ASTM D-5942. A tough material if it can absorb large shock loads without cracking or deforming easily. In impact testing, the energy absorbed by the test object is usually expressed in Joules and read directly on the calibrated scale (dial) on the testing machine. If a pendulum with weight G and at position h_1 is released, it will swing to the final position at a height of h_2 which is also almost the same as its original height (h_1), where the pendulum swings freely. On a good testing machine, the scale will show more than 0.05 kilograms of effort (kg.m). When the pendulum is released from a high-level position, the pendulum will swing to hit the test rod, and then energy will absorb into a test rod [19].

The principle of this impact testing is to calculate the energy applied to the load and calculate the energy absorbed by the specimen. When the load is raised at a certain height, the load has potential energy, then when hitting the specimen, the kinetic energy reaches the maximum [20] .The energy absorbed by the specimen will cause the specimen to fail. The form of failure depends on the type of material, whether brittle fracture or fracture. By varying temperature changes, the fracture shape and energy absorbed by the specimen can be seen [21]. In the study conducted fiber Cyclone EFB has been shown to increase the value of the tensile test strength polymeric foam composite material. Polymeric foam composites use Oil Palm Empty Bunches fiber which has the best tensile strength of specimen B with a composition (70% Polymer, 15% Polyurethane, and 15% fiber) with a tensile load of 874,267 N, the stress of 9,014 MPa, and a strain of 0.025 mm/mm [22].

The addition of zinc oxide (ZnO) to a composite is one way to determine the effect of zinc oxide (ZnO) on the impact value of a composite. Zinc is a metal that is bluish-white, lustrous, and is diamagnetic. However, most commercial grade zinc is not glossy. Zinc is slightly less dense than iron and has a hexagonal crystal structure. Zinc reacts readily with non-oxidizing acids, releasing H_2 and producing divalent ions. Zinc is easy to react when heated in O_2 to produce the oxide, zinc can also dissolve in strong bases because of its ability to form zinc ions which are usually written as ZnO_2. Zinc oxide is an inorganic compound with the ZnO formula [23].

II. Methodology

A. Material Treatment

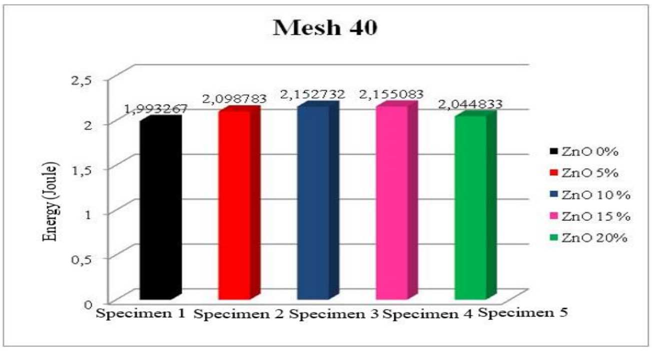
In this study, in the process of printing composites as test objects, the authors carried out two types of composite printing, the first was the process of printing the palm empty fruit bunch fiber composite, and the second was the process of printing the composite with palm empty fruit bunches (EFB) and Zinc oxide (ZnO). The step of treatment material is preparing of EFB, soaking EFB waste in NaOH, cleaning of EFB, need to dry in the sunrise, reducing EFB into small size (5 to 10 cm), refining fibers size and meshing fibers are made in 40, 60, 80, 100 of mesh size.

B. Specimen Testing

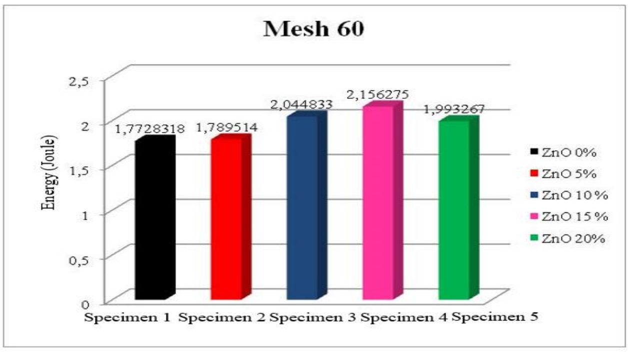
The form of test specimens used in this study has used specimen impact test specimen prepared following ASTM D5942-96 test standard and conducted using charpy impact testing machine.

III. Results and Discussions

Figure 1(a), we can see the impact test shows that each specimen with mesh 40 absorbs Energy (E) of more than 159.4613 Joules from the pendulum Charpy Work (W) on the pendulum to break the specimen worth 0.012757 kg.m. The curve shows that the specimen 4 have the highest impact strength (IS) 0f 2.155083 Joules/mm2 with 15 % ZnO more than another specimens.



(a)

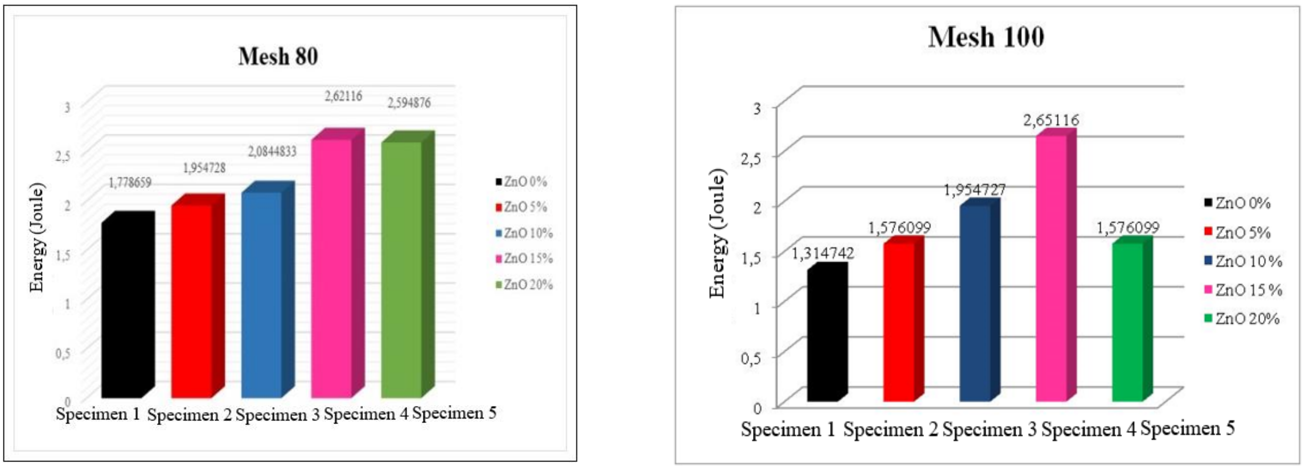


(b)

Fig. 1. Comparison of impact value with EFB meshing size 40 and 60.

Figure 1(b) shows the impact test of each specimen with EFB mesh 60 absorbs Energy (E) more than 138.2654 Joules from the pendulum Charpy Work (w) on the pendulum to break the specimen worth 0.011061 kg.m. The curve shows the comparision of impact value have the highest impact strength (IS) of 2.156275 Joules is specimen 4 with 15% ZnO.

Figure 2(a) shows that the impact test of each specimen with 80 mesh of EFB absorbs Energy (E) more than 142.2928 Joules from the pendulum Charpy Work (w) on the pendulum to break the specimen worth 0.011383 kg.m. The diagram shows that specimen 4 with EFB 80 mesh size and 15% ZnO also shows the highest impact value of the five compositions of the test specimen is specimen 4 with a value of 2.62116 Joules.



(a) (b)

Fig. 2. Comparison of impact value with EFB meshing size 80 and 100.

Diagram at figure 2(b) shows that the impact test of each specimen with EFB meshing of 100 and 15% ZnO absorbs Energy (E) of more than 105.1793 Joules from the pendulum Charpy Work (w) on the pendulum to break the specimen worth 0.008414 kg.m. The diagram shows that specimen 4 with EFB 100 meshing size and 15% ZnO also shows the highest impact value of the five compositions of the test specimen is specimen 4 with a value of 2.65116 Joules.

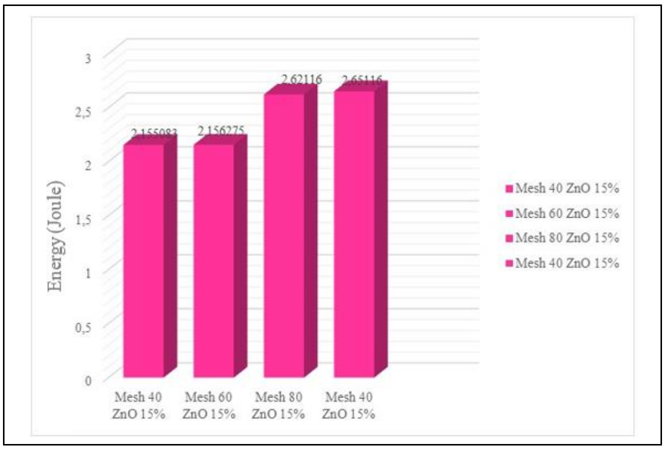


Fig. 3. Comparison of impact values based on EFB fiber size.

Figure 3 shows the comparison of the value of the impact strength of each specimen based on the size of the EFB fiber, showing that the highest value of impact strength is a specimen with a composition of 15% ZnO with an EFB fiber mesh size of 100 with an impact strength value of 2.65116 Joules.

IV. Conclusions

The impact strength of the composite material reinforced with EFB and ZnO as a reinforcing composite material increased significantly compared to composites without ZnO. Specimens with a composition of 15% ZnO with EFB fiber size 100 mesh were the specimens with the highest impact value compared to EFB fiber mesh sizes 40, 60 and 80, with an impact value of 2.65116 Joules. The addition of ZnO above 15% decreased the impact value of the composite material on each EFB fiber size.

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